CE

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A Systematic Literature Review of the Relationship Between Stretching and Athletic Injury Prevention

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Athletic-related injuries are a major cause for healthcare visits and financial burden for an otherwise healthy population of adults. The purpose of this article was to investigate the effects of stretching on injury prevention and to determine whether current stretching guidelines are beneficial for athletes. A systematic review of the literature was conducted through searching MEDLINE and CINAHL on topics related to stretching and injury prevention. Current belief is that stretching reduces injury incidence and that it should be performed prior to athletic activities. An examination of 11 articles provided inconclusive outcomes regarding the positive effect of stretching on injury prevention. A sport or activity-specific tailored stretch and warm-up program yielded the best outcomes in relation to preventing injuries. Direct negative effects of stretching were not identified; therefore, the application of stretching should be performed on an individual basis.

Introduction

Athletic-related injuries are the most treated nonfatal injuries in emergency departments. Adolescents aged 15 to 19 years represent roughly one-third (31.4%) of the population receiving care related to a sport ("Sport and Recreational Injury," 2008). In the 2012–2013 school year, high school sport-related injuries occurred at the rate of 2.16 injuries per 1,000 athletic exposures (Comstock, Collins, & Currie, 2013). Soft tissue, ligaments, tendons, muscles, and nerves are most commonly injured because of sports and recreational activities, overuse, and common everyday events. These injuries account for two million hospitalizations, 6.5 million outpatient visits, 18 million emergency department visits, 64 million physician office visits, and an annual cost of $28 billion (American Academy of Orthopaedic Surgeons, 2013). Athletic involvement presents a multitude of health benefits for individuals; however, athletic injuries can result in negative effects in the future of the individual's health continuum. Pain-free mobility and the ability to engage in fitness-enhancing activity can be limited as a result of musculoskeletal injuries developed during athletic events (Garrick & Requa, 2003). Physical fitness has a positive correlation to mortality and morbidity. The effects of athletic injury or proper recovery affect the individual's ability to participate in athletic activities that are beneficial to health (Emery, Rose, McAllister, & Meeuwisse, 2007).

Athletic-related injuries have been documented to be a leading cause of osteoarthritis and are a major source for healthcare visits and costs for an otherwise healthy population of adults. There are significant health costs that are associated with sports injuries, osteoarthritis, and other diseases linked to physical inactivity (Emery et al., 2007). Stretching before and after an athletic exposure is a routine for nearly all athletes and is a common practice that begins at young ages. Although the commonly held belief is that stretching reduces injury, athletic injuries are still a common occurrence. There are limited practice guidelines available to direct the practice of stretching. Focus on prevention and the development of more effective sport-specific protective strategies for high-risk physical injuries are essential to study (American Academy of Orthopaedic Surgeons, 2013).

Concepts and Relationships

The factors that influence an individual to perform an athletic warm-up or stretch can be broken down into the following categories: environment, psychosocial, and nursing. Within these concepts are subconcepts that impact the practice outcome (see Figure 1). For the purpose of this article, the individual is defined as someone who is participating in athletic activities. This includes but is not limited to all generations, ages, races, and gender. The individual is multidimensional, being influenced by their particular environment, psychosocial support, and nursing or healthcare encounters. As a result, no one individual's encounter with the concepts

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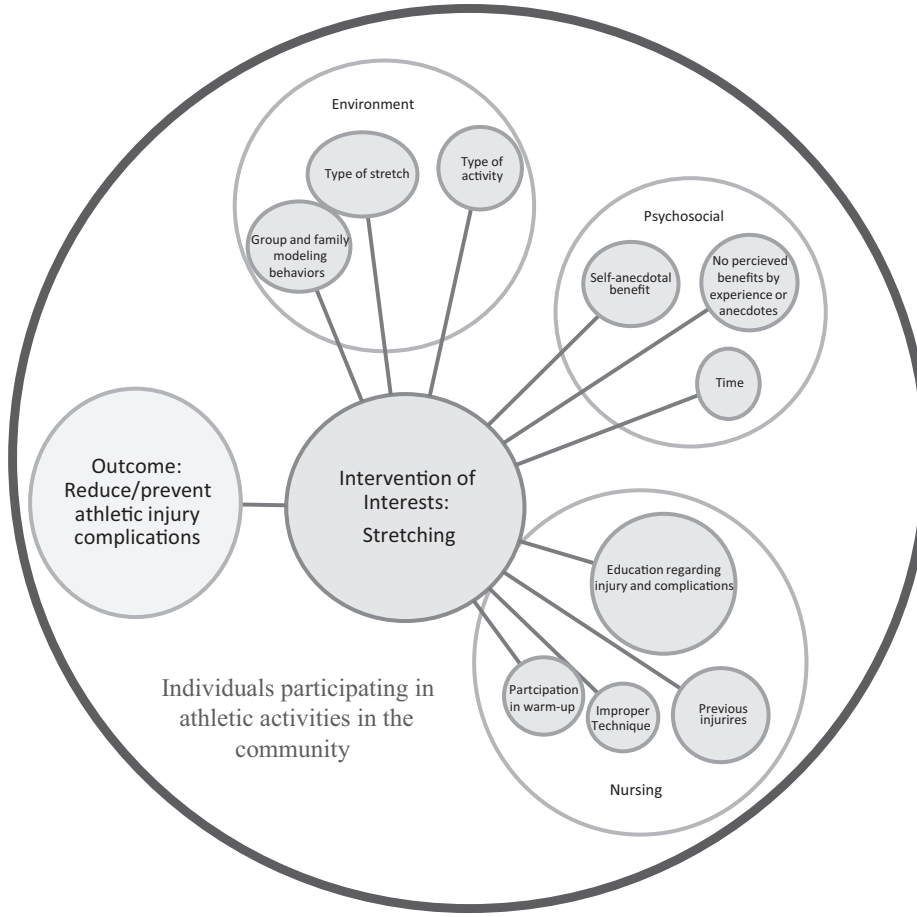

FIGURE 1. Concepts and relationships.

will be identical to another's contributing to challenging management of interventions.

Environment consists of an individual's physical surroundings in respect to their athletic activity. Athletic injuries are not limited to professional athletes, just as the environment is not limited to professional or organized facilities. An individual's environment can consist of their basement, backyard, neighborhood/city, public parks, and organized or professional arenas. Although the individual environments can vary immensely, an athletic injury encounter can be detrimental to an individual's health and well-being despite the environment in which it occurs or the role that athletic activity holds in an individual's life.

Nurse is defined in respect to an individual's health and well-being. For the purpose of this article, *nurse* will be defined as both the profession and the representative for the healthcare encounter. The role of the nurse is to provide an individual with skills and education surrounding health-promoting practices. Through health-promoting practices, the goal of injury prevention can be attained and physical and mental health can be maintained. Psychosocial factors influence an individual's response to the information and compliance regarding taught practices. Nursing plays a large role in the education and influence of an individual's beliefs and practices regarding warm-up and stretching with athletic activities, with the hope that decreasing the prevalence of athletic injuries will also reduce future complications.

The beliefs of an individual regarding warm-up and stretch practices are influenced by their psychosocial reality. Psychosocial factors encompass the individual's experience with previous sports injuries, family or group practices, and perceived benefits of the intervention.

The individual, environment, psychosocial, and nursing concepts all act independently and interdependently. With the knowledge of these concepts, propositions can be formulated to describe the relationship between an individual and athletic injury prevention. The propositions formed are: (1) individuals participating in athletic activities, stretching prior to athletic activity decreases complications of athletic injuries compared with those who do not stretch prior to athletic activities, (2) education regarding stretching techniques and proper form will increase compliance and decrease the prevalence of athletic injuries, and (3) behavior modeling of stretching within athletic groups or families will increase compliance with a result of decreasing athletic injury occurrence. A literature review will be performed to determine whether stretching has a positive correlation with athletic injury prevention. This investigation will determine whether current stretching guidelines and practice are beneficial to individuals participating in athletic activities.

Pender's Health Promotion Model

The Health Promotion Model (HPM) provides nursing with a framework to provide explanation of the complex biopsychosocial process that influences an individual's behavior in regard to health enrichment (George, 2011). The intervention of stretching in respect to the belief of injury prevention relates to Pender's HPM. Whether an individual performs the practice of stretching is dependent on many overlapping factors. When implementing the intervention of stretching, it is important to assess the individual's readiness to accept the intervention and their perceived barriers of compliance. Pender places these variables into categories of (1) individual characteristics and experiences (2) behavior-specific cognitions and affect, and (3) behavior outcome (George, 2011).

Individual characteristics and experiences relate to an individual's prior behaviors as the best predictive value of future behavior. In addition, other personal factors such as physical factors, self-esteem, self-motivation, perceived health status, education, and socioeconomic status affect behaviors. Behavior-specific cognitions and emotional factors are viewed as the driving motivational influences of the intervention. This category is composed of perceived benefits of the intervention, perceived barriers of the intervention, perceived ability to carry out the intervention, the activity-related emotional arousal, and interpersonal influences from family, peers, and healthcare providers. Core to whether an individual adopts an intervention is their commitment to the plan and any immediate competing demands. Through application of the intervention, the desired outcome is the establishment of a health-promoting behavior (George, 2011). The HPM can be used to direct nursing care in regard to helping an individual choose and carry out health-promoting behaviors to increase wellness.

Background

Stretching techniques vary according to the type of sport, program type, and personal preference. Various stretching techniques are associated with stretch-specific advantages and disadvantages. Ballistic stretching consists of repetitive bouncing movements at the limit of range of motion (ROM). This particular stretch not only increases ROM but also is associated with reduced muscle strength. Proprioceptive neuromuscular facilitation stretching is a reflex activation and inhibition of agonist and antagonist muscles, resulting in increased ROM and reduced jump height. Static stretching is a passive movement to the muscles maximum ROM and maintaining that position for an extended time period. Static stretching is related to not only an increased ROM but also a reduced strength of the muscle. Static stretching is the type of stretching that most individuals perform and are familiar with. The last type of stretch is dynamic stretching. The stretch consists of a slow joint movement as a result of antagonist muscle contraction throughout the ROM. The advantages and disadvantages of this type of stretch are unknown. In addition to stretching, many athletes participate in a warm-up with the intention of increasing the muscle temperature, resulting in increased tissue flexibility (Weerapong, Hume, & Kolt, 2004).

Popular opinion holds that stretching decreases the risk for injury and is beneficial to the performance of all athletes. True benefits of stretching and warm-up are unclear. It is often difficult to determine the effects of stretching alone since it is frequently combined with warm-up (Riewald, 2004).

Methods

A systematic review of the literature was performed to investigate the influence of stretching on reducing athletic injuries. The two databases used to assist in performing this search were Ovid MEDLINE and CINAHL. The searches were limited to articles in the English language. Search key words included "athletic injuries," "accident prevention and injury prevention," and "muscle stretching exercises and stretching." Included articles met the following criteria: (1) an abstract was available, (2) full-text article was offered online, (3) journal articles and research were relevant to sports injuries, and (4) articles were all in the English language. Study designs included randomized clinical trials, controlled clinical trials, and literature reviews that contained an investigation of mechanisms of various stretching techniques. From the search, nine articles were chosen for inclusion. Further examination of references in the nine articles yielded an additional two articles, which are were of historical importance for inclusion (see Figure 2).

Literature Review and Summary

This section presents the evidence identified through a search and review of literature related to the effectiveness of stretch programs to reduce the incidence of injury. Through the search and review of literature, 11 articles were identified in their relevance to the proposal that stretching prior to athletic activity decreases complications of athletic injuries compared with individuals who do not stretch prior to athletic activities. The print dates of the articles range from 1988 to 2010, being represented by sample sizes ranging from 60 to 1,892. Subjects consisted of male and female participants, animal and human subjects, professional and nonprofessional athletes, and military recruits. The studies examine the effectiveness of warm-up without applied stretch, warm-up with muscle stretching, sport-specific warm-up programs, and knowledge and education regarding sports injuries in the reduction of injury. Five of the 11 articles were randomized control trials, one practice guideline review, and five literature reviews. The articles can be grouped into the categories of: (1) The intervention reduced injury incidence, (2) the intervention did not reduce injury incidence, and (3) the intervention provided inconclusive evidence (see Table 1).

Support for Injury Reduction

Four articles were identified that supported stretching programs in the reduction of injury incidence. The interventions that were identified in reducing injury were

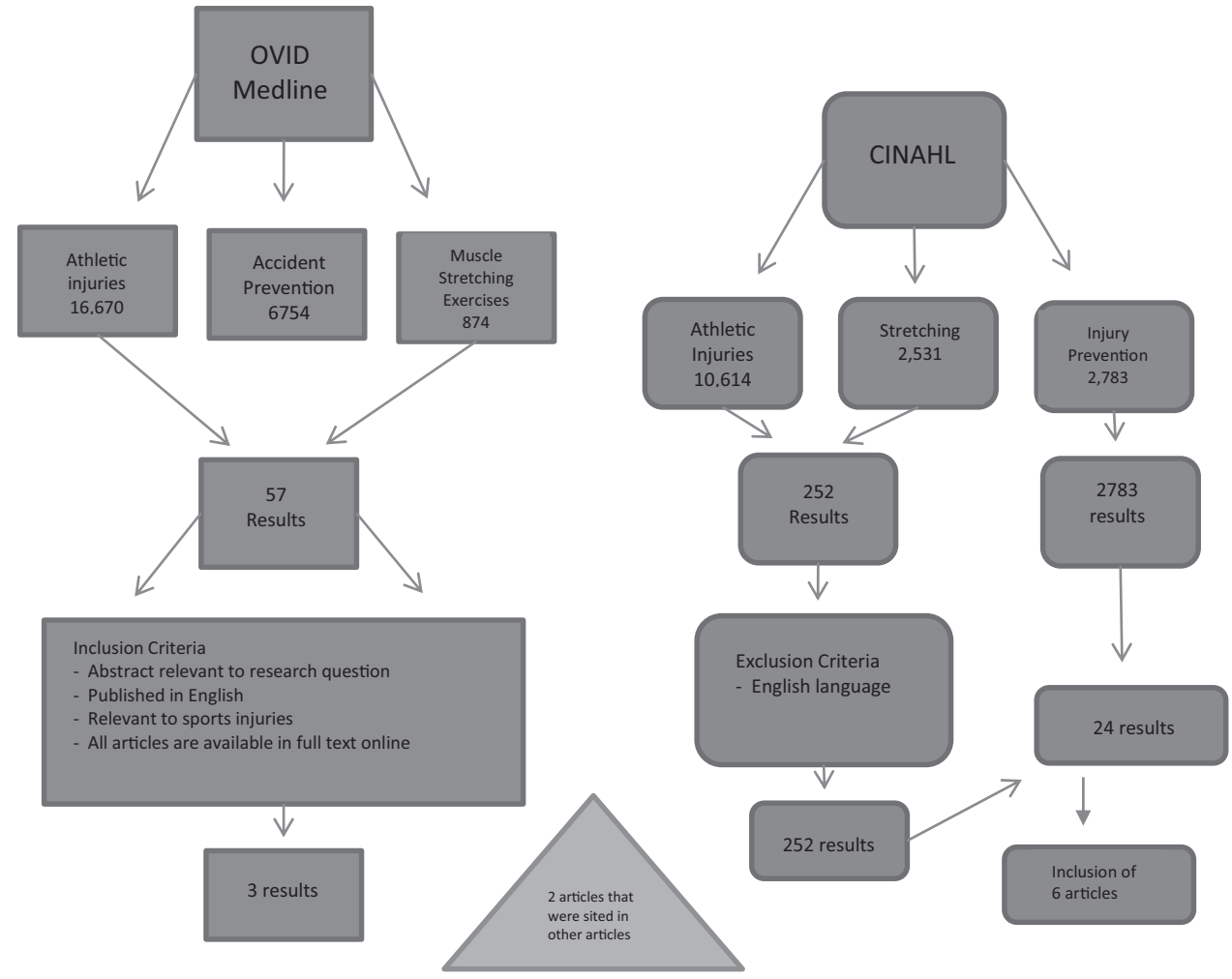

Figure 2. Research process.

warming up or preconditioning without applied stretch and sport-specific warm-up programs. All the sport-specific warm-up programs consisted of a warm-up period with applied stretch. Warm-up without applied stretch resulted in preconditioned muscles that required greater lengthening to introduce injury or tear (Safran, Garrett, Seaber, Glisson, & Ribbeck, 1988). Safran et al. (1988) presented this phenomenon through an experimental trial of motor nerve stimulation of muscles in New Zealand white rabbits. The experiment yielded a statistically significant result, finding that a greater force and length of stretch are required to tear preconditioned muscles. The effect of preconditioning was found to last approximately 30 minutes (Safran et al., 1988). The sport-specific interventions, tested in human subjects, consisted of a combination of aerobic, static stretch and dynamic stretch as well as balance and jumping exercises. The three sport-specific intervention studies, used in the sports of soccer and basketball, yielded results that structured warm-up programs significantly reduced injury incidence (Emery et al., 2007; Soligard et al., 2008). Emery et al. (2007) found a statistically significant reduction in acute-onset injuries following a sport-specific balance training program. The sport-specific training program developed by Soligard et al. (2008) found a statistically significant reduction in all injuries, including overuse and severe injuries in the intervention group.

The study performed by Safran et al. (1988) is a high-quality study in regard to the experimental design. The study was conducted on rabbits in a controlled environment allowing for uncontrollable contributing factors related to human subjects to be eliminated. Ten rabbits were used in the experiment with three muscles tested from each leg yielding a sample size of 60 (Safran et al., 1988). The warm-up intervention was performed through motor nerve stimulation to muscle threshold of isometric contraction. The effects of the motor nerve stimulation were measured through maximal force to failure, increase in length from rest, and the stress strain deformation. A constant that occurred in all injury was that preconditioning did not influence the site of tear or injury in the muscle, which was at the tendon of origin or insertion. Isometric preconditioning successfully increased muscle temperature by 1°C, which resulted in the muscle generating a force 4%–9% greater before causing a tear in muscles. This study is relevant to the act of warming up without applied stretch in human subjects, demonstrating an increased temperature of the muscle and muscle length, which results in less

Table 1. Research Matrix

Author	Article Title	Published Year	Objective	Findings	Statistical Findings	Level of Evidence	Quality of Study	Strength of Recommendation
Safran, Garrett, Seaber, Glisson, and Ribbeck	The role of warm-up in muscular injury prevention	1988	Test the effects of muscle activation without stretch on the behavior of muscle-tendon units	Greater force and increase in length are needed to tear warmed muscle	Force to failure; $p < .005$ Increase in length; $p < .05$, $p < .001$, and $p < .01$	Level 1	Level 1—Randomized control trial	A
Pope, Herbert, Kirwan, and Graham	A randomized trial of preexercise stretching for prevention of lower-limb injury	1999	Determine if preexercise stretching (performed as part of preexercise warm-up) reduces injury risk	Preexercise stretching did not produce a clinically useful reduction in injury risk	All injuries; $p = .67$	Level 1	Level 1—Randomized control trial	A
Riewald	Stretching the limits of our knowledge on…Stretching	2004	Summarize findings of literature review performed by the CDC	There is not sufficient evidence to support or discontinue stretching before or after athletic activity		Level 2	Level 2—Review of literature	B
Kovacs	The argument against static stretching before sport and physical activity	2006	Pose argument against belief that low static stretching is beneficial	Static stretching does not improve sport performance or reduce injuries		Level 2	Level 2—Review of literature	B
Emery, Rose, Mcallister, and Meeuwisse	A prevention strategy to reduce the incidence of injury in high school basketball: A cluster randomized trial	2007	Examine the role of a balance training program in reducing injury	Training program was effective in reducing acute-onset injuries	Acute onset injury; $p < .047$	Level 1	Level 1—Randomized control trial	B
Weerapong, Hume, and Kolt	Stretching: Mechanisms and benefits for sport performance and injury prevention	2004	Review of mechanisms of stretching to provide guidelines regarding the use of stretching to enhance performance and reduce injury	Limited scientific evidence to support benefits of stretching		Level 3	Level 2—Review of literature	B

(*continues*)

Table 1. Research Matrix (*Continued*)

Author	Article Title	Published Year	Objective	Findings	Statistical Findings	Level of Evidence	Quality of Study	Strength of Recommendation
McHugh and Cosgrave	To stretch or not to stretch: the role of stretching in injury prevention	2009	Review literature on the effects of stretching on injury and performance	Acute stretching will decrease ability to achieve maximum force. Stretching has no effect on injury risk.		Level 2	Level 2—Review of literature	B
Weldon and Hill	The efficacy for prevention of exercise-related injury: A systematic review of the literature	2003	Review RCT and CCT on the effects of stretching and injury reduction	No definitive conclusions. Preexercise stretching may increase injury risk. Postexercise stretch may reduce injury risk.		Level 1	Level 2—Review of literature	B
Soligard, Myklebust, Steffen, Holme, Silvers, Bizzini, Junge, Dvorak, and Andersen	Comprehensive warm-up program to prevent injuries in young female footballers: Cluster randomized controlled trial	2008	RCT to examine the effect of a warm-up program and rate of lower extremity injury	Injury risk reduce by 1/3. Significant reduction in secondary outcomes, i.e., overuse injuries	All injuries; $p < .041$ Overuse injuries; $p < .012$ Severe injuries; $p < .005$	Level 1	Level 1—Cluster randomized control trial	A
Woods, Bishop, and Jones	Warm-up and stretching in the prevention of muscular injury	2007	Examine warm-up and stretching on injury prevention	Warm-up is beneficial.		Level 2	Level 3—Usual practice, guidelines	B
Jamtvedt, Herbert, Flootorp, et al	A pragmatic randomized trial of stretching before and after physical activity to prevent injury and soreness	2010	RCT in community of physically active individuals to determine if stretching before or after activity reduces injury or soreness	Stretching does not reduce injury. Stretching reduces risk of bothersome soreness.	All injuries; $p = .69$ Muscle, ligament, tendon injuries; $p = .03$ Interaction of belief and effect; $p = .034$	Level 1	Level 1—Randomized controlled trial	B

Note. CCT = controlled clinical trial; CDC = Centers for Disease Control and Prevention; RCT = randomized controlled trial.

tension on the muscle at the site of origin, yielding a reduction in the incidence of tear (Safran et al., 1988). A limitation to this study is that only muscles of twitch (type II) fiber origin were tested, which may contribute to skewed results, even though this type of muscle fiber is the type most commonly injured in humans.

Sport-specific stretching protocols were designed and tested with randomized controlled trials in female soccer players and co-ed high school basketball players. Emery et al. (2007) and Soligard et al. (2008) designed sport-specific training protocols to reflect the most common injuries experienced by the athletes. Emery et al. (2007) designed a 5-minute balance training program that was performed by the training group in addition to a 10-minute warm-up that included aerobic, static stretch, and dynamic stretch, which were performed by the control and training groups. Results of the study may be limited because of the poor participation of 73% in the training group and 60% in the control group (Emery et al., 2007). Soligard et al. (2008) implemented a training program consisting of running exercises at a slow speed combined with active stretching consisting of balance and jumping exercises. The initial goal of the program was to increase awareness and neuromuscular control during the activities with the final outcome of injury reduction. Results of the study may be askew, as many of the reasons teams did not participate were a result of the increased time needed to perform the training program. Consequentially, the remaining participants were felt to have been more dedicated to achieve the desired outcome of injury prevention (Soligard et al., 2008).

A meta-analysis by Woods, Bishop, and Jones (2007) supported the significant effect of stretching and warm-up programs without applied stretch in the reduction of muscular injury. A critical time period for stretching and warm-up activity was identified. Stretching and warm-up should be performed 15 minutes prior to activity for optimal benefits. In addition, warm-up protocols, with an increase in muscle temperature, were found to have statistically significant findings whereas stretching protocols had varied results. It was found that stretching protocols should be activity specific (Woods et al., 2007).

Support Against Injury Reduction

Two articles were identified that did not support the effects of stretching programs in injury reduction. These experimental studies did not show significant results between the intervention and control groups in the incidence of injury. The randomized controlled trial performed on male army recruits by Pope, Herbert, Kirwan, and Graham (2000) showed that preexercise stretch did not significantly reduce injuries between the control and stretch groups despite good statistical power. Injury prevalence was greater in the control group, but additional uncontrollable factors, such as discharge or transfer of participants, were identified for contributing to the difference in incidence between the groups (Pope et al., 2000). A meta-analysis performed by McHugh and Cosgrave (2009) evaluated the effects of stretching on sports injury and performance. The review found evidence to support that stretching may decrease the strength of muscles, which could subsequently increase injury risk. In addition, overuse injuries were found to be unaffected by stretching or warm-up. Future research is needed to identify the significance of stretching on muscle strains in particular because evidence is lacking (McHugh & Cosgrave, 2010).

Pope et al. (2000) conducted a randomized controlled trial on 1,538 army recruits to determine the effect of muscle stretching during warm-up in reducing the risk of injury. In the study, every recruit participated in an active warm-up exercise before their physical training sessions. Recruits in the stretch group performed a 20-second static stretch, under supervision, to six leg muscle groups in addition to the warm-up exercise. Effects of the intervention were measured through incidence of injury and survival analysis. An injury incidence of 4.2% in the stretch group and 4.6% in the control group was found. The hazard ratio, injury rate in the stretch group divided by the injury rate in the control group, was 0.95, indicating that no significant difference is present between the rates of injury. The authors identified multiple factors that may influence the incidence of injury independent from a stretching program. These nonmodifiable factors consisted of fitness, age, and enlistment date, with fitness being the strongest predictor. Height, weight, and BMI were identified as having no role in predicting injury risk. The authors concluded that a muscle stretching program prior to activity did not significantly reduce the incidence of injury (Pope et al., 2000). The randomized control trial design of the study is strong, but the population sampled may not be representative of the general population. Also, there was a high rate of withdrawal or transfer of recruits during the study. The designed stretching program consisted of 20 seconds per stretch with no evidence or rational supporting the efficacy of this time length. These factors may have influenced the results of the study.

McHugh and Cosgrave (2010) performed a meta-analysis of the literature to determine the effects of stretching on injury risk, with the focus on muscle strains, and performance. Injury risk was identified as being multifactorial and sport-specific, which contributes to the difficulty of designing a randomized controlled trial. Stretching, with the implication of increasing functional ROM (flexibility), was shown to have a decreased ability to generate maximal force and produced no effect on overuse injury risk. Insufficient evidence existed related to muscle strains in respect to stretching. A lack of ability to isolate the stretch intervention in the reviewed studies was identified. As a result of this limitation, it is hard to determine whether stretching alone would influence injury risk (McHugh & Cosgrave, 2010).

Inconclusive Evidence

Five articles were identified as having inconclusive evidence regarding the effects of stretching and injury risk. Inconclusive results were found with respect to insufficient evidence to support or refute effects of stretching or mixed results of the effect of stretching.

The literature review performed by Weerapong et al. (2004) examined the benefit of dynamic stretching and the risk of injury from exercise. An examination of the mechanisms of stretching was performed with respect to providing guidelines for stretching to improve performance and reduce injury risk. There was limited scientific evidence to support the benefits of stretching in the risk of injury. Stretching was identified as a mechanism to increase flexibility, which was a factor seen to influence risk for injury. Flexibility required for specific sports or activities needs to be established to determine the associated benefits (Weerapong et al., 2004). Riewald (2004) performed a literature review and found that optimal levels of flexibility produced by stretching is sport-specific. In addition, it was concluded that stretching can have negative effects on muscles strength. This examination of the literature also found that a warm-up regimen has positive effects on performance and flexibility. A limitation identified was that most studies examined the effects of a combination of warm-up and stretching (Riewald, 2004). The literature review performed by Kovacs (2006) yielded results consistent with the reviews of Weerapong et al. (2004) and Riewald (2004). Furthermore, Kovacs (2004) suggested that a critical period to stretch would be after the exercise with the expectation of conditioning muscles and long-standing improvement of ROM and flexibility (Kovacs, 2004). A systemic review executed by Weldon and Hill (2003) also suggests that postexercise stretching may increase muscle-absorbing capabilities, which would influence injury risk reduction. Moreover, no definitive conclusions could be drawn because of the ambiguity of the review findings (Weldon & Hill, 2003).

Jamtvedt et al. (2010) performed a randomized controlled trial in a community population to determine the effects of stretching in relation to injury and soreness. The trial was worldwide, Internet-based, and with participants 18 years and older. Participants had a mean age of 40 years and the trial was conducted over a 12-week period. Running was identified as the most common type of regular physical activity. The stretch group intervention included the bilateral stretch of seven muscle groups, performed before and after vigorous physical activity. Stretching was not found to yield a statistically significant reduction of overall injury risk. However, a statistically significant reduction was found for risk of muscle, ligament, and tendon injuries. A small, not statistically significant, reduction of bothersome soreness was also found. In addition, a statistically significant relationship between a participant's belief of effectiveness of stretching and the effects of stretching on bothersome soreness was found. Limitations of the study were the compliance rate with the intervention and that the outcomes were self-reported (Jamtvedt et al., 2010).

Summary

A review of the literature was performed to support the proposal that stretching prior to athletic activity decreases complications of athletic injuries compared with individuals who do not stretch prior to athletic activities. A review of two scholarly databases, including MEDLINE and CINAHL, yielded 11 articles ranging from the years from 1988 to 2010. The literature presents contradicting information regarding whether a stretching program reduces injury risk. Sport-specific stretching programs that contained exercises specific to the muscle groups at high risk for injury appear to be the most effective way to reduce injury risk. A general warm-up of the muscle prior to activity also gives the impression of benefiting the reduction of injury risk. Non–sport-specific stretching appeared to have little or no effect on the reduction of injury incidence. Many of the stretching practices performed are a result of the preconditioned nature of the coaches regarding the beliefs of stretching benefits. The practice of stretching reveals minimal evidence to indicate negative effects.

Conclusions

With these results, it can be concluded that the practice of warming up with a sport-specific stretching program has a higher efficacy to yield beneficial results in injury reduction. Inconclusive overall evidence of injury reduction associated with stretching and minimal evidence of negative effects and their outcomes support that it is not contraindicated to perform stretching on an individual and sport-specific basis. Increased temperature of muscle, as a result of warm-up, appears to have the greatest influence on the incidence of injury. Many modifiable and nonmodifiable factors also exist that influence the incidence of injury.

Recommendations

Future Research

The need for continued research on the effects of stretching and the reduction of injury incidence is greatly needed, as current research is limited. Isolated studies focusing exclusively on the effects of stretching, without a warm-up period, would yield better results regarding the precise influence of stretching on injury risk. In addition, it would be beneficial to perform studies to isolate the effects of warm-up without applied stretch. Examination of the negative effects and outcomes of stretching need to be conducted. Also, it is difficult to design a well-controlled study due to the nonmodifiable variables presented when using human participants. In current controlled studies, it was difficult to control whether participants participated in exercise outside of the clinical trial and whether stretching was performed during those activities. Current research and data regarding practice guidelines are limited and inadequate. Further research needs to be performed to develop uniform practice guidelines.

Indications for Nursing Practice

A warm-up regimen, isolated from stretching, proves to have better efficacy and is recommended over independent stretching without warm-up. An activity-specific stretch and warm-up program should be designed to help decrease the incidence of activity-specific injuries. Generic stretching and warm-up programs were not shown to have efficacy in decreasing

injuries and would not be recommended. In an effort to decrease injury prevalence and associated complications, it is crucial for registered nurses to incorporate patient education regarding the importance of injury prevention and recommended stretch and warm-up. In addition, proper performance of the recommended practice should be provided. In every patient encounter, it is critical for the registered nurse to assess the individual's psychosocial, environmental, and healthcare factors, which influence their perceptions regarding athletic injury and practices of stretching and warm-up.

Through examination of the research, a warm-up should be performed prior to physical activity to increase muscle temperature. An active (jogging or sport-specific running exercises with dynamic stretching) or passive (i.e., sauna, heating pads) warm-up should be implemented to increase muscle temperature. The structure of the warm-up should be balanced to achieve adequate increased muscles temperature without causing fatigue. To ensure greatest muscle function, the warm-up should be performed prior to and within 30 minutes of the athletic activity. In addition to warm-up, stretching can be implemented on an individual and activity-specific basis. Whether stretching is performed prior to an athletic activity or afterward will be influenced by the type of activity. When it is appropriate to perform stretching prior to the activity, a combination of stretch with warm-up should involve the major muscle groups used for that activity. Applied static stretches should be performed for 30 seconds to each muscle group. Stretching postactivity should be consistent following all activities and will help increase muscle flexibility and ROM, as well as combat bothersome soreness. All recommendations should be made on an individual basis. It is crucial for the nurse to incorporate injury-risk assessments into their client encounters to determine individual characteristics, experiences, and behavior-specific cognitions. Consideration of these factors will lead to impact the development and implementation of appropriate stretch and warm-up regimens to modify or influence behavior outcomes.

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