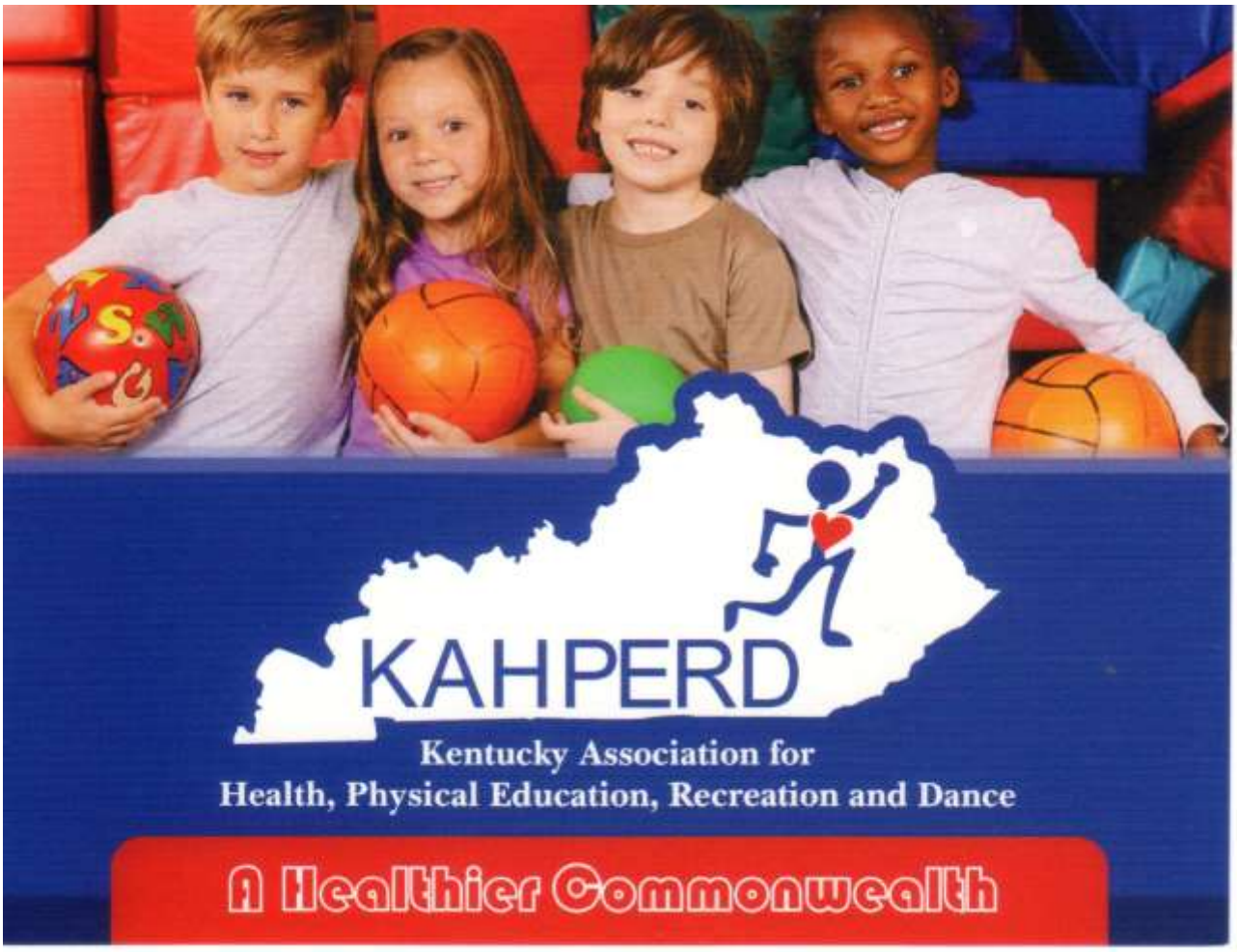
2020 Spring

Kentucky Society of Health And Physical Education



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Special Acknowledgement

Congratulation to Jessica Napier for being named the 2020 SHAPE America National Health Education Teacher of the Year!!

A Message from the Kentucky SHAPE President

Greetings Kentucky SHAPE friends,

Greetings from your 2020 president to my fellow KAHPERD members and readers of this Journal! What an unprecedented time we are navigating through. COVID-19 has changed all our lives and is shining a light on the importance of our field. I am so proud of how our organization is leading the way not only in Kentucky but across the nation to help provide resources for those in our profession. Our educators on every level have stepped up to the plate to be leaders in fighting this pandemic. Our theme for this year is to move toward a clear vision for every child and although no one could have envisioned this life changing event, we are doing and will continue to do the work. Please continue to check our website and social media accounts for updates on upcoming events. Finally, I would like to give a special thank you to Dr. Steve Chen, Dr. Stacey Forsythe, and Dr. Gina Blunt-Gonzalez for serving as our Journal co-editors, their time and commitment to this publication is a valuable asset to all KAHPERD members and beyond. Also, thank you to our writers for your professional contributions to this edition.
I am hopeful that we will soon be able to come together professionally to grow KAHPERD/KYSHAPE. Best wishes to all and stay well.

Respectfully Submitted
Robin A. Richardson, MS
Kentucky SHAPE President 2019 -2020

Acknowledgement

What a coincident! All of the articles in this issues are related to the theme of recreation. As the Editors of the Kentucky SHAPE Journal, we would like to show our appreciation to the following guest-reviewers for their assistance in reviewing this current issue.

Mr. David Castillo, Morehead State University; Dr. Jennifer Mak, Marshall University; Dr. Jennifer Dearden, Morehead State University; Dr. Elizabeth Ash, Morehead State University; Dr. Laurie Larkin, Eastern Kentucky University; Dr. Manuel Probst, Morehead State University, Dr. A.J. Mortara, Berea College

Sincerely,

Gina Blunt Gonzalez, Kentucky SHAPE Journal Co-Editor
Stacey Forsythe, Kentucky SHAPE Co-Editor
Steve Chen, Kentucky SHAPE Journal Managing Editor

Kentucky SHAPE Journal Submission Guideline

. SUBMISSION OF A PAPER

The Kentucky SHAPE Journal (former KAHPERD Journal) is published twice yearly (spring and fall) by the Kentucky SHAPE. The journal welcomes the submission of empirical research papers, articles/commentaries, best practices/strategies, interviews, research abstracts (spring Issue only) and book reviews from academics and practitioners. Please read the information below about the aims and scope of the journal, the format and style for submitted material and the submissions protocol. Your work will more likely to be published, if you follow the following guidelines thoroughly.

Articles are accepted via an electronic attachment (must be in Microsoft Word format, doc or docx) through e-mail to the editor before the deadline dates. Submissions should be sent to either one of the co-editors based on the topic (nature) and discipline of the study.

For an article related to health and physical education, health promotion, exercise science and exercise physiology, please email the submission to Gina Gonzalez: g.gonzalez@moreheadstate.edu
For an article related to recreation and sport management/administration, sport sociology, and sport coaching, please email the submission to Stacey Forsythe: Stacey.forsythe@wku.edu
Authors will send the final revision of their accepted work to the managing editor, Steve Chen: s.chen@moreheadstate.edu to get ready for publishing.

Deadlines: Spring issue—March 1 & Fall issue—September 1
Estimated publishing time: Spring issue—Mid May & Fall issue—Late November

AIMS AND SCOPE

The main mission is to bring together academics and practitioners to further the knowledge and understanding of issues and topics related to health, physical education, sport administration and marketing, exercise science, sport coaching, dance, and recreation, etc. We encourage submissions relating to these topics from a variety of perspectives.

CONTENT

All articles should be written primarily to inform senior practitioners and academics involved in areas of health, physical education, recreation and dance.
Research articles should be well grounded conceptually and theoretically, and be methodologically sound. Qualitative and quantitative pieces of research are equally appropriate. A good format to follow would be: Introduction, Literature Review, Methodology, Results, & Discussion, Conclusion, and Implication. Articles may include an abstract of approximately 150 words including the rationale for the study, methods used, key findings and conclusions. Article should not exceed 10 single-spaced pages (not including references, tables, and figures).
Reviews of books and/or reports are welcome (around 1000-2000 words). Information concerning the book/report must be sent to the editor.
Interviews (it would be nice to discuss with the editor beforehand) and best practice/strategy papers of 1,500-3,000 words should be objective and informative rather than promotional and should follow the following format: Objective/Background/Discussion and Practical Implication.

Research abstracts (300 words or less) are welcome. The submitted abstracts should have been presented (either an oral or a poster presentation) in the KAHPERD annual conference in the previous year.
*The editors are keen to discuss and advise on proposed research projects, but this is no guarantee of publication.

FORMAT AND STYLE

Manuscripts should follow the form of the guidelines for publications outlined in the 6th edition of the Publication Manual of the American Psychological Association.
Tables, charts, pictures, diagrams, drawings and figures should be in black and white, placed on separate pages at the end of the manuscript. They must be submitted photo ready and reproduced to fit into a standard print column of 3.5 inches. Only one copy of each illustration is required, and captions and proper citations should be typed on the bottom of the table and diagrams. Jargon should be reduced to a minimum, with technical language and acronyms clearly defined. The accuracy of any citations is the responsibility of the author(s).
For more specific style questions, please consult a recent edition of the journal.

SUBMISSIONS AND REVIEW PROTOCOL

Submission of a paper to the publication implies agreement of the author(s) that copyright rests with Kentucky SHAPE Journal when the paper is published.
Kentucky SHAPE Journal will not accept any submissions that are under review with other publications. All manuscripts submitted will be peer reviewed by 2 to 3 members of the editorial board. To be accepted for publication in the journal, the article must be approved by no less than 2 of the 3 reviewers. Authors will normally receive a decision regarding publication within six to 12 weeks. Rejected manuscripts will not be returned.

(Peer Reviewed Article)

An Analysis of Different Soft Tissue Mobilization Techniques and Treatment Parameters on Skeletal Muscle Health and Performance

William Hawkins, University of Southern Indiana (wchawkins@usi.edu)
Kaytlin Galloway, University of Southern Indiana

Abstract

Soft tissue mobilization techniques have been used for thousands of years in the treatment of muscle soreness and injury. In addition to ancient modalities like massage therapy there has been a recent surge in the popularity of self-myofascial release tools including foam rollers and massage sticks. Irrespective of these techniques' popularity and apparent efficacy most clinicians and users of self-myofascial release tools do not fully understand the mechanism by which positive outcomes are manifested, nor the best practices concerning their usage. The purpose of this investigation is to explore existing literature surrounding the history of soft tissue mobilization, science explaining the mechanism by which positive outcomes are attained and to provide insights surrounding the best practices of self-myofascial release. Our lab chose to focus our practical applications section on self-myofascial release because tools including foam rollers and massage sticks are affordable and many physical education teachers, athletics coaches and individual persons already have access to them. Our findings suggest that pressure administered by the tool or person's body mass appears to be correlated with positive outcomes. For this reason, the use of foam rollers appears to be more effective than massage sticks because more pressure is administered to the muscle. Further, the literature suggests that treatments lasting two minutes or longer were optimal for treatment of muscle soreness. Additionally, there is a small body of literature that has suggested that foam rolling may be a viable alternative to traditional dynamic warmups prior to exercise.

Introduction

Ancient human populations and modern athletes alike have suffered from soreness and muscle pain. There is evidence that populations from ancient Greece and Rome used small, curved metal tools known as strigils to scrape dirt and sweat from the body, but anecdotally found relief from generalized muscle soreness (Hammer, 2008). Similarly, in Asia, a healing technique called Gua Sha originated using animal bone and horns for instrumentation (Hammer, 2008; (Lee, Choi, Kim, & Choi, 2010). To our knowledge these are the first implementations of soft tissue mobility modalities. These rehabilitation modalities have become in-vogue again and are collectively called instrument assisted soft tissue mobilization (IASTM). IASTM is a specific form of soft tissue mobilization, just as massage therapy and foam rolling are. Though soft tissue mobilization is commonly practiced and recommended by health care professionals and clinicians such as physical therapists, athletic trainers, and coaches, very few prescribers understand the mechanism by which it causes improvement in muscular health. The purpose of this manuscript is to shed light on the body of research that has investigated soft tissue mobilization and to present our findings in a way

that is palatable to physical therapists, occupational therapists, physical education teachers and athletics coaches.

There are several forms of soft tissue mobilization including the previously mentioned IASTM. Other commonly utilized techniques include massage therapy and self-myofascial release. Self-myofascial release includes techniques like foam rolling where the patient massages themselves using a tool and their body mass. Though the intensity and duration does vary between treatment types and even within each treatment type (Swedish vs deep tissue massage) at their root, each of these treatment modalities serves to mechanically compress and stretch the underlying muscle tissue. For this reason, it is logical to group these treatments together when discussing how they can be used as a recovery tool. In our practical applications section, we discuss only self-myofascial release because foam rollers and massage sticks are accessible by nearly every physical education teacher, coach and athlete.

Proposed Benefits of Soft Tissue Mobilization

Increasing Range of Motion (ROM) and Flexibility

The most often proposed benefit of soft tissue mobilization is that it can increase ROM of affected joints. Passive range of motion has been defined as the range of motion available to a joint or series of joints (Gleim & McHugh, 1997) and is usually measured manually with a goniometer. The majority of studies that have analyzed the effects of soft tissue mobilization on muscle and connective tissue have been based on passive range of motion as a primary outcome measure (Crosman, Chateauvert, & Weisberg, 1984; Hernandez-Reif, Field, Krasnegor, & Theakston, 2001; Huang et al., 2010; Morien, Garrison, & Smith, 2008; Nordschow & Bierman, 1962; Wiktorsson-Moller, Öberg, Ekstrand, & Gillquist, 1983). These studies suggest that soft tissue mobilization like massage, IASTM and foam rolling may be beneficial for increasing joint ROM (Crosman et al., 1984; Diana Hopper et al., 2005; D Hopper et al., 2005; Huang et al., 2010; Leivadi et al., 1999; Morien et al., 2008). Though understanding the relationship between soft tissue mobilization and flexibility is important, more research is needed to further understand the mechanism that causes the relationship.

For example, one study found an increased ROM and no associated decrease in passive tension or electromyography (EMG) following massage (Huang et al., 2010). This is an interesting finding because it has been hypothesized that at least a portion of the increased ROM comes from neural responses caused by the treatment. The authors of this investigation suggested that modified stretch perception, increased stretch tolerance, or increased compliance of the hamstrings were possible mechanisms for this observed increase in joint ROM (Huang et al., 2010). As previously stated, further research is needed to explore how soft tissue mobilization alters flexibility and ROM in healthy and injured muscle.

Treatment of Muscle Damage

In addition to increasing joint ROM it has been hypothesized that soft tissue mobilization may be beneficial in the treatment of post exercise muscle damage. One of the most prolific research

cohorts on the topic at hand have devised a protocol for testing soft tissue mobilization on rodents with exercise induced muscle damage (Butterfield, Zhao, Agarwal, Haq, & Best, 2008; Crawford et al., 2014; Haas et al., 2013; Waters-Banker, Butterfield, & Dupont-Versteegden, 2014). The Ohio State research group has set out to answer multiple research questions including how soft tissue mobilization affects muscle recovery following bouts of intense eccentric exercise which is known to cause muscle damage (Butterfield et al., 2008). The in vivo animal model allows the researchers to induce muscle damage through an eccentric loading protocol while the rabbit is anesthetized. While anesthetized, the tibialis anterior is maximally contracted by a surgically implanted stimulator while the muscle is being stretched through the ankle joints ROM causing repeated maximal eccentric contractions (Crawford et al., 2014).

Butterfield et al. have used eccentric loading prior to IASTM and massage treatments in order to evoke muscle soreness and damage as soft tissue mobilization has been indicated for such cases. They found that 30 minutes of cyclic compressive loading of the tibialis anterior with a metal IASTM tool can improve skeletal muscle recovery following a bout of damaging eccentric exercise (Butterfield et al., 2008). Animals who received soft tissue mobilization demonstrated statistically significant increases in recovery of peak torque following muscle damage as well as decreased leukocyte infiltration (Butterfield et al., 2008). These data not only demonstrate that IASTM has the potential to decrease recovery time following muscle damage, but that leukocyte infiltration likely plays a role in skeletal muscle recovery following soft tissue mobilization.

Increasing Blood Flow

Another proposed benefit of massage is an increase in blood flow. Although anecdotally, authors have agreed that massage can increase blood flow; study results have been inconclusive largely because of research study design limitations. Besides having a small sample size (Bell, 1964; Dubrovsky, 1983; Hansen & Kristensen, 1973), most of these studies had no reported statistical analysis, (Bell, 1964; Dubrovsky, 1983; Hansen & Kristensen, 1973) nor did they use a control group (Bell, 1964; Dubrovsky, 1983; Hansen & Kristensen, 1973). These limitations make it hard to differentiate the changes in blood flow caused by soft tissue mobilization from normal variation. More importantly, venous occlusion plethysmography and Xenon wash-out techniques used in these studies have their own limitations.

Venous occlusion plethysmography generally demonstrates underestimation of blood flow due to the inflated cuffs extreme sensitivity to movement artifacts (Shoemaker, Tiidus, & Mader, 1997; Tiidus & Shoemaker, 1995). At times the changes of blood flow could not be expressed quantitatively because of these limitations (Hansen & Kristensen, 1973). Moreover, venous occlusion plethysmography cannot be used to measure blood flow during soft tissue treatments but only immediately following the treatment (P. Tiidus & Shoemaker, 1995). Further, the Xenon wash-out technique is believed to overestimate blood flow because of the local trauma from injection of the tracer (Shoemaker et al., 1997; P. Tiidus & Shoemaker, 1995; P. M. Tiidus, 1999). Pulsed Doppler ultrasound has been used to investigate muscle blood flow and has indicated that manual massage does not affect microcirculation in the muscle after treatment (Shoemaker et al., 1997; Tiidus & Shoemaker, 1995). However, the ultrasound used in these studies detected changes in the large artery and vein. Because pulsed Doppler ultrasound generally used to examine major

blood supply it is difficult to draw any conclusion about whether soft tissue mobilization causes increased microcirculation in the affected region.

In addition to localized changes in blood flow, it has been suggested that soft tissue mobilization techniques may lead to alterations in systemic blood flow (Franklin, Ali, Robinson, Norkeviciute, & Phillips, 2014). Previous research shows that flow-mediated dilation (FMD), the "gold standard" in-vivo measure of endothelial function, is impaired in healthy but sedentary young adults after an acute bout of strenuous lower extremity resistance exercise involving both eccentric and concentric muscle contractions (Phillips, Das, Wang, Pritchard, & Gutterman, 2011). Franklin et al. set out to explore if this decreased FMD could be attenuated by soft tissue mobilization and their data suggests that it can (Franklin et al., 2014). In Franklin's study, a single lower extremity soft tissue mobilization treatment resulted in the elevation of brachial artery FMD that lasted for 48 hours after exertion-induced muscle injury. This treatment also increased FMD in the absence of exercise (Franklin et al., 2014). The most compelling evidence to support soft tissue mobilizations ability to alter blood flow is at the macro-circulatory level as opposed to within the microcirculation of the muscle that was treated.

Proposed Mechanisms of Change

Musculo-tendinous tissue that is compressed by soft tissue mobilization is believed to undergo histochemical modifications that lead to a host of downstream signaling cascades. These downstream signaling cascades are apparently mediated by fibroblast proliferation but the exact mechano-transduction pathway is not fully understood. Musculo-tendinous fibroblasts have several structural characteristics that make them necessary for muscle and tendon cell function. Musculo-tendinous fibroblasts are easily identified by their flattened, elongated shape as well as their elongated nuclei and actin-based cytoplasmic protrusions (Kjær et al., 2009). Tendinous fibroblasts interact with the extracellular matrix (ECM) by way of an advanced coupling network that is often referred to as collagen cross linking (Kjær et al., 2009). As previously mentioned, the exact mechano-transduction pathway by which soft tissue mobilization initiates molecular signaling is not fully understood but it is believed to be initiated by the repeated deformation of structural proteins located in the ECM of muscle.

Musculo-tendinous repair occurs in a three-step process: inflammation, proliferation, and remodeling. During the acute inflammatory stage, blood platelets and fibrin cover the musculo-tendinous damage and fibroblasts and phagocytic cells relocate to the site of soft tissue injury. The fibroblasts begin to produce fibronectin. In the proliferative stage, fibroblasts increase in number and begin synthesizing Type III collagen. The remodeling or maturation stage involves a reduction in cellularity and realignment of collagen fibers. Finally, during the maturation stage, collagen production shifts from immature, Type III collagen, to mature, Type I collagen, and fibronectin production decreases (Davidson et al., 1997).

Based on what modern research methods have determined about the mechanism by which damaged muscle heals and the current body of research it is believed that soft tissue mobilization evokes healing by increasing fibroblast activity in the proliferation stage of recovery (Gehlsen, Ganion, & Helfst, 1999).

Practical Applications

Focus of Self-myofascial Release (SMFR)

Self-myofascial release (SMFR) may be the most pertinent method for many athletes in terms of ease and accessibility. There are several methods and tools that are used for SMFR such as foam rollers and stick rollers. Foam rollers are made of compressed foam cylinders that are used by applying pressure between the muscle and ground surface. Roller sticks are a handheld device that are described as being "similar to a rolling pin, but with a dense rubberized surface" (Jay et al., 2014). These modalities can be self-administered with a tool that can be obtained from any facility that sells sports equipment.

Increasing ROM/flexibility

Since ROM is dictated by several possible factors including stretch perception, stretch tolerance, and muscle compliance, there is very little data supporting the actual mechanism behind the effects of SMFR. Most of the research done supporting SMFR in respects to ROM is based solely on observations of changes in ROM rather than studying the mechanism by which it is altered. As Table 1 demonstrates, positive results are obtained when using the foam roller and roller massager (MacDonald, Button, Drinkwater, & Behm, 2014; Sullivan, Silvey, Button, & Behm, 2013). A possible explanation for this could be that with both methods, bodyweight and maximal pressure could be applied to the muscle tissue, increasing the beneficial effects. The use of the stick roller did not show increased ROM (Mikesky, Bahamonde, Stanton, Alvey, & Fitton, 2002). A possible explanation for this negative result is the limitation of pressure that the upper extremities could apply on the stick. The amount of pressure applied is likely an influential factor in ROM benefits. It is important to note that pressure descriptions for Mikesky et al., 2002 and Roylance et al., 2013 were not descriptive.

Table 1: Effects of SMFR on ROM

Author& Year	Protocol	SMFR tool	Muscle Group Treated	Force Applied	Outcome
(MacDonald et al., 2013)	1 min x 2 rounds	Foam roller	Quadriceps	"Place as much of their body mass as possible onto the foam roller"	Increased knee extension ROM
(Sullivan et al., 2013)	5-10 sec x 1-2 rounds	Stick roller	Hamstrings	Maintained constant 13 kg with custom device	Increased sit-and-reach test
(Mikesky et al., 2002)	2 min x 1 round	Stick roller	Hamstrings	"Concentrate on the test they were able to perform while they administered self-massage"	No increase of ROM in active straight leg raise
(Roylance et al., 2013)	2 min (estimated)	Foam roller	Various	Pressure not specified	No increase of ROM in sit-and-reach test

Decreasing Muscle Damage

The effects of SMFR on delayed onset muscle soreness (DOMS), a proxy of muscle damage and athletic performance following treatment, were evaluated and shown in Table 2. SMFR is believed to increase peak torque and decrease recovery time. In the studies focusing on DOMS, there was a significant reduction of pain following treatment (MacDonald et al., 2014; Pearcey et al., 2014; Jay et al., 2014). It is important to note that pain was measured using a questionnaire related to perceived pain rather than directly measured using a pressure algometer.

Table 2: Effects of SMFR on DOMS

Author & Year	Protocol	SMFR tool	DOMS-inducing Protocol	Measurement	Effect
(MacDonald et al., 2014)	60 sec x 2 rounds per exercise	Foam roller	10 x 10 rep backsquat (60% of 1 RM), 2 min rest between each	BS-11 Numerical Rating Scale of pain at 0, 24, 48, and 72 hr	Reduction in pain
(Pearcey et al., 2015)	60 sec x 2 rounds per exercise	Foam roller	10 x 10 rep backsquat (60% of 1 RM), 2 min rest between each	PPT at 24, 48, and 72 hr	Reduction in pain
(Jay et al., 2014)	10 min	Roller massager	10 x 10 rep stiff-legged deadlift with kettlebell	VAS for pain and PPT at 48 hr	Reduction in pain

Athletic Performance

The measurement of athletic performance allows for a more practical evaluation on the effects of SMFR on tissue damage, shown in Table 3. When performance was evaluated, there was only one study indicating positive results (Peacock, Krein, Silver, Sanders, & Von Carlowitz, 2014). Peacock et al. found that SMFR improved power, agility, strength and speed when compared with a dynamic warm up. Still other studies showed no change in performance for maximal torque production in muscle (MacDonald et al., 2013; Sullivan et al., 2013) following SMFR. These findings contradict each other in the sense that torque production, power, speed and agility are often correlated. Further investigations, with larger sample sizes should be used to further examine the effects of SMFR on these variables associated with athletic performance.

Table 3: Effects of SMFR on Athletic Performance

Author, Year	Protocol	SMFR tool	Muscle Group Treated	Force application, instruction to subjects	Effect
(Peacock et al., 2014)	30 sec x 1 round	Foam roller	Various	Not specified	Increased vertical and long jump, 1 RM bench press, sprint, and agility test
(MacDonald et al., 2013)	1 min x 2 rounds	Foam roller	Quadriceps	"Place as much of their body mass as possible onto the foam roller"	No change for MVIC knee extension at 90° knee angle and rate of force development
(Sullivan et al., 2013)	5 or 10 sec x 1-2 rounds	Roller massager	Hamstrings	Maintained constant 13 kg with custom device	No change in MVIC knee flexion torque

Blood Flow

Appropriate blood flow and perfusion is important for muscle healing. There are claimed benefits that SMFR increases blood flow in the tissues treated. According to (Okamoto, Masuhara, & Ikuta, 2014), blood flow can be increased by reducing arterial stiffness. Their results showed that SMFR using a foam roller with the force of one's body weight for one minute was beneficial in increasing blood flow and arterial function. It is also suggested that increased flexibility of muscles increases blood flow (Okamoto et al., 2014). As previously mentioned, SMFR can be beneficial for ROM and flexibility, and thus beneficial for blood flow.

SMFR Best Practices and Future Research Recommendations

Based on the literature described in this manuscript, the following practical applications have been drawn.

- Pressure dose does seem to be important; positive relationship between pressure applied and outcomes
- Most positive results for SMFR utilized foam rollers rather than stick rollers
- Treatments for reduction in pain should be at least two minutes in duration
- Foam rolling may be an effective warm-up technique

Our research cohort has several recommendations for researchers interested in exploring how soft tissue mobilization affects muscular health and athletic performance. First, researchers must report pressure forces administered during treatment. Without reporting these findings, it is difficult to

compare findings between research investigations. In the same vein, researchers should aim to report specific treatment parameters including total time of treatment, total number of strokes and the direction in which pressure was administered relative to the muscle (parallel vs perpendicular). Additionally, laboratory grade testing equipment should be used to collect outcome variable data. For example, rather than using the v-sit reach as a measurement of hamstrings flexibility, one should use an iso-kinetic dynamometer or, at minimum clinicians highly trained in measuring hamstrings flexibility with goniometers.

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Identifying Perceived Barriers to Social Equity and Equal Access in Kentucky State Parks

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Abstract

Public lands offer American residents and visitors shared spaces for recreation, resource protection, and ecological management. Despite being open to all visitors, public lands experience disparate visitation by various demographic groups. Potential visitors also sometimes experience barriers to visiting public lands, which make this opportunity improbable or impossible based on their experiences. State parks are one form of public land that offer an ideal opportunity for all residents and visitors to use these spaces for varied, overlapping purposes. However, state parks similarly experience varying levels of use based on group membership. This study examines barriers to accessing Kentucky State Parks. Using in person surveys, the authors find that Kentucky State Parks experience important barriers based on age and race/ethnicity.

Keywords: State parks, barriers to visitation, park access, state parks visitation

Introduction

Public lands are an important and unique part of the American experience (Arnold & Jacoby, 2017; Zellmer, 2019). Public lands offer protection to the nation's natural experiences and ecology while also managing its natural resources (Blumm & Jamin, 2017; Stauffer, Miller, Wilson, Brittingham, & Brauning, 2017). However, public lands do experience issues in terms of equal access to all groups. For example, public lands may inadvertently or intentionally exclude certain experiences from land management. Past examples include leaving out persons of differing abilities (Corazon et al., 2019), persons of color (Flores and Kuhn 2018; Chase, Teel, Thornton-Chase, & Manfredo, 2016; Rushing, 2009), and low income residents (McCreary, Fatoric, Seekamp, Smith, Kanazawa, & Davenport, 2018; Sage, Nickerson, Miller, Ocanas, & Thomsen, 2018). State and city parks are similarly at risk of excluding certain communities despite being ideal locations for multiple communities to come together in using public lands for varying, yet overlapping, reasons (Loukaitou-Sideris & Mukhija, 2019; Stephens, 2019).

This study examines barriers associated with equal access to state parks in Kentucky. The study examines demographic variables that help researchers identify how particular groups experience these barriers. Using a random sample of in-person surveys at five Kentucky state park locations and the Searle and Jackson's Perceived Barriers Scale, the authors find that users experience barriers to Kentucky state parks in terms of both age and race/ethnicity. While the race/ethnicity finding is confirmed by literature, the age finding here (that younger persons feel more barriers to accessing Kentucky state parks) is unique and deserving of more research.

The researchers find that Kentucky state parks are particular susceptible to barriers relating to age and race (specifically persons of color). The study offers a foundation for future research in the state in making state parks equally accessible to all Kentuckians and state visitors.

Background Information

Public lands and Equal Access

Public lands are a valued part of American life. Public lands include national parks, national forests, national monuments, and state parks, just to name a few. Public lands represent a form of trust between residents and public land managers in which large swaths of the nation are set aside for protection (Arnold & Jacoby, 2017). Public land uses include outdoor recreation, wildlife refuges, public grazing, and natural resource management, as well as an ecological laboratory for research and preservation (Stauffer et al 2017). Public lands are rooted in the Public Trust Doctrine, the idea that citizens have entrusted public lands to the government's care and management for the public's benefit (Zellmer, 2019). Public lands have recently attracted attention during the nation's most recent presidencies as citizens, politicians, and corporations negotiate the protection of these extraordinary public spaces amid national and international economic changes (Blumm & Jamin, 2017).

From a theoretical perspective, equity can be defined as the fairness or justice of a situation or distribution (Nicholls, 2001). Nichols argues that equity appears in four classes: equality, compensatory, demand, and marketing. Equality implies that all would receive equal input and participation in public lands, while compensatory pursues giving isolated or unengaged groups additional resources to make their participation whole. Demand rewards those who are actively engaged, although this often results in excluding others as part of the process (Crompton & Wicks, 1988), while marketing posits economic participation (whether through taxes or fees) is part of the right to participate. The distribution of public facilities and services is a concern to many providers as they seek to ensure equity and that the accessibility of these facilities and services is available to all. Accessibility relates to the ease in which a service or site may be obtained or viewed (Nicholls, 2001). The failure for an agency to be fair, reasonable, and nondiscriminatory can lead to various complaints and decrease the amount of support for the agency or parks department (Park, Ellis, Kim, & Prideaux, 2010). Meanwhile, persons excluded or without access to outdoor recreation options may make their perspective known, or (as is often the case) their perspectives may also be overlooked, misheard, or simply ignored.

Research on physical barriers to public lands

Cost forms an ongoing access issue for public lands. User fees are a commonplace idea among many public lands as these fees support infrastructure and maintenance costs. However, fees to access public lands can often form a major hurdle to access (Lamborn, Smith, & Burr, 2017). The barrier is formed not in the actual cost to access a particular location, given that these costs are usually small. Instead, research finds that it is the lack of a willingness to spend these small amounts in light of budgetary issues and perceptions of what expenditures are legitimate (McCreary et al., 2018). One unexpected finding is that low-income users may actually drive further to access

non-fee locations compared to fee-locations or change their plans in the face of fee increases (Sage et al., 2018). Sage and associates (2018) also find that these diversions also reduce gateway expenditures in the surrounding area, making barriers into a tangible issue for regions with public lands. Differential pricing (offering a rate for local residents versus non-local residents) may offer one option for attracting local populations who might not otherwise come, although this can also cause some level of resentment among non-locals as well (Zou & Petrick, 2019). Increasingly, outdoor recreation studies are finding that outdoor recreation users frequently buy primary or secondary homes in the areas they often visit, meaning that differential pricing may simply serve the persons already coming to visit a particular public land area (Maples, Bradley, Giles, Leebrick, & Clark, 2019).

State Parks as Public Spaces

State parks present an ideal location for exploring social justice and public lands. State parks can often include urban areas, making them an ideal location for having multiple communities utilizing the park for myriad overlapping uses (Loukaitou-Sideris & Mukhija, 2019). Moreover, state parks are sometimes even able to incorporate applications to expand on the visitor experience and develop ties to the park among new users (Robinson & Morris 2017). While state parks offer a social laboratory for exploring equality and access, they nonetheless still experience some of the same issues as other public lands, including varying levels of use among persons of color (Whiting, Larson, Green, & Kralowec, 2017).

Kentucky State Park System's mission is "to stimulate economic development in rural areas through tourism, to provide quality recreation opportunities for residents and visitors throughout the Commonwealth, and to preserve and interpret Kentucky's significant natural, cultural, and historic resources" (Pros Consulting, 2010, p.4). Providing quality recreation opportunities for residents includes elimination of discrimination against those citizens of a different race, economic status, or social status. These benefits include enhanced mental and physical states, social and psychological wellbeing, as well as benefits to the community (McMeekin, Hancock, & Bahn, 2008). The benefits that are associated with individuals participating in recreation at public parks are well documented, however, the equal access to these benefits are still in question. Ensuring that equality and social equity to the public parks system is important so that all individuals are able to experience outdoor recreation, and that they are not discriminated against due to race, economic status, or social status. As such, the present study aims to identify barriers associated with social equity and equal access at state parks and to identify demographic variable that may help the researchers identify specific groups that may be under-represented as visitors at Kentucky State Parks

Methodology

Site Selection

For this study, the researchers selected five specific sites in Eastern Kentucky near the Appalachian Mountain Range. These included two resort parks (Sites One and Two), two historical parks (Site Three and Four), and one recreational park (Site Five). Site One is Cumberland Falls State Resort Park, located in south central Kentucky in McCreary County. Site Two is Natural Bridge State

Resort Park, which spans Powell and Wolfe Counties and is located in the Red River Gorge area of the Daniel Boone National Forest in Kentucky. Site Three is White Hall State Historic Site, located is central Kentucky in Madison County near Richmond, Kentucky. White Hall is the former home of Cassius Marcellus Clay, a famed abolitionist and prominent Kentuckian (White Hall-Clermont Foundation, 2014). Site Four is Boone Station State Historic Site, located in nearby Fayette County. Later in his life, Daniel Boone moved his and other families to a different settlement area located near Athens, Kentucky. Finally, Fort Boonesborough State Park represents Site Five. Fort Boonesborough (also located in Madison County) has many different attractions on site, including a museum, boating and paddling access to the Kentucky River, camping sites, and open spaces for picnicking and gathering.

Survey Design

To identify perceived barriers by potential visitors to state parks, the researchers utilized a previously validated measure (the Perceived Barriers Scale) by Searle and Jackson (1985) often used in the study of barriers. This instrument features 13 statements (Table 4) related to typical barriers to visitation to natural areas and parks. For each statement, respondents rated their agreement within a typical five-option Likert scale, ranging from "strongly disagree" to "strongly agree." Each item deals with distinct barriers to visiting a particular location (here, a state park).

In addition to the perceived barrier scale, researchers asked respondents to provide information related to their visit(s) to the park. Information sought included how often they visit, how long ago (in years) their first visit to the park was, how far they travel (miles) to visit the park, and visitor type. Visitor type included day user, tent camper, RV camper, group camper, and lodge and cabin guests. In addition, researchers also asked all respondents to provide demographic information, including age, sex, race, ethnicity, level of education, and income.

Survey Facilitation & Sampling

The researchers visited each of the five research sites three times to solicit volunteer respondents. The researcher slotted three visits to each park into specific days of the week, with one of the visits being over Saturday and Sunday, another visit being Monday through Wednesday, and a visit being Thursday through Friday. To ensure random sampling, researchers approached every third adult visitor to solicit participation in the research study. For large groups, the researcher approached first known adult only, and resumed the every third adult approach to solicitation.

The researchers applied descriptive analysis for a better understanding of the general park visitors' demographic and perceived barriers of those visitors. The researchers utilized the collected demographic variables for comparison with the general population in the state of Kentucky. Additionally, ANOVA tests were employed to investigate if park visitors' perceived barriers of visiting the state parks, in this study, varied with their user type and demographics, such as age, race, level of education, and family annual income. Chi-square tests were used to examine if park visitors' demographic differ among parks.

The researchers approached 452 adult visitors (18 and older), with 261 state park visitors completed the survey for a response ratio of 57.7%. As may be seen in the following information, if the respondent completed a specific section of the survey, that aspect was included in analysis.

Results

The mean distance travel to the park visited was 72 and respondents averaged 7.7 visits per year. The average age of respondents was 36 (Table 1), 52% were male, 96% were not Hispanic/Latino, and 87% considered themselves to be white (Table 2). The respondents in this study reported normal educational attainment, with 60% having attain a high school diploma or equivalent and 38% having a bachelor's degree or higher. Finally, the mean household income of respondents was $56,209.31 (Table 3).

Table 1. Respondent Age Categories

Age	N	%
18-24	87	33.3
25-34	53	20.3
35-44	42	16.1
45-54	40	15.3
55+	39	15.0
Total	261	100

Table 2. Race and Ethnicity of Research Respondents

Race	Kentucky (2010 Census)	Research Study
White	88.6%	87% (N=230)
Black or African American	8.1%	2% (N=4)
American Indian, Alaska Native	0.3%	2% (N=6)
Asian or Indian	1.3%	1% (N=2)
Native Hawaiian or Pacific Islander	0.1%	1% (N=3)
More than One Race	1.6%	4% (N=11)
Another Race Not Listed	-	4% (N=10)
Ethnicity	**Kentucky (2010 Census)**	**Research Study**
Hispanic/Latino	3.2%	4% (N=11)
Not Hispanic Latino	85.9%	96% (N=256)

Table 3. Family Income and Education Levels of Research Respondents

Education Completed	Kentucky (2010 Census)	Research Study
Less Than High School	17.6%	2% (N=6)
High School Diploma/Equivalent or Higher	82.4%	60% (N=259)

Bachelor's Degree or Higher	21.0%	38% (N=100)
Family Income	Kentucky (2010 Census)	Research Study
	$42,610	$56,209.31

Respondents completed an assessment of perceived barriers related to park visitation (Table 4). Respondents rated their agreement to each barrier statement on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree). The overall mean score of for respondents was 1.92, showing that respondents did not agree with any of the barrier statements (Table 4). Overall, this finds that barriers to state parks is likely low. However, a more detailed examination of how scores may change based on demographic categories such as those listed in the literature review is required in examining equity.

Table 4. Recreation Barriers Response Means

Statement	Mean*
Going to a state park is too physically demanding.	1.93
I have no one to go with me to a state park.	1.93
There are no state parks near me to go visit.	1.90
Going to a state park involves too much risk.	1.81
My family and friends are not interested in going to a state park.	1.99
Going to a state park is too costly.	1.94
I do not like nature.	1.47
I cannot participate in nature-based activities.	1.68
Family commitments keep me from going to a state park.	1.94
The expenses of traveling and staying at a state park are too great.	2.19
I do not know what to expect from a state park.	1.95
I have no time to go to a state park.	2.12
I have no information about the state parks and what they offer.	2.16
Mean	1.92

*Based on a 5 point scale 1=Strongly Disagree, 5 = Strongly Agree

In addition to baseline analysis, and to gain a better understanding of the perceptions of barriers, the researchers analyzed the data by running several ANOVA with the perceptions of barriers being the dependent variable. Independent variables used for ANOVA included income, education, user type, age, and race and ethnicity. Perceptions of barriers across various levels of income, education, and user type were not significant (Table 5). However, age and race/ethnicity were variables that showed statistically significant differences across the levels of the variable.

Table 5. ANOVA Results

Variable	F	Sig.
Income	3.155	0.780
Education	2.230	0.110
User Type	1.822	0.164
Age	2.951	0.021
Race & Ethnicity	7.246	0.008

When considering race and ethnicity of participants, the researchers found that visitors self-identified as white were significantly less likely to perceive barriers to park visitation than compared to non-white visitors. Additionally, the researchers organized participants into five groups based on their age selected (18-24, 25-34, 35-44, 45-55, & 55+). Using ANOVA, perceptions of barriers across these age groups was found to be significantly different ($F=2.951$, $p=.021$). Resultantly, the researchers ran a Tukey post-hoc test to identify specific age groups that differed significantly. The Tukey post-hoc analysis revealed the age group 25-34 was significantly different in their perceptions of barriers when compared to the users that selected ages 55 and older. Therefore, participants falling within the age range of 25-34 were significantly more likely to have a higher overall perception of barriers present when compared to participants 55 years of age or older.

Overall, park opportunities are scattered throughout the state, making most residents reasonably near a free park opportunity. Nonetheless, barriers are noted in the analysis, requiring further examination and consideration so these barriers may be lowered.

Discussion

This study utilizes Searle and Jackson's (1985) measure of perceptions of barriers in examining barriers to Kentucky state parks. In general, the overall perceptions of barriers in this study are quite low. The respondents, when aggregated, generally did not feel as though any of the barriers mentioned in the instrument were in place with the state parks in this study. The researchers believe this positive finding is a result of the dedication and investment by the state park system in Kentucky to ensure equal access to all Kentucky residents. In the broad sense, Kentucky State Parks appear to address the idea of equality (Nichols, 2001). Yet the two findings on race and age require further exploration. As identified in existing research, this study confirms that age and race/ethnicity both present barriers to Kentucky state park areas. At the same time, the study found a somewhat counterintuitive finding that younger persons (aged 25-34) reported stronger barriers to participation compared to other age groups. When examined together, the two findings are congruent with the idea that the outdoors have long been the domain of older, white persons, yet it also raises the question of how persons of color and younger generations might be included in conversations about state parks. Both findings speak to shortcomings in compensatory and demand approaches to social equity within the state.

The second component of social equity are compensatory and demand, where the supplier focuses more supply at higher need areas and supplies more where demand is needed, respectively. One final piece in the conversation about social equity is the idea of market forces. While not within the scope of this research project, state park properties that are closer to large urban areas necessitate more resources, financial and otherwise, to accommodate for need related to more visitation. Within this issue, market forces demand more investment related to properties within a certain distance from these urban areas. Further research is necessary to identify the visitor types to these parks with higher resource demands; as such, parks may see a much more diverse visitor type than do other state parks. When considering resources and market forces, it may make sense to address budgetary issues at state parks near urban areas.

Conclusion

This research project was not without limitations. Through the process, the researchers identified areas of necessary information that was not attained through this study. An important aspect of determining barriers to access to public areas such as state parks is ascertaining the needs and identifying the barriers of individuals that are not visiting the park. While the researchers believe this pilot study highlights the positive attributes of the Kentucky State Park system, more information is necessary to identify reasons and beliefs of state park non-visitors. While such information would provide quality information regarding barriers to access and barriers to equitable use of state parks, such information is not as easily attained. The researchers recommend the initial step of surveying local residents within the counties where these parks are located. The researchers believe local resident surveys may provide information necessary to further understanding equitable use of state parks in Kentucky.

Based on the findings, the researchers recommend further inquiry to determine where state park visitation barriers may exist for various Kentucky residents. Specifically, young adults and non-white respondents were more likely to note higher levels of barriers to park visitation, yet the instrument did not provide the information necessary to determine where or why these barriers exist. The researchers specifically recommend a qualitative research approach to determine what these barriers might be; as such, inquiry may provide in-depth information to ascertain any specific areas of concern. In review, the researchers believe areas of improvement exist within the Kentucky State Park system, as evidenced by findings in this study; however, the Kentucky State Park system is proactive in ensuring that all residents are able to visit natural and historical areas across the commonwealth.

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(Peer Reviewed Article)

The Relationship between Physical Activity Levels of College Students and Their High School Physical Education

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Introduction

Adult and childhood obesity rates are at an all-time high, according to the Center for Disease Control's (CDC, 2015) *State of Obesity Report*. Over the past 35 years, obesity rates have more than doubled for American adults and more than tripled for children since 1980. As shown, Figure 1 helps to visually reinforce this growing problem of adult obesity in America.

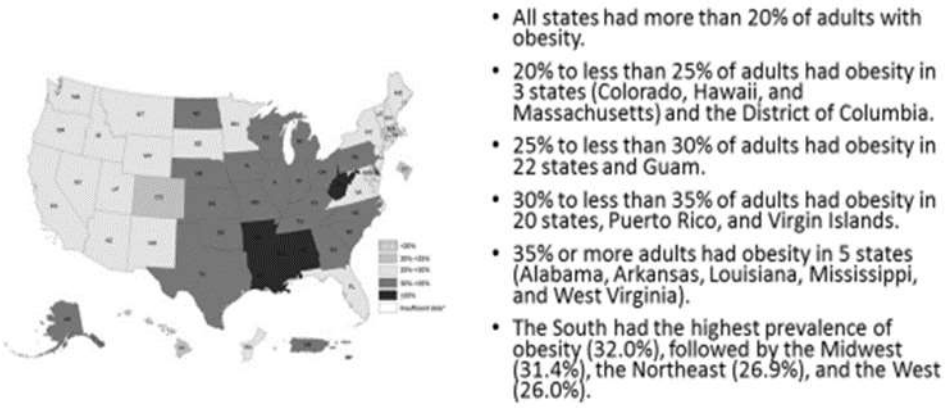

Figure 1. Prevalence of obesity among adults (2016). Reprinted from National Center for Chronic Disease Prevention and Health Promotion, Div. of Nutrition, Physical Activity, and Obesity, Prevalence of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2017. Retrieved from https://www.cdc.gov/obesity/data/prevalence-maps.html

The *2010 Healthy People* report established and cited ten high-priority public health areas with physical activity (PA) being the first leading health indicator (Buck, Jable, & Floyd, 2004). In other words, PA is the number one indicator of overall health and wellbeing. The CDC describes obesity as a complex health issue to address, which results from a combination of causes and contributing factors including individual factors such as behavior and genetics. Behaviors can include dietary patterns, PA, inactivity, medication use, and other exposures.

Additional contributing factors in our society include the food and PA environment, education and skills, and food marketing and promotion (CDC, 2015). Although the prevalence of cheap and convenient food options, ethnic makeup, hereditary predispositions, and modern technologies and conveniences that lead to a more sedentary lifestyle are among the contributing factors, PA (or

physical inactivity) remains as a leading cause and contributor to adult and childhood obesity in America. Figure 2 demonstrates the lack of daily PA among students in grades 9-12. The percentage of students who meet the daily recommended one hour of moderate to vigorous intensity physical activity is represented.

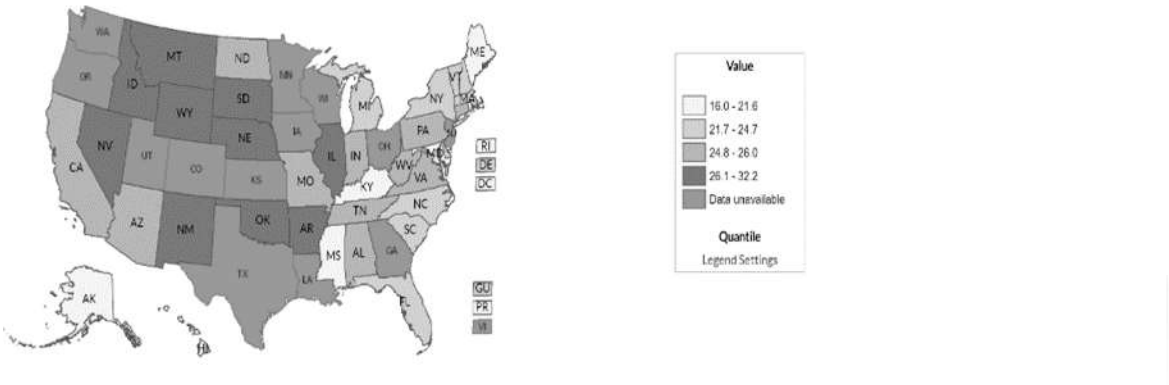

Figure 2. Percent of students in grades 9-12 who achieve 1 hour or more of moderate and/or vigorous-intensity physical activity daily. (2015). * View by Total. Reprinted from National Center for Chronic Disease Prevention and Health Promotion, Div. of Nutrition, Physical Activity, and Obesity, Adolescents who are physical active daily. Retrieved from https://nccd.cdc.gov/dnpao_dtm/rdPage.aspx?rdReport=DNPAO_DTM.ExploreByTopic&islClass=PA&islTopic=PA1&go=GO

The *2010 Healthy People* report went further to state that physical education (PE) is the "primary source of PA and fitness instruction" for children and adolescents (US Department of Health and Human Services, 2000). However, many states have reduced or eliminated PE classes at the high school level (Institute of Medicine of the National Academies of Science, 2013). When school districts look to reduce or balance their budgets, PE is one of the curriculum areas that is considered for reduction (National Association for Sport and PE, 2013). This has created many variances across the states as to the amount and frequency that local districts offer a quality PE program. The most recent *Shape of the Nation* report, released in 2012, reported on many of these differences. There are 44 states that require some sort of high school PE, but the differences among these requirements are vast (National Association for Sport and PE & American Heart Association, 2012). The added component of exemptions and/or substitutions for PE classes means that the actual amount of high school PE that takes place may be much worse than what initially existed in the report. The *Shape of the Nation Report* makes it clear that many high school students are not getting the recommended amount of 225 minutes of PE per week (National Association for Sport and PE & American Heart Association, 2013). Figure 3 depicts the percentage of daily PE of students in grades 9-12.

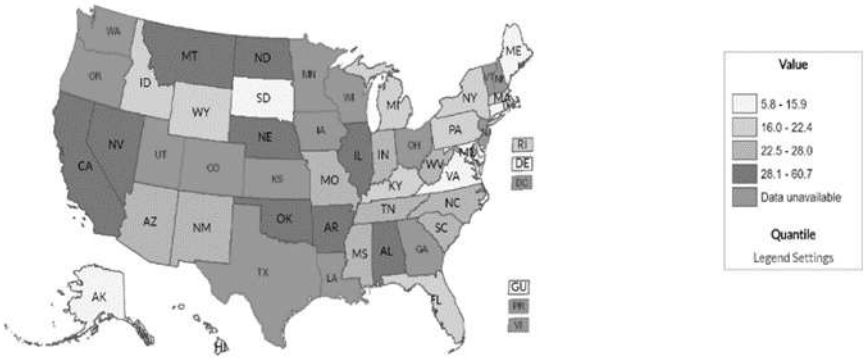

Figure 3. Percent of students in grades 9-12 who participate in daily physical education. (2015).* View by Total. Reprinted from National Center for Chronic Disease Prevention and Health Promotion, Div. of Nutrition, Physical Activity, and Obesity, Adolescents who participate in daily physical education. Retrieved from https://nccd.cdc.gov/dnpao_dtm/rdPage.aspx?rdReport=DNPAO_DTM.ExploreByTopic&islClass=PA&islTopic=PA1&go=GO

Projecting forward and including the adult population, *Healthy People* 2020, the latest report to be released, estimated that only 48.8% of American adults participated in 150 minutes of moderate PA or 75 minutes of vigorous PA each week, or an adequate combination of both (United States Department of Health and Human Services, 2013). *Healthy People* 2020 also found that 31.6% of adults participated in no PA each week, and only 20.8% of Americans meet the objectives of Healthy People 2020 for aerobic and muscle strengthening PA activities each week.

Clearly, adults are not meeting the recommendations for PA. Both the American Heart Association (2013) and the American College of Sports Medicine (2013) has recommended that adults obtain 150 minutes of moderate to vigorous PA each week. Individuals can split the 150 minutes into three to five days of exercise. The American Heart Association and the American College of Sports Medicine (2013) also indicated that PA can be broken into 10 to 20 minute sessions several times a day. Research has demonstrated that PA is an important factor in disease prevention and improved health (McLachlan & Hagger, 2011; National Association for Sport and PE, 2011; Partridge et al., 2011). The challenge is many Americans are not meeting the PA recommendations (United States Department of Health and Human Services, 2013). Adding to this problem is PE, a class that can teach proper PA habits, has been reduced or eliminated in many school districts across the nation (Institute of Medicine of the National Academies of Science, 2013).

Therefore, the stated problem is that a reduction in frequency and duration of PE in public schools is directly diminishing the leading indicator of overall health and wellness, which is PA. This continues to affect child and adulthood overweight and obesity statistics.
The purpose of this quantitative study is to examine the current PA levels of college students and its relationship to the students' prior amounts of PE.

Methods

The research for this study was a quantitative correlational design that examined the idea that greater amounts of high school physical education positively affects the PA habits of traditional college students. The study aimed to determine if a relationship exists between the number of semesters of physical education that college students receive in high school and their current physical activity habits and if relationships exist among demographic characteristics.

The International Physical Activity Questionnaire (IPAQ) and additional demographic questions were used to collect data on multiple variables that were examined for relationships through the use of statistical tests (IPAQ, n. d.). The short form of the IPAQ was used for this study, which is a publicly available, open access survey tool that requires no formal permission for use. Development of the tool began in 1998; research in 12 countries took place that demonstrated reliability and validity (IPAQ, 2005). In this study, the relationship between the numbers of years of high school physical education received were measured for a relationship with the current PA habits of the traditional college students age 18-24.

A thorough analysis was completed on the independent, dependent, and covariate variables using a variety of statistical tests. After data collection was complete, the data was first post-screened to eliminate the participants who had biases or limitations previously discussed. The remaining collected IPAQ data from the participants were then cleaned and processed. The cleaned and processed data allowed the researcher to convert vigorous PA, moderate PA, and walking into MET-minutes per week for each of these dependent variables.

IPAQ (2005) stated that these three variables must be analyzed as continuous data using median values when possible. The cleaning and processing of the IPAQ data allows for two additional dependent variables to be created: MET-minutes per week and PA classification. MET minutes per week must also be analyzed as continuous data using median values when possible. The PA classification is analyzed as categorical data. The participants were classified in the low, moderate, or high PA category based on the scoring protocol for the IPAQ, 2005). The proposed one independent, six dependent, and six covariate variables are displayed in Table 1.
Table 1

The short form of the International Physical Activity Questionnaire guidelines for data cleaning and processing, and were strictly followed (IPAQ, 2005). The first step required that all students in the sample who did not qualify based on their responses in the demographic section of the questionnaire were eliminated from analyses. They included students who were current intercollegiate athletes, members of an ROTC program, and students enrolled in a PA lab, as these individuals would have biased the PA data in a positive direction. Students who were outside of the 18 to 24-year-old category were also eliminated, and the remaining data were then cleaned further. After cleaning all the data as described above, data were processed in Microsoft Excel.

The total time for each case in each of the categories needed to be expressed in minutes, not hours, so that the required categorical analysis of MET-minutes per week could be calculated. The remaining data were then processed and converted into usable dependent variables. To process the IPAQ data, all PA data was converted into MET-minutes per week. Table 2 shows how MET-minutes per week were calculated using the collected data.
Table 2

After the MET-minutes per week were calculated in each PA category, the sum of all three categories was calculated. A new dependent variable known as total MET-minutes per week was created. Finally, a categorical score according to the IPAQ (2005) guidelines was assigned to each case based on the total MET minutes per week and the number of days and minutes of PA in each category. Each case was assigned to the low, moderate, or high PA category. This categorical data allowed for another dependent variable to be created and used for analysis.

Results

Descriptive Statistics

After initial IPAQ data cleanup, 285 people were left for SPSS analysis. To identify potential multivariate outliers, the Mahalanobis distance statistic was calculated for each respondent. Three rounds of box plots identified 91 univariate outliers that were removed and which reduced the sample to $N = 194$.

For current physical activity category, most of the respondents had either moderate (36.1%) or high (45.9%) levels of physical activity. Almost three-fourths of the sample (73.2%) were females and almost all (91.2%) were Caucasian. More than half were either freshman or sophomores; the same percentage lived in resident housing (54.6%), as compared to commuters (45.4%). The findings further showed 85% reported having high school activity outside of PE class or school sports teams at least three times a week. Number of high school PE semesters ranged from none (8.8%) to 7–8 semesters (14.9%; $M = 2.91$, $SD = 2.31$). About two-thirds of the sample (64.4%) were high school varsity athletes.

For descriptive statistics of seven selected variables, the average number of high school PE semesters was $M = 2.91$ ($SD = 2.31$). Total MET minutes per week had an average of $M = 1{,}449.95$ ($SD = 812.71$). Average high school activity level score had a mean of $M = 3.07$ ($SD = 1.38$).

As preliminary analyses, Tables 1 through 3 display the Pearson and Spearman correlations for the six dependent variables with each of the eight predictor scores. As stated above, both Pearson correlations and Spearman correlations were used to examine the relationships between the primary variables to provide statistical verification.

Cohen (1988) suggested some guidelines for interpreting the strength of linear correlations. He suggested that a weak correlation typically had an absolute value of $r = .10$ (r^2 = one percent of the variance explained), a moderate correlation typically had an absolute value of $r = .30$ (r^2 = nine percent of the variance explained), and a strong correlation typically had an absolute value of $r =$

.50 (r^2 = 25 percent of the variance explained). Inspection of the Table 1 (VPA MET and MPA MET) found 18 of 32 correlations to be significant but only one to be of moderate strength using the Cohen (1998) criteria. Specifically, there was a positive Spearman correlation between VPA MET and having participated in physical activity at least three times a week during high school (r_s = .30, p < .001).

Table 1. Pearson and Spearman Correlations for VPA and MPA MET with Predictors

	VPA MET				MPA MET			
Predictors	**Pearson**		**Spearman**		**Pearson**		**Spearman**	
PE Semesters	.16	*	.23	****	.25	****	.20	***
Gender Identity [a]	.08		.08		.04		.02	
HS Varsity [b]	.22	***	.25	****	.19	**	.18	**
Caucasian [b]	.16	*	.14	*	-.04		-.04	
Housing [c]	-.03		.00		-.02		-.03	
Year in college	.08		.07		.09		.07	
HS Activity Level Score	.19	**	.19	**	.17	*	.14	*
HS 3x / week activities [b]	.24	****	.30	****	.21	***	.25	****

Note. N = 194.

Inspection of Table 2 (walking and sitting) found six of 32 correlations to be significant but none to be of moderate strength using the Cohen (1998) criteria. The strongest correlations in the table were the negative correlations between having participated in physical activity at least three times a week during high school with the current amount of sitting. This correlation was true for both the Pearson correlation (r = -.22, p < .005) and the Spearman correlation (r_s = -.22, p < .005).

Table 2. Pearson and Spearman Correlations for Walking and Sitting with Predictors

	Walking				Sitting			
Predictors	**Pearson**		**Spearman**		**Pearson**		**Spearman**	
PE Semesters	-.09		-.04		-.08		-.10	
Gender Identity [a]	-.04		-.03		.09		.08	
HS Varsity [b]	-.14		-.10		-.21	***	-.20	**
Caucasian [b]	-.06		-.04		-.08		-.07	
Housing [c]	.10		.13		-.08		-.08	
Year in college	-.02		-.02		.08		.06	
HS Activity Level Score	-.06		-.07		-.16	*	-.15	*
HS 3x / week activities [b]	-.04		-.01		-.22	***	-.22	***

Note. N = 194.
* p < .05. ** p < .01. *** p < .005. **** p < .001.
[a] Gender: 1 = *Female* 2 = *Male*.

[b] Coding: 0 = *No* 1 = *Yes*.
[c] Housing: 1 = *Commuter* 2 = *Resident*.

Inspection of Table 3 (Total MET and PA category) found nine of 32 correlations to be significant but none to be of moderate strength using the Cohen (1998) criteria. The strongest correlations in the table were the positive correlations between having participated in physical activity at least three times a week during high school with PA category. This was true for both the Pearson correlation ($r = .23$, $p < .001$) and the Spearman correlation ($r_s = .22$, $p < .005$).

Table 3. Pearson and Spearman Correlations for Total MET and PA Category with Predictors

	Total MET				PA Category			
Predictors	**Pearson**		**Spearman**		**Pearson**		**Spearman**	
PE Semesters	.15	*	.15	*	.10		.11	
Gender Identity [a]	.04		.06		.02		.03	
HS Varsity [b]	.14	*	.11		.10		.09	
Caucasian [b]	.05		.03		-.01		-.01	
Housing [c]	.03		.04		.09		.10	
Year in college	.08		.08		.06		.06	
HS Activity Level Score	.16	*	.15	*	.12		.11	
HS 3x / week activities [b]	.22	***	.21	***	.23	****	.22	***

Note. $N = 194$.
* $p < .05$. ** $p < .01$. *** $p < .005$. **** $p < .001$.
[a] Gender: 1 = *Female* 2 = *Male*.
[b] Coding: 0 = *No* 1 = *Yes*.
[c] Housing: 1 = *Commuter* 2 = *Resident*

Answering the Research Question

The following research question guided this correlational study: What is the relationship between the number of years of physical education that college students receive in high school and their current physical activity habits? Table 9 displays the relevant Pearson, Spearman, and partial correlations for high school PE semesters with each of the six dependent variables. The Pearson and Spearman were used to examine the simple bivariate relationships between high school PE semesters and the dependent variables, whereas the partial correlation examined each relationship controlling for seven covariates (gender, athletic status in high school, ethnicity, current housing status, current year in college, high school activity participation outside of PE and sports, and high school activity [3x/week]). Partial correlations were used instead of the equivalent multiple regression model (Minium et al., 1999) for parsimony in that only one of the six partial correlations were significant and the use of partial correlations allowed for the presentation of results of all six analyses to be on one page.
Table 9

VPA MET minutes per week was significantly related to the number of high school PE semesters using the Pearson correlation ($r = .16$, $p < .05$) and the Spearman correlation ($r_s = .23$, $p < .001$) but not the partial correlation. ($r_{ab.c} = .11$, $p = .13$). MPA MET minutes per week was significantly related to the number of high school PE semesters using the Pearson correlation ($r = .25$, $p < .001$), the Spearman correlation ($r_s = .20$, $p < .005$) and the partial correlation. ($r_{ab.c} = .22$, $p < .005$). In addition, total MET minutes per week was significantly related to the number of high school PE semesters using the Pearson correlation ($r = .15$, $p < .05$) and the Spearman correlation ($r_s = .15$, $p < .05$) but not the partial correlation. ($r_{ab.c} = .11$, $p = .13$). This combination of findings provided support to reject the null hypothesis; however, none of the correlations in Table 9 were of moderate strength using the Cohen (1988) criteria.

In summary, this study used survey responses from 194 participants to examine the current PA levels of college students and its relationship to the students' prior amounts of PE. The primary hypothesis for this study (high school PE participation and current physical activity) was supported.

Discussion

The primary research question asked, *what is the relationship between the number of years of physical education that college students receive in high school and their current physical activity habits?* It was hypothesized that there would be a statistically significant correlation between the number of semesters of physical education that college students receive in high school and their current physical activity habits. Using Pearson, Spearman, and the partial correlation analysis methods, findings supported the primary hypothesis confirming a positive relationship between the amount of PE and recurrent PA levels and provided support to reject the null hypothesis. These findings differed from a study completed by Cleland et al. (2008) that found no significant correlations but saw a trend when examining time in physical education and PA behaviors 20 years later. The results from the current study were similar to the results of a study by Trudeau et al. (2004) that found weak correlations between childhood PA at ages 10 through 12 and adult PA at age 35.

The present study found that about 18% of the students in the study participated in no moderate or vigorous PA in the seven days prior to completing the IPAQ questionnaire, which was very similar to data from the National College Health Assessment (American College Health Association, 2013) and *Healthy People 2020* that reported PA data on all 18-to-24-year-olds (United States Department of Health and Human Services, 2013).

In addition to the main research question, relationships among demographic variables were explored. A Pearson and Spearman correlation analysis was performed between each of the six dependent variables with each of the eight predictor variables in the study for VPA and MPA. Eighteen correlations were discovered to be statistically significant; however, only one was at moderate strength. That moderate correlation was found on the Spearman analysis between VPA MET and having participated in PA at least three times per week during high school. Those results indicated a moderate correlation between participating in PA activities 3x/week while in high school (HS) and current vigorous PA levels for the study participants. According to the data, the predictors of gender, commuter/residential, and year in college had no significance. Predictors with

low or weak significance were HS varsity sport participation, ethnicity, and HS activity level scores.

Correlations between the same predictors and the walking and sitting data showed six of 32 correlations to be significant; however, none were of moderate strength. The strongest correlations were negative correlations between having participated in physical activity at least three times a week during high school with the current amount of sitting. This finding supported the notion that participants who reported having been physically active 3x/week or more in high school report the least amount of sitting in the seven days prior to completing the IPAQ questionnaire. Other weak correlations comparing predictors to walking and sitting consisted of participation in HS varsity sports and HS activity level scores.

Individuals who participated in a varsity sport in high school were more likely to be in a higher IPAQ PA category. They were also more likely to participate in more vigorous MET-minutes per week. These results were similar to a study by Makinen et al. (2010) that found that individuals at low levels of education who participated in competitive sports as adolescents were more likely to engage in higher amounts of adult PA. A study by Engstrom (2008) found that adults who participated in greater amounts of PA were more likely to have participated in a sports club or in track and field when they were adolescents.

A study by Horn et al. (2008) found that 12th-grade females who participated on an interscholastic sports team were more likely to be physically active the year following graduation from high school. Individuals who participated in high school sports or other competitive sports as adolescents did so voluntarily, meaning they were not required to participate, as in specific high school classes, including physical education. Thus, it can be argued that students who volunteer to participate are more intrinsically motivated because intrinsic motivation or self-determined motivation is connected to increased amounts of PA (McDavid, Cox, & Amorose, 2012; Brunet & Sabiston, 2011).

Implications for Practice

One of the major roles of SHAPE America is to promote quality physical education within the K-12 setting. SHAPE (2013) believes a quality K-12 physical education program provides the following: (1) an opportunity to learn, (2) meaningful content, (3) appropriate, (4) instruction, and (5) student and program assessment. Quality physical education programs promote positive attitudes towards PA and help students acquire a cognitive understanding of health-related fitness so they can be physically competent to be physically active throughout their lives (SHAPE, 2013). To accomplish this, SHAPE (2013) recommended that secondary students receive 225 instructional minutes of physical education per week for the whole school year. Valid research that can demonstrate that increased secondary physical education is related to increased PA behavior later in life would add value to the profession.

The self-determination theory (SDT) suggests that all people have three basic needs: the need for autonomy, competence, and relatedness (Kilpatrick et al. 2002). Studies have shown that when students feel fulfilled within these SDT components, PA activity and motivation to be physically

active were increased. When applied to the physical education setting, educators must provide correct and appropriate learning opportunities to move students through each of these SDT components. When done effectively, students move from "having to" to "wanting to" participate in PA.

Strong links have been found between intrinsic motivation and fulfillment of the need for autonomy and competence in individuals who are intrinsically motivated only for activities that have intrinsic value to them (Ryan & Deci, 2000). Research has demonstrated that an autonomous classroom environment is one that includes student choice and occasions during class for self-direction (Sun & Chen, 2010). Competence could be the ability to understand how to use fitness equipment and put together a personal workout plan, key components in the development of a physically active lifestyle. Sun and Chen stated that competence is one of the main goals of the education process. It could be theorized that greater amounts of PE received in high school encourage students to be more autonomous and competent, therefore participating in greater amounts of PA in college.

The current study explored relationships between the amount of high school physical education received and the PA habits of traditional college students. A few trends surfaced after the collected data were analyzed. Overall, for college students in the study, a positive correlation was shown between MVP and VPA levels and their prior amounts of physical education. Furthermore, the total MET minutes per week of PA in all intensity categories for college students demonstrated a positive correlation when compared to the amount of PE they received in high school. Even when controlling for all other predictors in the study (gender, athletic status in HS, ethnicity, housing status, current year in college, HS participation outside of PE/Sport, and PA activity 3x/week), the amount of high school PE had a positive effect on the PA habits of college students within the study.

These findings demonstrated the value of physical education at the secondary level. This study also demonstrated that physical education received during all four years of high school could be related to the greatest amounts and intensity of PA as a traditional college student, and further established that PA habits formed during the college years have a long-term impact on PA habits as an adult (Xiaofen et al., 2005). Therefore, it is recommended that the federal government, states, and local school districts mandate the weekly recommended secondary physical education instructional time of 225 minutes and provide funds for secondary physical education programs.

According to the most recent *Shape of the Nation* report, states with weaker physical education time mandates, such as Michigan, which only requires one semester of secondary physical education, and Wisconsin, which requires three semesters of secondary physical education, should consider increasing their mandated physical education time requirements (National Association for Sport and Physical Education and American Heart Association, 2012).

It is also recommended that state and local school districts end the practice of reducing the amount and/or eliminating secondary physical education as a cost-saving measure and/or reason to add additional instructional minutes for other subject areas. Prior research has established that physical education improves academic performance and additional time does not harm overall learning

(Trost & Mars, 2010) while promoting PA (National Association of Sport and Physical Education, 2011).

Data relevant to the seven demographic questions led to several implications. No relationship was shown between gender and physical activity levels as it related to prior amounts of physical education. Varsity interscholastic athletes participated in significantly more vigorous PA each week and were significantly more likely to be in the highest PA category on the IPAQ. These findings could suggest that these individuals could be more self-motivated and therefore participate in more PA as traditional college students. It is recommended that, if states and/or local school districts must consider offering exemptions, substitutions, and/or waivers for physical education, they only consider such exemptions to individuals who participate in interscholastic varsity sports and not other academic content areas. It is also recommended that states and/or local school districts use research-based arguments other than physical activity levels later in life when mandating for no exemptions, substitutions, and/or waivers from physical education for interscholastic sports participation. The current study and past research such as Engstrom (2008), Horn et al. (2008), and Makinen et al. (2010) established a relationship between interscholastic sports participation and increased PA later in life.

This study found no significant differences in PA levels between races, most likely due to the lack of racial diversity within the sample; therefore, no implications and/or recommendations can be made in the area of race, based on the available collected data. Additionally, no significant relationships were found between residential and commuter students in the study in any PA category. Universities that offer recreational space and/or facilities for students to be physically active can attract students to use these areas, regardless of their residential student status. However, universities could advertise these spaces using strategies that will reach both residential and commuter students. It could be recommended that universities employ strategies to retain students on campus throughout the academic day in areas that promote and advocate for increased physical activity and recreational opportunities.

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(Peer Reviewed Article)

Breaking Down Barriers: An Investigation into the Lack of Female Head Coaches in NCAA Affiliated Institutions

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Abstract

The purpose of this study was to investigate the rationales behind the gender disparity between male and female head coaches at the National Collegiate Athletic Association (NCAA) affiliated institutions. Intercollegiate female athletic participation is at an all-time high. Yet, more women find male coaches coaching their sports. This study aimed to determine what hinders women from pursuing and obtaining head coaching positions at the collegiate level in either gender sports. Interviews were conducted in two different phases with two groups of NCAA Division-I female coaches (n = 22 and 8, respectively) in the southeast United States. The findings addressed the barriers and challenges faced by female coaches while trying to be a head coach and their thoughts for pursuing coaching opportunities in men's sports. As past studies had identified, negative stereotypes and misconceptions about female coaches clearly affect respondents' perceptions about pursuing a head coaching position. Networking was highly valued as a critical factor for obtaining and keeping positions. Researchers believed with more female role-model coaches being hired by the professional leagues, this trend would inspire more women to strive for leadership and coaching positions in the sports world.

Introduction

An all-time high female participation rate in intercollegiate and high school athletics has been reached in the last three years (Sage, Eitzen, & Beal, 2019). The growth of female athletic participation has been a constant surge since the implementation of the Title IX legislation in 1972. This legislation enacts numerous regulations to support gender equality in education and public works setting. Title IX has garnered for itself the most attention and impact in high school and college athletics. Before this legislation was enacted, college and universities typically offered about an average of 2.5 female sports (Acosta & Carpenter 2014). Fifty years later, the average number of women's sports offered throughout college campus is 8.13. This number represented more than 240,000 female athletes (about 43% of total amount of athletes) competing across universities in the United States (Sage et al, 2019). The amount of growth seen in women's collegiate athletics is substantial. However, specific statistics that have declined drastically as opposed to the female athletic participation are the number and growth of female athletic coaches. The influx of new administrative and coaching opportunities in collegiate athletics were well publicized and witnessed, somehow women seem to be left behind for those employment opportunities. In 2014, there were 13,963 female professionals working throughout intercollegiate athletics. The number accounted for 4,154 head coaches, 7,503 assistant coaches, and 239 athletic directors (Acosta & Carpenter, 2014). More specifically, these numbers reflected that over 77% of

all athletic director positions were held by men. Less than 44% of those athletic teams have a female head coach (Burton 2014; Acosta & Carpenter, 2014). It was believed that the number of female coaches in female sports would continue to drop (Blom, Abrell, Wilson, Lape, Halbrook, & Judge, 2011). Ironically, before Title IX was introduced in 1972, over 90% of collegiate women's athletic teams were led by a female head coach (Stark, 2017).

The recent social movement, "Me Too," has inspired and empowered a lot of women to pursue a career in various professional fields often dominated by males (i.e., politics, business, military, and high-tech industries) and fight for gender equity (i.e., equal pay for female workers) and women's rights (i.e., compensation for maternity leave). Yet in the field of collegiate athletics, the lack of female administrators and coaches remains to be an ongoing unsolved issue. Particularly, female coaches not only have limited spots to coach female teams, they are not given the chance to lead the men's athletic teams at all. With the increase of female sport participation, it is logical to assume many females would love to engage a career in athletic administration and coaching. Becoming a coach is usually a common step to enter the field of collegiate athletic administration. Evidently, female candidates' coaching opportunities have been significantly taken by their male counterparts. Women can be inspired to become politicians, soldiers, business professionals, and many other professions. Yet, it seems it is impossible for them to even get the chance to coach sports on the male teams. Although there are currently 10 coaches and two female assistant coaches in the National Basketball Association and National Collegiate Athletic Association (NCAA) Division-I men's basketball (Greene, 2019), Becky Hammon and Katie Stowers are just sporadic exceptional individuals propagandized by media as iconic female coaches for elite men's professional sports. The purpose of this study is to gain a better understanding about two issues: (1) why female coaches continue to lose the head coaching position to males? And (2) why female coaches are not able to obtain coaching positions in male sports? The researchers would investigate the perceived stereotypes and underlying reasons that contributed to the lack of female head coaches in collegiate athletic setting. In addition, the researchers would address the common barriers that female coaches may need to overcome to obtain head coaching positions. The findings of this study could offer insight to a successful pathway that female coaching candidates could take to combat the aforementioned problems, and ultimately help women breakthrough the glass ceiling of head position hiring in the male-dominant sports. We need to clear the obstacles and misconceptions that hinder women from pursuing a successful sports career. Thus, more gender-neutral processes can be developed to help females obtain more coaching and administrative positions.

Literature Review

Scholars have provided three key rationales for contributing to the low number of female head coaches in either gender (male or female) of collegiate athletics. They include: (1) the stigma of women not belonging to the male dominated athletic field, (2) social constraints and negative stereotypes associated with female coaches, and (3) the myth that females were incapable of coaching (Acosta & Carpenter 2014*).* The researchers would address each of these concepts in detail in the following paragraphs.

The stigma of females not belonging to the male dominated athletics

Historically, men have predominant control in coaching and administrative roles in athletics. When individuals turn on the TV to watch sports, most of the time the programs will likely cover male sports and they would see male coaches guiding the teams. Some may ask why this phenomenon keeps occurring. According to Kanter (1977) and Fryklund (2019), the theory of homologous reproduction can be used to explain the hiring in collegiate athletics. This theory indicates that a male-centered athletic department would systematically replicate itself by hiring similar types of individuals to maintain existing environment and culture. The existing dominant male leaders would use exclusion and demarcation to prevent the females and other minority candidates from obtaining positions of control. It is easy to see that the sports world is primarily ran by men because the sports administrators simply adopt "the good ole boys" mentality to hire new coaches and staffs.

What was the point to even introduce Title IX, if it did not help provide more resources and job opportunities for females in administration and coaching? Ever since Title IX was implemented, the ratios of female administrators and coaches at collegiate level have steadily declined. Colleges and universities often combine men's and women's programs under one department and leave only one athletic director in charge of all athletics. According to National Collegiate Athletic Association's report (NCAA's), only 20% of all NCAA athletic directors are female, and there are only 3% of male sports coached by a female (Stark, 2017). The number of female coaches in youth sports is also significantly underrepresented. According to the report of Sports and Fitness Industry Association, among 6.5 million adults who coach youth leagues only 27% are female (Flanagan, 2017).

Unfortunately, with fewer and fewer female head coaches in athletics, this triggers a reaction with fewer and fewer role models for young girls who wish to pursue a coaching career. Few visible women coaches mean that there is a lack of role models to inspire the next generation (Auerbach, 2013; Magowan, 2015). There is a growing form of sexism that makes things even tougher for females to even go into the coaching profession. This form of stereotype starts to impact the young female athletes in their early sports career.

Social constraints and negative stereotypes associated with female coaches

Gender roles define how individuals are expected to act, dress, speak and conduct themselves based on their chosen gender (Planned Parenthood, 2018). Traditionally, our society holds a view that women are expected to dress in a feminine fashion, be polite, accommodating, submissive, and nurture the kids. Men are expected to be the bread winner by being strong, aggressive, and bold. The "role congruity theory" states that there is prejudice against females in certain types of leadership positions because leadership positions are more stereotypically linked to men. The theory shows that gender roles are related to men and women and that certain positions are viewed more as appropriate depending on the sex resulting in a male bias within male dominated fields (Burton, 2014). The different persona presented by males and females is a major reason that females are being held back from certain occupational positions in a male dominant society.

Gender stereotypes are defined as the widely accepted judgement or biases toward a person, or group of people with a specific gender (Planned Parenthood, 2018). They often lead to unfair or

unequal treatment of women, known as sexism. Gender stereotypes can be broken down into descriptive and prescriptive components (Koenig 2018). Descriptive components describe the acts and behaviors that women and men usually carry out. Prescriptive components are beliefs that lays out what men and women should do. Negative prescriptive stereotypes address undesirable conducts or behaviors that one sex should avoid engaging in or carrying out (Koenig 2018). Studies have shown backlashes can result as people engaged in conducts defined by prescriptive stereotypes (Rudman and Glick, 2010). When female coaches try to demonstrate strong leadership or devote excessive long hours to their job without focusing on taking their family, often time a reaction of anger and moral outrage may surface. People become put off when they perceive those female coaches as being tough, overbearing and neglecting their family responsibilities (Bradford & Keshock, 2009). It is quite common to see women hold themselves back for athletic jobs due to family challenges and organizational barriers (Mazerolle, Burton, & Cotrufo, 015). Because dominant female coaches can easily violate prescriptive stereotypes and upset the public, therefore they are less likely to get hired for head coaching positions (Rudman Moss-Racusin, Glick, & Phelan, 2012).

Female athletic coaches, especially at the collegiate level, often violate the norms of typical gender stereotypes. Many female coaches need to be dominant, aggressive, and competitive in order to secure their job, yet these stereotypical male traits may make them unpopular (Welch & Sigelman, 2007). For athletes at the youth level, the coach's gender and leadership style can leave a lasting impression on boys and girls. Parents across the country may not even be aware of how social stereotypes are affecting these young athletes. For instance, one mother was vetoed by her children as a coach, because she is their mother. Her kids do not even want her to cheer on the field (Flanagan, 2017). Research has shown that men and women can have similar resumes, but the violation of certain positive prescriptive stereotypes can stir up public prejudice toward female candidates (Gill 2004). Female coaches labeled as masculine, strong willed, or a workaholic would have a hard time securing a top leadership role.

Common misconceptions about female coaches

There are many misconceptions and myths throughout the sport's community regarding female coaches. Many of these misconceptions are created based on gender stereotypes and perceived gender roles. These untrue assumptions can really hurt women's chances for pursuing head coaching positions. One of the most prevalent misconceptions found in past studies is that females are incapable of coaching male athletes and their sports. Male athletes have doubt about a female coach's coaching style. Often, female coaches are perceived to be easy going and less intense (Murray, Lord, & Lorimer, 2018). Several female coaches of men's sports have expressed that they need to give a strong first impression and "portray an unshakable presence" in front of male athletes (Kamphoff, 2010). However, they did not feel it necessary to express the same attitude while coaching female athletes (Blom, et al. 2011). The reality is that coaches must adapt the appropriate coaching styles to meet the needs of their athletes whether being tough and demanding or soft and caring.

Some might attribute a female's inability to coach male athletes because they have not played the sport before or have not played the sport at the professional level (Hensley & Chen, 2019). For

example, it may be difficult for females to coach football, because they do not play football on men's teams. Ironically, the same argument can be made for male coaches who coach female softball. Besides, many successful male coaches of professional leagues or elite collegiate programs did not play the sport they coach at the elite level. Playing experience alone does not make someone a great coach. Therefore, denying female's coaching opportunities due to their lack of playing experience in male sports should be disputed (Walker & Bopp 2010).

Another common misconception about female head coaches is that they lack knowledge of the game compared to their male counterparts. There are tons of heartbreaking stories about females being forced out of their jobs. There is a stigma that females are not as good as or as strong of coaches as their male counterparts. (Benbow, 2015; Hensley & Chen, 2019). Welch & Sigelman, 2007). Many also pointed out that male athletes may not respect female coaches' authority and question their knowledge of the games (Kalin & Waldron 2015). Women have long been underrepresented in coaching professions. Historically, men have held coaching positions in athletics for a long period of time, thus it gives athletes a false sense about male coaches' confidence and superior knowledge (Frey, Czech, Kent, & Johnson, 2006). Kelsey Martinez's tenure as the first ever-female strength and conditioning coach in the National Football League clearly illustrates this point. She had to work extra hard to prove her ability, but was released quickly because she was critically scrutinized (Gehlken, 2019). The aforementioned assumptions often lead to a preference of male coaches over female coaches by athletes. In fact, many male athletes have never experienced a female coach throughout their playing career. It is unrealistic for men to assume females cannot coach, because they literally have not worked with female coaches before.

Another huge misconception is that the equal amount of job opportunities is available to women for pursuing coaching careers like men. In fact, women have less than a half of the opportunities that men do. There were only 2-3% of female coaches in male sports at the collegiate level. The cross-over effect in athletics (men crossing over to coach female sports) has decreased the odds of women getting head coaching positions in women's sports due to the increase of male applicants (Blom, et al., 2011). The cross-over phenomenon is not interchangeable for women, and therefore leaves less opportunity for female coaches.

Methodology

Participants and Procedures

In order to address the female coaches' experiences and perceptions about being a head coach of collegiate athletic sport, this study took a two-step process to collect thoughts and feedback from collegiate female coaches and administrators. The initial step took place between early February and mid-March of 2019. The researchers reached out to 55 female coaches and administrators of 13 mid-size NCAA Division-I institutions in southeast and mid-west region via emails and phone calls. Twenty-two participants responded to our invitation to conduct the guided interview. All of them were current head coaches, assistant coaches or current administrators with former head coaching experience. Although none of the participants are coaching a male sport right now, a few administrators do oversee both male and female sports. Participants' ages range from 31-52.

During the initial process, each participant was interviewed either on the phone or face-to-face for her responses to a series of survey questions concerning elements such as: stereotypes associated with female coaches; and possible professional challenges encountered by female coaches. Participants were guided to express their agreement to a series of identical Questions (or statements). They could agree, disagree, or remain neutral to the issue. Researchers ensured that participants were given adequate time to thoroughly think through questions and make notes if so desired. They could also address each of the questions with additional open-ended comments.

Later, eight of the twenty-two participants voluntarily agreed to do the in-depth interview with the researchers. Additional qualitative information was collected during the 20-minute in-depth interview with eight voluntary coaches. They shared their coaching experience and provided suggestions and views on how fellow female coaches may pursue a head coaching position in a male driven athletic environment. The phone interviews were conducted in the month of April. Notes were taken by the researchers periodically throughout each step of the interview process. The second phase interviews were also recorded, so researchers could refer to original conversations to examine the accuracy of responses. Among those female coaches, four were head coaches and four were assistant coaches. Their respective coaching sports include women's basketball, women's lacrosse, women's golf, women's volleyball, and softball.

Instrumentation

Participants of this study were guided by the researchers through a semi-structured initial interview process with each participant aware of the purpose of the study. Participants were asked to express their agreement on ten statements (or issues) (please see Table 1 and 2 for details). Those statements were composed based on the review of past literature (Acosta & Carpenter, 2014; Baker, 2014; Bradford, & Keshock, 2009; Kalin & Waldron, 2015; Welch & Sigelman, 2007). They were created to explore female coaches' perceptions on gender stereotypes experienced in their work, general environment in athletics, and their ambition for pursing a head coaching job in men's sports.

For the in-depth interview, interview questions (n = 9) were broken down into three sections (see Appendix 1). The first part of the interview was about the participant's individual sport experience and playing history. Participants got to share their prior athletic experience and the significance of their role models in coaching. The second section of the interview was devoted to their transition process in coaching and barriers they had faced in their pursuit of a coaching job. In the final section, participants were asked to discuss their thoughts on why females do not hold more coaching positions in athletics.

Results

A total of twenty-two respondents participated in the initial interview. The data was collected in a one and a half-month period. After analyzing the participants' general responses and additional comments, the researchers used two tables (Table 1 and 2) to quantitatively illustrate the

participants' responses toward the ten designated questions. Table 2 focused on personal experience as to whether participants had dealt with it or not. Table 3 explored participants' agreement toward six fixed statements related to gender stereotypes associated with female coaches in athletics. The results showed 21out of 22 participants (95.45%) had dealt with gender stereotypes as an athletic coach at some point throughout their career. Seventeen of 22 participants (77.3%) claimed they were stereotyped by their male administrators. Sixteen participants (63.63%) stated that they had been told they did not present enough leadership qualities at their job. Four participants had heard from the male ADs saying their program was looking for someone with "stronger" qualities. Two participants were blatantly told that hiring departments were not considering women for the position at all. The ADs simply did not believe that the athletes would respond to a female coach. Overall, a high majority of participants (18 out of 22; 81.8%) claimed they felt they were more (or equally) qualified for the position, yet the institution still hired a male candidate.

For these female coaches, 63.63% of them felt they were treated differently from their male counterparts on a day-to-day basis. Five participants shared they had been disrespected by other fellow coaches due to their gender or had been questioned for their coaching skills and knowledge. Several female coaches also perceived their supervisors used double standards to judge and evaluate their performance. The overall answers to these questions are astounding, since many of the participants clearly experienced stereotyping or discrimination in their career.

Table 1. Participants' perceptions on gender hiring

Statement	Yes	No
Have you ever dealt with stereotyping in your current position?	95.45%	4.55%
Have you ever thought about you would hold your current position?	0%	100%
Has a man ever been chosen for a position over you, which you felt you are more qualified for?	81.81%	18.19%
Have you ever been chosen for a position over a man, which you felt he was more qualified?	13.63%	86.37%

Table 2. Participants' agreement to guided statements

Statement	Agree	Neutral	Disagree
I have been stereotyped for not having enough leadership qualities.	63.63%	27.27%	9.10%
I felt the male colleagues who I work with are treated differently.	63.63%	22.72%	13.65%
I felt women's opportunity for being a head coach have been threatened.	36.37%	31.81%	31.81%
Athletes are more likely to respond to male coaches (men in power).	40.90%	31.81%	27.27%
I have been considered as soft spoken and caring.	81.81%	18.18%	0.0%
I have considered to be a head coach of men's team (or an administrator of men's athletics).	45.46%	27.27%	27.27%

Of the eight participants who participated in the in-depth interview, all of them were currently coaching the female sport they had played in college. Seven coaches (87.5%) stated that they had a strong female role model in their athletic careers. The female role model identified by everyone

interviewed has one similar characteristic. All the role models are participants' former playing coach. The researchers analyzed eight participants' various responses and summarized them into four factors: (1) negative stereotypes, (2) misconceptions of male counterparts, (3) family duties, and (4) lack of networking. These four factors are viewed as the primary barriers and challenges for women pursuing or maintaining a head coaching position in collegiate athletics. Seven coaches further expressed they were hesitant to pursue head coaching positions due to the negative stereotypes associated with female coaches. Three coaches indicated family obligations were another obstacle for women to maintain a head coaching job. For more time will need to be devoted to game analyses, public speaking engagement, and recruiting. They would need to sacrifice more family time during the season to deal with the coaching duties. It was not a surprise for the participants to believe that male athletes were more likely to buy-in to male coaches' instructions and ideas. All the coaches expressed this assumption and stated their credibility often being challenged. Three coaches even believed that it was a waste of time for them to apply for the job, if the position had been historically held by a male coach. In fact, seven of the eight coaches who were involved in the in-depth interview really had no interest in coaching a male sport. They seemed to believe their primary focus should be to contribute to the growth of female athletics first. Whether they were interested in men's athletic coaching jobs or not, all participants agreed the lack of effective networking would hamper their chance for advancing to head coaching role.

Discussion

The results of this study showed that the participants' perceptions about stereotypes and job difficulties associated with female coaches were similar to the viewpoints presented in the past studies. The use of open-ended responses was intended to yield more different types of comments from various interviewees. Interestingly, many of these participants who were involved in the second phase interview still reiterated similar thoughts and experiences while reflecting their coaching journey. A high majority of the participants had experienced some sort of gender discrimination and stereotyping during their career or within their current position.

All eight coaches of the second phase interview had a former coach as the strong role model. As Imeson (2017) stated, the guidance of athletes' female mentor had a significant impact on female athletes' desire to remain in a coaching capacity, when they finished their playing career. Female role models have definitely posed a significant effect on the desire to remain in the sport for the participants of this study. They all expressed, without having a decent playing career and working hard to learn from their role model (mentor), they would not get a chance to land a coaching job in collegiate athletics. It is absolutely ridiculous to question their knowledge of the sport, motivation, and work ethics. It is extremely rare to find female coaches at the collegiate level without a background as an athlete. In men's college basketball (or professional basketball), we are quite sure having elite playing experience is not a mandatory qualification to be on a coaching staff. For example, the head coach of Texas Tech, the 2019 NCAA Tournament Finalist, was a student manager for Indiana back in his college days. For female candidates to have a chance to coach in college sports, their former experience and qualification must be far more exemplary in order for them to beat male candidates for the position. Some participants expressed their performance had always been evaluated critically. Evidences had shown female coaches were quick to be judged and had less margin for any error (Gehlken, 2019).

Having a strong professional network was an essential component that all participants valued for successfully obtaining a collegiate coaching position. Many of our twenty-two participants (in the first phrase of interview) and all eight coaches of the second phrase interview begin their journey as a graduate or volunteer assistant. These positions are regularly held by former student-athletes right after their graduation. Nearly all participants of this study ended up working for a former coach. This practice serves as a great opportunity for newly retired collegiate players to begin their coaching career. Creating a prolific network through one's playing experience will increase the probability for landing a coaching job. Often, female coaches started from these non-salaried or low-paid positions to get their foot in the door and gradually cultivated their coaching techniques and advanced their coaching rank. A study had shown when the position of AD in the athletic department was held by a female, there was a higher percentage of female head coaches than when the AD position was being held by a male (Acosta & Carpenter 2014). However, even under a female athletic director, the percentage of female head coaches on staff was still under 50%. Researchers believe it is important to point out the large gender disparity in AD and head coaching positions throughout the collegiate athletics. When there are not enough female ADs to help female coaching candidates to build their professional network, it makes networking more difficult and unrealistic for a newly graduated young female candidate.

On responses to Question 6 and 9 of the second phrase interview, negative stereotypes and misconceptions associated with female coaches were viewed as main reasons that affect female coaches' decisions in staying in their profession. Seven of eight participants indicated colleagues' unkind words and attitude as main reasons that discourage women to pursue a coaching position or stay in coaching. Their supervisor and colleagues often did not respect their ability for holding the job or trust them during the critical/competitive game situation for giving instruction. One participant indicated a misconception floating around women's college basketball. Many believe female head coaches need to have a male coach on the bench to draw up plays in late game scenarios. A common misconception like this can hurt female coaches' confidence and make ADs distrust well qualified female coaches.

Another participant vividly remembered the story shared by Carol Hutchins, the head softball coach at The University of Michigan, in the 2017 NCAA Champion Magazine. Numerous athletic directors of other institutions solicited names of potential head coaches from Coach Hutchins. Every time that she brought up names of female coaches, those directors would reject her suggestions. The general excuses included those ladies did not apply, they did not seem to be interested in the job, they might not be tough enough, or they were probably not ready for the call. Coach Hutchins was frustrated by these responses. She was quite sure that Jim Harbaugh (Michigan's Head football coach) did not apply for the Michigan job, either, but the university went out and got him anyway. All she expects is that more schools would go out and hire a good female coach. Female coaches are just as capable of handling coaching and administrative duties as their male counterparts. The problem seems to stem from the male athletic administrators (ADs) simply not wanting to hire females in top coaching or administrative positions.

The majority of participants of the second phase interview do not consider the family duties as main barriers in pursuing a head coaching position. The researchers did not go deeper to discover why participants felt this way. We assumed this small group of samples might have strong support from

their family members. Since several interviewees of this small group were experienced head coaches already, they probably understood how to better handle family responsibilities with better time management and prioritization. Researchers sincerely hope that more educational workshops and administrative support in the department can be provided to help future female coaching candidates properly handle familial duties. There is no reason for female coaches to sacrifice their career aspirations due to the family commitment. Unfortunately, many successful female professionals seemed to have dealt with this issue before.

Noted that the presence of male coaches in female sports varied at different levels among sports, few participants perceived that women's basketball and softball had more male presence and dominance than the women's lacrosse. The women's lacrosse coaches felt that many women's lacrosse programs were run by women. Although males do play the sport of lacrosse, for certain reasons, there is no tendency of men trying to pursue a coaching job in women's lacrosse. Researchers found it was unique to learn about female coaches' perception about the gender cross-over effect on coaching in collegiate athletics. Only about 46% of 22 respondents were interested in pursuing a coaching job in men's sports. Over two third of the majority did not feel that male coaches' occupancy of head coaching positions in female sports was a concern (nearly 32% of participants hold a neutral position on this issue). We assume more women would want to try and pursue those positions in men's sports in order to promote gender equity in hiring or empowering women from a social standpoint. Participants told us they were either not interested at jobs in men's athletics or would focus on improving the number of coaches in women's sports. While looking at the largely unequal distribution of male and female coaches in sports, this may be a prominent cause of the cross-over effect. There were rarely female coaches in men's athletics because women do not want to coach men at all. However, coaching in the men's sports can really open up a coach's financial advancement. It may also create a strong social movement by having more female coaches to coach men's sports, because these examples symbolize the actual breaking through of the gender barrier. We had witnessed several 2020 Super Bowl commercials illustrating this theme. The researchers believe the remaining burden for the future professionals was to educate and convince the public that women are capable of coaching men. We need to understand their low desire for coaching of men's sports was truly about lack of interest, not about fear of not being accepted.

Conclusions

In conclusion, it appears that female candidates still struggle with different types of stereotyping in collegiate athletics today. Our results showed stereotypes, misconceptions, and lack of networking can have detrimental effect on female candidates when they pursue a collegiate coaching career. By no means are we attempting to blame the male dominance and control as the sole cause of the decrease of female coaches in collegiate athletics. However, if the athletic programs across the nation continue to operate in the systematic fashion as seen in the Review of Literature, it certainly makes it more difficult for women to be hired into those leadership positions.

One of the researchers can testify, with years being coached by both men and women, female coaches usually left a bigger impact on leadership influence than male coaches did. Leadership is not something that is transferred from generation to generation, it is something that is earned

through hard work and determination (Baker, 2014). Women will continue to rise through the ranks in collegiate athletics because they are worthy of holding the leadership role and capable of helping others develop and grow. As one of the interviewees mentioned, enough women realize coaching as a viable job opportunity, because they might not have a female role model along the way to guide them (Auerbach, 2013). The researchers believe more professional leagues will promote and share the successful stories of the inspirational female figures in sports (i.e., Becky Hammon, Sarah Thomas, Jen Welter, and Katie Stower) through mass media (Springer, 2015). More female coaches being hired by the professional leagues should inspire more future female athletes to seek opportunities in coaching professions, and gradually change the hiring culture of the collegiate athletics as well (Grautski, 2017).

Men have been gaining more and more coaching roles in youth leagues for many years. In general, men are more driven with work, while the society expects professional women to maintain a balance work-life relationship. With more men involved in coaching at various levels (i.e., youth leagues, travel leagues, interscholastic athletics, and collegiate athletics), athletes starting at a young age would begin to get accustomed to women not being the one coaching. This phenomenon can affect the way boys and girls view the adult female coaches. The researchers believe it is vital to have more women coaches coaching in youth sports in order to effectively alter the misconceptions about the female coaches.

One of the main limitations of the study was the small number of individuals responding to the survey. It was really difficult to solicit qualitative responses from a great amount (greater than 100) of female college coaches due to a limited time frame. In addition, many participants may share similar kind of athletic environment, since they mainly worked under a similar size of athletic department within two mid-major conferences. It would be ideal for the further researchers to expand the participant pool to schools of major conferences. Perhaps different results of perceived barriers and willingness for pursuing a head coaching job can be obtained.

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Appendix

Appendix 1. Second Phase In-Depth Interview Questions

Section 1. Individual sport experience and playing history
1. Your past playing experience:
2. Your coaching experience:
3. What made you pursue coaching?
4. Did you have strong female role models throughout your athletic career? (Coaches, administrators, etc.)
Section 2. Barriers related to the profession
5. Was the transition from a player into a (head) coach easy for you?
6. What were the greatest difficulties you found in pursuing a head coaching position?
7. Do you think these challenges may be different for men candidates who are pursuing the same position?
Section 3. Perceptions about pursuing a head coaching job
8. Would you ever pursue a coaching position in a male sport? Why or why not?
9. In your opinion, what is the main reason(s) as to why women don't hold more coaching positions in athletics?

(Peer Reviewed Article)

Role of the MCT-1 T1470A polymorphism (rs1049434) in the Uptake of Lactate in Resistance Trained Females

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Abstract

The purpose of this investigation was to examine the role of the MCT-1 T1470A single nucleotide polymorphism on blood lactate clearance rates in resistance trained females. Twenty-seven resistance trained females participated in our investigation. Each participant performed a thirty second Wingate test on a cycle ergometer. Lactate was measured before the test, immediately following the test and -10, -20, -30 and -40 minutes post. Lactate decreases were calculated for each 10-minute period. Participants were divided into three groups based on their T1470A genotype (TT, TA, AA). There was no significant interaction between genotype and lactate clearance ($p > 0.05$), however the TT genotype group had significantly higher clearance rates when collapsed across time points ($p \leq 0.05$). Lactate clearance was higher in the TT genotype when compared to both the TA genotype ($p < 0.05$) and the AA genotype ($p < 0.05$). This effect was caused by significantly higher lactate accumulation in TT genotype subjects immediately following the Wingate test when compared to TA ($p < 0.05$) and AA ($p < 0.05$) subjects. To our knowledge, our investigation is the first that demonstrates that the MCT-1 genotype effects lactate clearance in women. Our findings differ from the body of literature carried out using male participants, which suggests that the T allele adversely effects lactate clearance. Further, our findings indicate that peak lactate clearance occurs earlier in the TT group compared to the TA and AA group in resistance trained females. Future research should continue to examine the MCT-1 polymorphism in women and how this genetic information can be integrated into exercise prescription protocols.

Key words: MCT-1 T1470A

Introduction

The purpose of this investigation was to examine the role of the MCT-1 polymorphism on blood lactate clearance rates in resistance trained females. Lactate is a byproduct of anaerobic glycolysis, which is the primary way skeletal muscle creates energy (ATP) during intense physical stress or exercise. Lactate decreases the pH of muscle cells and blood, therefore reducing the functional capacity of skeletal muscle to carry out work. Following exercise, the fates of lactate are either oxidation by skeletal and cardiac muscle or gluconeogenesis by hepatic tissue (Bergman et al., 1999). However, during active recovery following high intensity exercise the principle consumer of lactate is skeletal muscle (Gladden, 2004). The clearance of lactate by skeletal muscle during active recovery appears to be most dramatic during the first twenty minutes following the lactate accumulation event (Baker & King, 1991; Baldari, Videira, Madeira, Sergio, & Guidetti, 2004; Menzies et al., 2010). Our gene of interest, monocarboxylate transporter-1 (MCT-1), encodes the transporter protein that facilitates the majority of lactate reabsorption into skeletal muscle via symport with a proton (Cupeiro et al., 2016). There is evidence that a single nucleotide polymorphism (SNP) at nucleotide 1470 (AA, TA, TT) and the resultant amino substitution at amino acid 490 (Glu, Asp/Glu, Asp) in the sequence of this gene leads to downstream functional differences in the encoded protein pump's ability to facilitate lactate reabsorption (Cupeiro et al., 2016). This relationship has never been explored in resistance trained women, who produce less lactate during exercise compared to men, even when normalized for body mass (Hicks, Kent-Braun, & Ditor, 2001). The aim of this study is to further examine the relationship between the MCT-1 polymorphism and lactate clearance and to see if this relationship is moderated by differences in skeletal muscle caused by sex.

Sexual dimorphisms in skeletal muscle performance have been extensively characterized and have been attributed to differences in levels of systemically circulating hormones (Brown, Ning, Ferreira, Bogener, & Lubahn, 2009; Haizlip, Harrison, & Leinwand, 2015), muscle mass (Brown et al., 2009; Haizlip et al., 2015), and skeletal muscle fiber-type distribution (Haizlip et al., 2015; Staron et al., 2000). Cellular metabolism is an important consideration in the comparison of lactate production and clearance in men and women. Differences in metabolism and substrate utilization have been examined exhaustively and it seems men have higher glycolytic capacity and a greater reliance on these capacities than age and training status matched women (Tarnopolsky, 1998). For example, women have a lower respiratory exchange ratio on average compared to men when performing steady state exercise at sub-maximal $V0_2$ max intensities (Carter, Rennie, & Tarnopolsky, 2001; Devries, Hamadeh, Phillips, & Tarnopolsky, 2006; Romijn, Coyle, Sidossis, Rosenblatt, & Wolfe, 2000; Tarnopolsky, 1998). This suggests women preferentially metabolize fat compared to men when working at the same relative workload. Muscle biopsy studies indicate that this preferential metabolism of glucose in men is not caused by increased glycogen storage capacity compared to women (Tarnopolsky, 1998). There is evidence that substrate utilization rates appear to be at least partially regulated by fluctuation of sex hormones associated with menstrual cycle (Devries et al., 2006; Romijn et al., 2000). This sex hormone theory is further supported by a study indicating that women spared glycogen at a higher rate during the luteal phase than the follicular phase of the menstrual cycle (Devries et al., 2006).

Due to these sex differences in glucose metabolism and subsequent lactate production during high intensity exercise, we examined the role of the MCT-1 polymorphism in lactate clearance in

resistance-trained females. Cuperio and colleagues observed that the MCT-1 polymorphism likely plays a smaller role in lactate clearance in women compared to men (Cupeiro et al., 2012). However, this study focused on subjects with no prior training status requirement and was carried out during circuit training which generally evokes a smaller lactate response than the thirty second Wingate test. To our knowledge, the relationship between MCT-1 genotype and lactate clearance has never been explored in resistance trained women, where we expect higher lactate levels to result in genotype-based clearance variation. We hypothesize that by recruiting resistance trained women with presumably more muscle mass than prior investigations and by using the 30 second Wingate we would create a large enough initial lactate accumulation event to observe that that the MCT-1 SNP effects women's ability to clear lactate just as it does in men.

Methods

Participants

A power analysis conducted with G*POWER (Unviersitat Kiel, Germany) determined that 18 participants were needed in the present study for a power of 0.80, with an effect size of 0.3 and an a = 0.05. We collected additional participants due to low sampling rates of the TT genotype. For the purposes of this study, 27 resistance trained women (age 20.8 ± 2.0 yrs, mass 65.0 ± 8.4 kg, height 166.2 ± 5.7 cm) were recruited for participation. Participants were classified as resistance trained if they self-reported resistance training more than three times weekly for the previous six months. Prior to participation, subjects provided written informed consent that was approved by the university Human Subjects Committee. Participants were advised not to eat or drink for two hours prior to testing to avoid contamination of salivary samples. Further, participants were asked to refrain from exhaustive exercise for 24 hours prior to testing.

Protocol

Participants' blood lactate was determined through capillary sampling in the fingers (Lactate Plus, United States). A baseline sample was taken immediately upon arrival into the laboratory prior to the participants mandatory warmup. The warmup consisted of walking at 3.2 mph on the treadmill for two minutes. Following the warmup period, participants performed a 30 second Wingate test on a cycle ergometer (Monarch, Sweden). Peak power and minimum power were determined in real time and fatigue index was calculated for each participant. Follow-up blood lactate measurements were taken immediately following exercise as well as -10, -20, -30 and -40, minutes post exercise. Immediately following the Wingate test participants began recovery exercise which consisted of walking on a gradeless treadmill at a pace of 3.2 mph for the duration of the 40-minute blood sampling period.

Genotype Analysis: Saliva was collected from subjects by vigorous swishing with sterile Phosphate Buffered Saline (PBS). Cells were pelleted and washed with PBS before storage at -80°C. Genomic DNA was subsequently purified using the QIAmp DNA Blood Mini Kit (Qiagen, Germany). A 418 base pair fragment of the MCT-1 gene (NM_003051.3) flanking the T1470A polymorphism was amplified via PCR using Phusion High-Fidelity PCR Master Mix (New England Biolabs, USA) with the addition of 3% dimethyl sulfoxide. Primers for amplification were as follows: forward primer 5′ - CGG CTC AAT GAC ATG TAT GGA TAC TAC - 3′, reverse primer 5′ - AAA TCC CAT CAA TGA ACA ACT GGT ATG ATT TCC AC - 3′ (Figure 1). The amplification program

consisted of initial denaturation (98°C, 30 seconds); 30 cycles of denaturation (98°C, 10 seconds), annealing (55°C, 30 seconds), and extension (72°C, 30 seconds); and final extension (72°C, 10 minutes). Successful PCR was confirmed via electrophoresis on a 1% agarose gel. PCR fragments were enzymatically purified with EXO-SAP IT (ThermoFisher, USA) following manufacturer's protocol. Purified fragments were subjected to Sanger Sequencing at GeneWiz LLC using the forward PCR primer. Genotype was determined by visual inspection of the sequencing trace files.

Statistical Analysis

In order to asses lactate clearance rate changes, lactate removal rates were calculated for each ten-minute interval. This was accomplished by subtracting the blood lactate concentration at the beginning of the phase from the blood lactate measured at the end of the phase. A one-way mixed factorial ANOVA [genotype (AA, TA, TT) x lactate clearance (0-10 min, 10-20 min, 20-30 min, 30-40 min)] was used to examine interactions between MCT-1 genotype and lactate clearance rates across time. Alpha values were set at .05 and Bonferonni corrections were used in all analyses. This statistical model was chosen to mimic that of Cuipero's lab (Cupeiro et al., 2012). In order to observe if individual genotypes have differences in lactate before or immediately following the Wingate test a one-way ANOVA was run genotype x lactate level (pre, post) at both time points. Additional one-way ANOVA were run between genotype and age, height, weight, peak power, minimum power and fatigue index.

Results

Genotype frequencies were 10 (37.0%), 15 (55.6%) and 2 (7.4%) for AA, TA and TT respectively. The interaction effect between genotype and lactate clearance was non-significant ($p = 0.123$); however, there was a significant between-subjects main effect for genotype ($p = 0.003$) (Figure 1). The initial lactate production was higher in the TT group when compared to TA ($p = 0.001$) and AA ($p = 0.003$) (Figure 2).

Beyond producing higher levels of lactate, TT subjects cleared lactate earlier in the active recovery period. Lactate clearance in the TT group was significantly higher than AA ($p = 0.009$) and TA ($p = 0.002$) in the 0-10 minute interval. TT subjects experienced peak lactate clearance in the 0-10 minute interval whereas AA and TA subjects experienced peak clearance in the 10-20 minute interval (Figure 1).

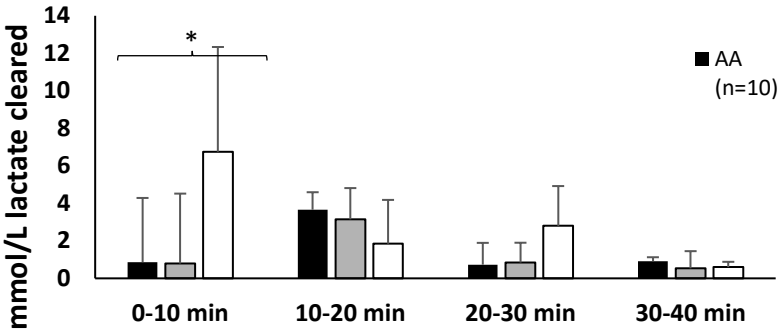

Figure 1 Lactate clearance of each genotype across time (mean ± SD): ANOVA revealed a significant difference in clearance between TT and TA (p=0.002) as well as AA (p=0.009) at the 0-10 minute time interval. Peak clearance for TT occurred in the 0-10 minute interval whereas peak clearance for TA and AA occurred in the 10-20 interval. Significance of ANOVA model was set to (α=0.05).

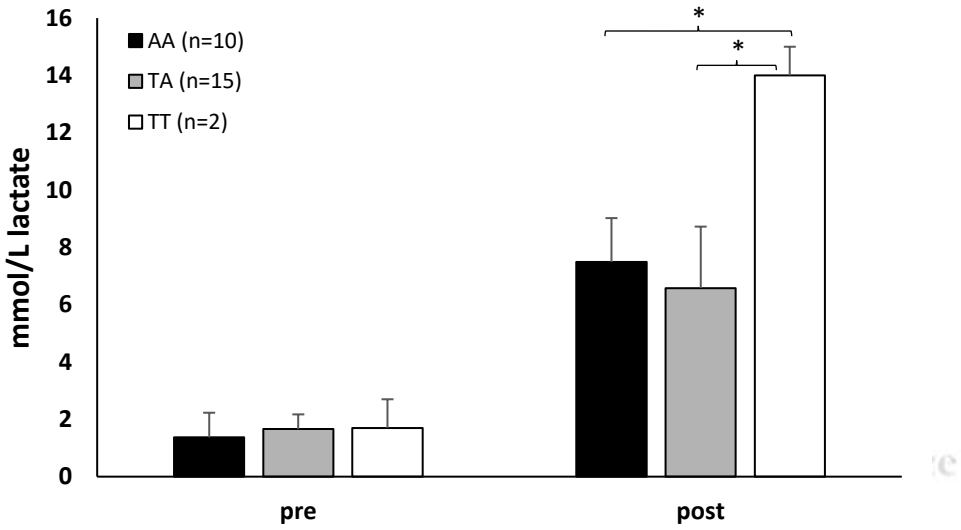

Figure 2 Basal and immediately following Wingate lactate levels (mean ± SD): ANOVA was utilized to examine basal and immediately post exercise lactate levels. Immediately following exercise, the TT group had significantly more lactate than the TA (p=0.001) and AA (p=0.003) groups respectively. Significance of ANOVA model was set to (α=0.05).

There were no significant main effects for genotype and peak power (p = 0.194), minimum power (p = 0.569) or fatigue index (p=0.648). Further, there were no main effects between genotype and any anthropometric variables (Table 1).

Table 1 Genotype, Demographic and Wingate Performance Data (mean ± SD): Data presented as mean plus or minus standard deviation. Significance of ANOVA model was set to (α=0.05).

	TT (n=2)	TA (n=15)	AA (n=10)	*p*
Age (years)	20.9 (±1.29)	20.73 (±2.31)	20.5 (±2.12)	0.959
Height (cm)	165.23 (±5.88)	167.44 (±5.52)	169 (±4.24)	0.534
Weight (kg)	61.75 (±5.28)	66.18 (±8.45)	70.5 (±9.76)	0.211
Peak Power (watts)	691.00 (±52.33)	577.64 (±87.82)	567.45(±87.69)	0.194
Minimum Power (watts)	286.50 (±85.56)	239.29 (±85.6)	253.10 (±57.59)	0.569
Fatigue Index (%)	58.89 (±9.27)	58.89 (±9.07)	55.05 (±9.18)	0.648

Discussion

Our most noteworthy finding is that the TT genotype cleared lactate earlier during the active recovery period when compared to the TA and AA groups. Peak lactate clearance for the TT group occurred in the 0-10 minute interval whereas peak clearance for the TA and AA groups occurred in the 10-20 minute interval. Further, we demonstrated similar lactate production levels to the research that has been carried out in men, which confirms that the Wingate test is a valid method to study the MCT-1 polymorphism and corresponding lactate clearance.

To our knowledge, our investigation is the first that has reported a significant main effect of the MCT-1 genotype on the lactate clearance rates in females. This main effect for genotype was caused by the TT group's initial lactate response being 47% and 53% higher than the AA and TA groups respectively. It is likely that we would have seen an interaction effect between genotype and time at the 0-10 minute and 10-20 minute if our TT genotype was not under-powered (n=2). These results differ from the existing literature which found that the T allele adversely effects lactate clearance (Ben-Zaken et al., 2015; Cupeiro et al., 2012; Fedotovskaya, Mustafina, Popov, Vinogradova, & Ahmetov, 2014; Sawczuk et al., 2015). Again, it is important to note that these investigations featured male participants with only one exception (Cupeiro et al., 2012).

Our data are in disagreement with Cupeiro's 2012 publication which suggests that the MCT-1 SNP only plays a role in lactate clearance in men (Cupeiro et al., 2012). However, it is important to note that our study differed from Cupeiro's in two critical ways. First, our female population was resistance trained. Second, we used a 30 second Wingate test to evoke a lactate response rather than a circuit training session.

Our investigation captured only 7.4% of participants having the TT genotype. There has been a wide variety of MCT-1 genotypic frequencies reported in the literature, so our results are not surprising. Several labs have demonstrated a nearly even distribution between the three genotypes (Ben-Zaken et al., 2015; Cupeiro et al., 2012). However, it has also been demonstrated in athletic

populations, like the participants we recruited, that there is a wide variety of genotype and allele frequencies (Fedotovskaya et al., 2014; González-Haro et al., 2015; Sawczuk et al., 2015). We agree with hypotheses in the literature that these differences in genotype frequencies between athletic populations are due to sport specialization (Fedotovskaya et al., 2014; González-Haro et al., 2015; Sawczuk et al., 2015), the adaptive process of natural selection in populations, and the neutral process of genetic drift in populations of different origins (Cupeiro et al., 2016).

Practical Applications

Given our results, it is logical that athletes and fitness coaches who have access to gene sequencing technologies should be considering the MCT-1 SNP in their exercise prescription protocols whether the client is male or female. The use of MCT-1 gene sequencing data will be of importance to those who compete in sports and occupations where lactate accumulation events occur in rapid succession (hockey, lacrosse, military, firefighting, etc.). Unfortunately, the body of literature surrounding the utilization of SNP's in exercise prescription is minimal and must grow for gene sequencing-based exercise prescription protocols to be optimized. For example, there are no published papers that have studied longitudinal changes in lactate clearance abilities following MCT-1 genotype specific exercise plans. In order to solidify the legitimacy of exercise prescription based on the MCT-1 polymorphism further research should continue to explore the role of the MCT-1 SNP on the regulation of lactate clearance and how the role of MCT-1 in lactate clearance is modified by sex, exercise intensity and exercise recovery intensity.

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(**Peer Reviewed Abstract)**

Developing Mindfulness in College Students Through Yoga Classes: Effects on Stress, Sleep Quality and Eating Habits

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Abstract

The benefits of a regular yoga practice are well-established, and include better sleep, stress reduction and increased emphasis on better health habits. Koru, a mindfulness technique, bears similarities to stress-reduction qualities found in the practice of yoga. This study used quantitative and qualitative data to explore the connection between college students' involvement in a regular yoga practice and its effects on the development of mindfulness and the improvement of other health behaviors. In spring of 2019, students in four sections of a college-based yoga class were surveyed both pre- and post-course about sleep, stress and mindfulness. Surveys were supplemented with self-reported student reflections on these concepts. Information from both were cross-referenced to verify whether improvements occurred in these health-related areas. Additionally, students in two sections were asked to maintain and submit diaries detailing a home-based practice, with points provided for the assignment. Responses from students in both groups were compared and assessed to determine if further benefits accrued from a home practice.
Research continues in fall of 2019. Current surveys have added questions about student eating habits. As in spring, surveys are supplemented with both self-report reflections from all students, and home practice diaries from two student sections.

Key Words: mindfulness, yoga, college students, stress, sleep, eating habits

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