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Original Research

Pre- and Post-Activity Stretching Practices of Collegiate Soccer Coaches in the United State

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ABSTRACT

International Journal of Exercise Science 13(6): 260-272, 2020. Current pre- and post-activity stretching guidelines are designed to optimize performance and reduce injury risk. However, it is unclear whether soccer coaches adhere to these recommendations. The purpose of this study was to determine if collegiate soccer coaches' perceptions and practices align with current scientific recommendations. A total of 781 questionnaires were electronically distributed to soccer coaches from NCAA Division I and III universities. The questionnaire obtained demographic, professional, and educational information, as well as stretching practices. Statistical analysis consisted of computing frequency counts and means where applicable. Pearson's Chi-square tests were performed to assess the potential differences in stretching perceptions and practices among the cohort of soccer coaches. Results suggest that soccer coaches are choosing some forms of stretching more frequently than other coaches (χ^2 = 342.7, $p < 0.001$). Further analysis failed to determine significant associations between stretching type and coaching certification, level, sex, years of experience, and age. Of the 209 respondents, 84.9% believed pre-activity stretching to be of greater than average importance on a seven-point Likert scale. Dynamic stretching (68.7%) or a combination of static and ballistic stretching (18.0%) prior to athletic events was the most typical stretching prescribed. Current post-activity practices demonstrate that most coaches (95.4%) are using some form of a general cool-down following practice or competition. This study is an important assessment of the extent to which collegiate coaches administer appropriate stretching techniques. Most coaches adhere to current recommendations; however, they should continue to evaluate their practices against ongoing research and the practices of their peers.

KEY WORDS: Warm-up, cool-down, protocols for implementation, training theory

INTRODUCTION

Collegiate soccer athletes are expected to maintain high fitness levels during long duration training or competition sessions, in which players are exposed to both anaerobic and aerobic bouts of activity. Because of this, athletes must properly prepare for these sporting demands through pre-activity practices, which typically consists of performing general aerobic activity,

followed by warm-up and sport-specific movements (18). After practice or competition, athletes normally participate in post-activity practices such as cool-down sessions to begin recovering from sport-related exercise. At the collegiate level, the head soccer coach is often responsible for implementing both pre- and post-activity stretching practices. However, some of these coaches may be unaware of the current scientific recommendations regarding appropriate stretching techniques during these time periods (19, 20), which may lead to reduced athletic performance and increase the risk of injury.

The American College of Sports Medicine (ACSM) suggests that a gradual progression of exercise volume and intensity may reduce the risk of musculoskeletal injury and adverse cardiovascular events (19). A pre-activity warm-up is important as it physically prepares the athlete for the demands of subsequent activity (38) through various physiological mechanisms, including: increased muscle temperature, oxygen availability for the working muscles, and joint flexibility (24). To obtain the benefits of a warm-up, athletes may implement a variety of stretching practices (8), including static stretching (SS), dynamic stretching (DS), proprioceptive neuromuscular facilitation (PNF) stretching or ballistic stretching (BS). SS has been considered an essential component of a warm up and involves moving a limb through the full range of motion (ROM) and holding the stretched position for 15-60 seconds (21). SS has been shown to effectively increase flexibility and ROM (39, 50). However, recent studies provide evidence that repetitive bouts of SS prior to activity may adversely affect performance of movements requiring: strength, high speed, and explosive or reactive forces (14, 35, 53). SS has been associated with diminished soccer performance (3, 4), and injury rates in soccer athletes did not improve following the addition of SS to a warm-up protocol (54). To obtain the benefits of SS (improved joint flexibility and range of motion), this modality should be implemented after sporting activity during the cool-down period (11, 34).

The current research on warm-up methods recommends that athletes perform DS prior to activity (5, 23, 27) as opposed to SS. DS is a movement based warm up that involves actively moving a joint through its full ROM without holding the stretch for any length of time. Typically, DS includes load resistance exercises, plyometric movements, or maximum voluntary isometric contractions (13). For athletes to receive the optimal benefit of stretching practices, they should perform DS as part of a comprehensive warm-up that includes aerobic and sport specific activity (18). Research has shown that dynamic stretching prior to activity can result in increased agility, sprint performance, vertical jump performance, and maximal muscle strength (8, 25, 37). Many of the proposed benefits of an active warm up are associated with increased muscle and core body temperature (9, 47). As a result, coaches should rely on dynamic movements that elevate heart rate and increase body temperature when designing a warm-up routine as opposed to a cool-down routine. However, it is important to note that there are also a few studies that provide contradictory evidence that DS has no effect on performance or muscle strength (12, 48).

Another stretching technique that is commonly used in the athletic environment to optimize performance and enhance active and passive ROM is PNF stretching (33). PNF stretching techniques involve both stretching and contracting the muscle group being targeted. The

purpose of PNF stretching is to increase flexibility and ROM through stimulation of the neuromuscular system via "contract relax" (CR), "hold relax" (HR), and "contract-relax agonist contract" (CRAC) methods (33). Although there are deviations in the above nomenclature in the literature, the purpose of the PNF technique is to elongate the musculotendinous unit through (1) passively placing the target muscle into a position of stretch, (2) a static (isometric) contraction of the stretched target muscle and (3) passively moving the target muscle into a greater position of stretch (17, 42, 46). Finally ballistic stretching can be used in the preactivity warm ups and uses high velocity bouncing movements to force the body beyond its normal range of motion (6, 41). Although BS is a common stretching technique, there is some indication of a greater risk of injury (36) and the scientific evidence concerning the effects on performance remain unclear (15, 26, 45). However, PNF stretching techniques, along with SS and BS, are commonly used to increase ROM of a specific joint by lengthening the musculotendinous unit (16, 46). Despite the available literature on the different stretching modalities, it is important to note that the amount of controlled research trials are insufficient to fully validate the effectiveness of the general warm-up and cool down on enhanced athletic performance and reduction in injury rate (19).

The co-authors of this study have previously examined the implementation of pre-activity practices in variety of other sports by surveying coaches (volleyball, basketball, tennis, football, track and field, cross-country) and in sport medicine staff by surveying athletic trainers (ATs) (27–31). The initial study by Judge et al. (31) indicated that football coaches often employ SS, PNF, and BS techniques in the pre-activity warm-up despite current research providing evidence against this practice (5). A related survey of tennis coaches (28) found that only half of the participating coaches implemented pre-activity flexibility training in accordance with contemporary research findings. Additionally, even though most football and tennis coaches recommended post-activity stretching, they did not typically follow published guidelines (28, 31). Another group that is heavily involved in preparing athletes for practice and competition are ATs. A recent study by Popp et al. (43) found that only 32.2% of ATs recommended DS as part of a pre-activity warm-up, whereas a larger percentage (42.2%) recommended a combination of SS and DS. ATs reported that only 28.0% of athletes are performing DS prior to activity. These studies show that many coaches and athletic trainers are not following the pre-activity guidelines recommended for their respective sport.

Research on DS that involves soccer athletes has demonstrated improvements in measures of muscular activity (2), acceleration and speed (3, 11), kicking biomechanics (4), and agility time (49) when compared to SS. The "11+" warm-up was developed by sports science and sports medicine experts, and has been extensively evaluated, resourced, and promoted (7). Fédération Internationale de Football Association (FIFA) has promoted the 11+ warm-up routines since 2009 (11), and this governing body makes resources and implementation guidelines available to soccer coaches working all levels. The 11+ routine was developed as an easy to implement, exercise-based warm-up program to prevent lower limb injuries in soccer players (10) and has been recommended and adopted worldwide (44). The 11+ can replace traditional pre-training and pre-game warm-ups, and it does not require expensive equipment or specific technical expertise to implement. The program is comprised of 15 exercises and is broken down into three

core components: slow speed running and active stretching, followed by high-speed running exercises with cutting and pivoting movements, and concluding with core and leg strength exercises (1). Research on the effects of DS and injury prevention programs, such as the 11+, support the usage of this form of stretching with soccer players. Coaches, especially at lower levels, are the key driver of successful implementation of warm-up routines (10), but it is unknown if soccer coaches at any level follow the research-based guidelines for warm-up and cool-down routines. The purpose of the present study was to investigate the knowledge and practices of National Collegiate Athletic Association (NCAA) Division 1 and Division III soccer coaches to determine to what extent contemporary stretching practices align with current research. In accordance to previous research on pre-activity practices, we hypothesized that NCAA Division I and Division III soccer coaches would employ techniques in the pre-activity warm up that fail to align with contemporary research findings.

METHODS

Participants

A total of 781 questionnaires were electronically distributed to soccer coaches from NCAA Division I and III universities. Only one coach, either the head coach or one of the assistant coaches, from each program was allowed to complete the survey. Coaches were to be excluded from participating in the research study if they were not a head or assistant NCAA Division I or Division III soccer coach. Two hundred and nine coaches returned completed usable surveys, representing a 26.8% response rate. Respondents represented coaches from 73 conferences of Division I (41.7%) and Division III (58.3%) soccer programs. The authors of this manuscript have complied with all of the ethical policies set forth by the Editorial Board (40). This study was approved by the Institutional Review Board at Ball State University and carried out in conformity with the ethical standards of the Declaration of Helsinki. A power analysis performed on the results of a similar experiment (32) suggested that a sample size of 150 participants would be adequate to detect differences in responses.

Protocol

An e-mail describing the project and containing an informed consent waiver and a hyperlink to the online survey was sent to all NCAA Division I and Division III soccer coaches in the United States. An online research instrument was adapted from the survey instruments used previously in similar studies (27–31). The online survey consisted of 42 multiple-choice or open-ended questions covering coach education, flexibility training, muscular conditioning, aerobic training, anaerobic training, and general periodization information. The researchers added several questions regarding the periodization and practice design used by the respective coaching staff on a year-round basis, instead of solely addressing flexibility-based questions as in previous research projects. The survey was then reviewed by a licensed U.S. Soccer Federation coach to confirm its clarity and content. The surveys were distributed via email and the recipients were asked to complete the survey as soon as possible. An e-mail reminder was sent to all non-respondents two weeks after the initial email distribution in an attempt to increase the response rate. Data was collected during a three-week period from October–November 2017. However,

the timing of the data collection was not ideal, as it was during the middle of the main competitive season for all NCAA Division I and Division III soccer programs.

Statistical Analyses

After the data collection process was completed, the validity from the instruments findings was analyzed using principal component analysis. Like items on the survey were compared and sampled for similarity using Kaiser-Meyer-Olkin statistics, and the results indicated that the instrument had construct validity ($p > 0.60$). The data were initially gathered collectively in a series of general results, and frequency counts and means were determined when applicable. Significant items of interest included descriptive variables about the coach and pre-activity flexibility practices. Pearson's Chi-square analyses were performed to determine if coaching demographics and backgrounds impacted stretching practices. The level of significance was set at alpha < 0.05 for all analyses, and statistical analyses were performed using JMP version 13.0.

RESULTS

Coaching Background: Coaches in the present analysis represented 73 NCAA Division I and Division III soccer conferences from all eight regions of collegiate soccer in the United States. The majority of coaches were male (76.6%), older than 36 years of age (68.9%), and experienced in the range of 2-12 years (48.8%). One-hundred thirteen coaches (53.1%) indicated prior participation as players at the professional or semi-professional level, and 90 coaches (42.3%) reported collegiate soccer playing experience (Table 1).

Certification: One-hundred ninety nine (94.8%) coaches held at least one professional soccer certification (USSF, NSCAA, UEFA, or GK license). Eleven (5.2%) of the coaches did not hold a soccer certification.

Education: Two-hundred and eight (99.5%) of the coaches who responded held at least a bachelor's degree, 116 (54.7%) completed a graduate degree, and nine (4.3%) coaches reported a doctorate degree. One coach reported having only a high school education. Of the 209 respondents, only 56 (26.8%) of the coaches achieved their degrees in physical education, exercise physiology, kinesiology, sports science, or a related subject.

Current Pre-Activity Practices: The overwhelming majority of coaches (99.5%) had their athletes perform some type of general warm-up, consisting of jogging, small-sided games, ball drills, or other related activities. There was one coach who reported no implementation of a general warm-up prior to activity. Most coaches (64.7%) believed that a general warm-up was 'very important'. Almost all coaches (99.0%) reported some type of pre-activity stretching, with only two coaches not performing any stretching with their athletes. Within these responses a Chi-square test was performed to determine if the coaches were choosing some stretching types more often than would be predicted by equal chance. The results did suggest this ($\chi^2 = 342.7$, $p < 0.001$, $w = 1.28$), and in particular the choice that was selected at the highest frequency was DS, with 68.7% of coaches implementing this stretching type into their pre-activity routine (Figure 1). Thirty-five (18.0%) coaches reported a stretching routine that

consisted of SS and BS. The majority (54.3%) of respondents to this survey reported that stretching prior to practices or games was 'very important'.

Table 1. Participant characteristics.

Variable	Descriptor	Percentage
Age	24-30 y	12.9 (*n* = 27)
	31-35 y	15.8 (*n* = 33)
	36-45 y	32.5 (*n* = 68)
	46-55 y	26.3 (*n* = 55)
	>55 y	12.4 (*n* = 26)
Gender	Male	76.6 (*n* = 164)
	Female	23.4 (*n* = 50)
Education	High school	0.5 (*n* = 1)
	College	40.6 (*n* = 86)
	Graduate	54.7 (*n* = 116)
	Doctorate	4.3 (*n* = 9)
Soccer experience	Professional / Semi-professional	53.1 (*n* = 113)
	Collegiate	42.3 (*n* = 90)
	Club	3.3 (*n*=7)
	High School	0.0 (*n*=0)
	None	1.4 (*n* = 3)
Head coaching experience	0-2 y	16.3 (*n* = 34)
	3-5 y	17.2 (*n* = 36)
	6-10 y	18.2 (*n* = 38)
	11-20 y	27.8 (*n* = 58)
	>20 y	20.6 (*n* = 43)
Soccer coaching certification	Yes	94.8 (*n* = 199)
	No	5.2 (*n* = 11)

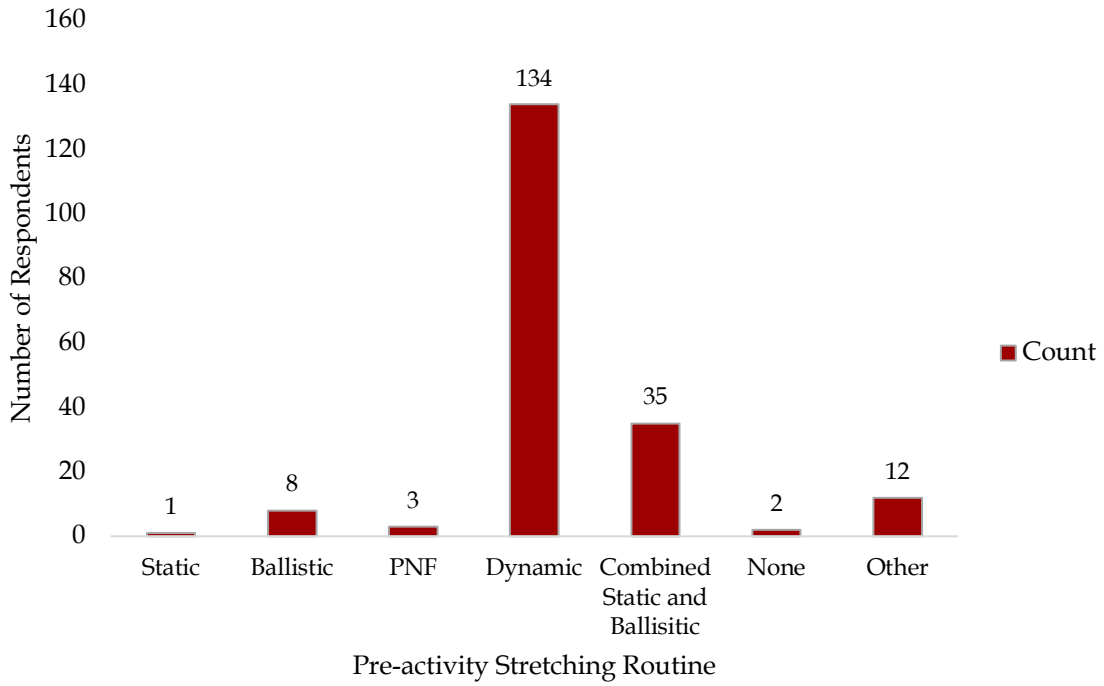

Figure 1. Count of responses by pre-activity stretching.

Current Post-Activity Practices: Most coaches in this survey (95.4%) reported using some form of a general cool-down following practice or competition, while only nine coaches (4.6%) reported not having their athletes perform any post-activity cool-down and stretching, and five coaches reported the absence of post-activity stretching. The most popular cool-down activity after an athletic event was jogging (74.0%).

Seventy-one (36.0%) coaches implemented a combination of SS and PNF stretching post-activity. A slightly smaller proportion (35.0%) of coaches stated that they have their athletes only perform SS or BS post-activity, and 22 coaches (11.2%) reported DS as their post-activity routine. Four coaches (1.9%) indicated that foam rolling, in combination with another modality, was part of post-activity practices. Only five coaches (2.5%) did not report having athletes perform post-activity stretching. The majority of coaches (51.6%) believed post-activity stretching to be 'very important'.

Coaching Experience: The results of the Chi-square analysis did not determine years of coaching experience to impact the pre-activity stretching practices implemented by coaches ($\chi^2 = 0.242$, $p = 0.993$). The majority of coaches in all range categories performed DS during the pre-activity period. Twenty-three (71.9%) of the coaches with the least experience (≤ 2 years), reported using DS pre-activity, with 21.9% using a combination of SS and BS. At the 3-5 years of coaching experience level, 67.7% performed only DS and 16.1% performed SS and BS during the pre-activity period. In the 11-20 years of experience category, 72.9% of coaches used DS and 18.8% used a combination of SS and BS. It was reported that 65.1% of coaches with the greatest amount of experience (>20 years) used DS, while 13.9% in this category used SS and BS during the warm-up period. The majority of coaches who responded to this survey (51.6%) had less than ten years of coaching experience, and 68% of those respondents used DS as their pre-activity stretching practice. In comparison, 69.2% of coaches with more than 10 years' experience reported the use of DS pre-activity.

The level of coaching (Division I vs Division III) was not determined to significantly influence pre-activity stretching routines ($\chi^2 = 0.802$, $p = 0.849$). The majority of Division I (70.1%) and Division III (68.2%) coaches reported having their athletes perform DS. At the Division I level, 13% of coaches used a combination of SS and BS, while 21.2% of coaches at the Division III level performed this same pre-activity stretching routine.

Coaching Sex and Age: The majority of coaches in this survey were older than 36 years of age (68.9%) and predominantly male, with 50 (23.4%) of the respondents being female. From the Chi-Square analysis, it was suggested that neither sex ($\chi^2 = 2.15$, $p = 0.142$) nor age ($\chi^2 = 3.94$, $p = 0.413$) influenced the pre-activity stretching routines employed by coaches. A greater majority of male coaches (71.8%) implemented DS compared to female coaches (56.3%), while a greater percentage of female coaches (27.1%) reported having their athletes perform SS and BS during the warm-up period compared to male counterparts (15.5%). Only one female coach used exclusively BS, while seven (4.9%) male coaches performed this warm-up stretching practice.

Coaching age was determined not to be a significant factor on pre-activity stretching practices, as the majority of coaches in each age category performed DS during the warm-up period. Most coaches (61.5%) in the youngest age group (24-30) performed DS, while 23.1% of coaches reported having their athletes use SS and BS. Of the coaches in the 46-55 age group, 77.3% used DS, 7.5% used BS, and 9.4% used a combination of SS and BS. The majority of coaches in the oldest age group (>55 years) used DS (56.5%), with 26.1% using SS and BS.

DISCUSSION

This paper is a continuation of a line of inquiry examining pre-activity preparation practices of sport coaches (27–31). The purpose of the study was to investigate the knowledge and practices of NCAA Division 1 and Division III soccer coaches to determine to what extent contemporary stretching practices align with current research. Results provide evidence that soccer coaches appear to be prescribing pre-activity warm-up and stretching in a more evidence-based manner than coaches in many other sports that have been examined, and thus refutes our hypothesis. Statistically, a majority of coaches in the present study adhere to recommended warm-up practices, with 208 out of the 209 (99.5%) respondents reporting the use of a general warm-up, consisting of jogging, small-sided games, ball drills, or other related activities. Of the 209 coaches, only three were 'neutral' in their beliefs toward the importance of a general warm-up prior to practices or games, with the remaining coaches believing that general warm-ups were important in preparing soccer athletes for sporting demands. A general warm-up, typically performed through aerobic activity, helps facilitate various physiological mechanisms such as enhanced blood flow, rate of muscle contraction, and nerve transmission (51). A similar study was conducted on warm-up practices in track and field throwing programs, determining that a high number (96.2%) of collegiate track and field coaches also implement some type of general warm-up prior to an athletic event (29). Although a track and field throwing athlete typically seeks to enhance anaerobic attributes such as strength and power, as compared to a soccer athlete's emphasis on endurance-based training, the results of both studies indicate that a general warm-up can benefit a variety of athletes in terms of performance and injury resiliency.

Following a general warm-up, current scientific evidence suggests that soccer athletes perform DS to improve subsequent sport performance (2–4); most coaches (68.7%) in this study indicated the use of this pre-activity practice with their athletes. However, 44 (22.6%) coaches reported a pre-activity routine that consisted of SS and/or BS, practices that are not recommended by warm-up researchers due to the potential increase of injury and diminished performance output (24). An additional eight (4.2%) coaches used a combination of SS and DS in their pre-activity warm-ups despite evidence that this type of warm-up does not benefit soccer athletes in terms of sprint, dribbling, and penalty kick performance (20). Static stretching in a warm-up has been reported to impair neural input to the muscle (14), decrease reflex sensitivity (22), and increase musculotendinous unit compliance (8). Despite contrasting evidence from current literature, some coaches continue to implement SS into their athlete's warm-up, possibly due to a reluctance to change traditional routines (30).

The present study was designed to determine whether specific coaching characteristics influenced the pre-activity stretching practices implemented by coaches. It was determined that coaching sex, age, years of experience, and level of coaching (Division I vs Division III) did not impact the stretching techniques in the warm-up protocol. The majority of coaches across all demographic characteristics of interest adhered to the recommended practice of DS during pre-activity practices. The findings from this study contrast a previous examination in pre-activity practices of collegiate tennis coaches, in which coaching experience was determined to significantly influence their compliance with research recommendations (28). The results of the previous study determined that older coaches (≥10 years' experience) were less likely to follow research recommendations (28), whereas the current study determined that a greater percentage of older coaches were in compliance with current research through the use of DS in their athlete's warm-up. Similar inquiries from this research group have also shown that football coaches and practicing ATs are continuing to implement SS during pre-activity periods (31, 43) even though the current scientific evidence overwhelmingly favors DS for improved performance (8). While this study suggests that many soccer coaches are currently aligned with best practices in pre-activity warm-up, there are still coaches who are prescribing activities that are not recommended. Therefore, it is critical that coaching education continue to be pushed and that organizations such as the National Strength and Conditioning Association (NSCA) continue to promote science-based professional certifications.

This study also highlights the importance of soccer coaches examining their own practices for alignment with current scientific recommendations and ongoing research. Soccer coaches appear to be prescribing pre-activity warm-up and stretching in a more evidence-based manner than coaches in other sports. It is apparent that a coach cannot solely rely on past practices that have been handed down by previous coaches, so strength and conditioning professionals can be of great benefit to provide coaches with the most effective warm-up and training practices. The readily available soccer coaching certification/licensure courses are a useful resource in allowing coaches to find the most pertinent information about pre-activity preparation practices. Certification programs that are grounded in research principles, such as the NSCA's Certified Strength and Conditioning Specialist (CSCS) Certification Program, stress the importance of staying current in research trends, and how to apply that knowledge on the field. It is suggested that national governing bodies in other sports, in collaboration with professional organizations such as the NSCA or NCAA, determine the most beneficial warm-up practice and promote its use to coaches and trainers across all levels. As the knowledge base for stretching and warm-up strategies continues to grow, this study is a reminder that coaches should use up-to-date information, thus ensuring that their athletes are prepared with the best available treatment and preventative care.

Some limitations with the current study include the sample population survey response rate. Although the response rate is approximately 10% higher than similar surveys conducted with other collegiate sporting populations (29, 30), including a larger sample of collegiate soccer coaches from NCAA Division I and III universities may improve the validity of the data obtained. Additionally, the data were collected via electronic self-report surveys, which may contain error as a result of subjective biases. Thus, there may be variance due to respondent

deception in order to present the researcher with a false impression of pre- and post-activity stretching practices. Nonetheless, this study presents new data suggesting that many soccer coaches are aligned with current scientific recommendations of pre- and post-activity stretching. As the body of literature pertaining to stretching and warm up protocols continues to evolve, soccer coaches should adapt their practices to ensure the best possible exercise and athletic preparation programs. Future research inquiries should investigate the level of familiarity and implementation of sport specific, evidence-based warm-up protocols and injury prevention programs. Implementation and adherence to suggested pre- and post-activity stretching recommendations is important to reduce the risk of injury and enhance overall athletic performance.

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