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The Effect of Warm-Up Protocols on the Occurrence of Medial Tibial Stress Syndrome in High School Cross Country Athletes

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THE EFFECT OF WARM-UP PROTOCOLS ON THE OCCURRENCE OF
MEDIAL TIBIAL STRESS SYNDROME IN HIGH SCHOOL CROSS COUNTRY
ATHLETES

A Capstone Experience/Thesis Presented in Partial Fulfillment
of the Requirements for the Degree Bachelor of Science
with Mahurin Honors College Graduate Distinction
at Western Kentucky University

By:

Makayla B. Mack

May 2021

CE/T Committee:

Dr. Kayla Baker, Chair

Dr. Rachel Tinius

Dr. Dennis Wilson

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ABSTRACT

Medial Tibial Stress Syndrome (MTSS, i.e. shin splints) is among one of the most frequently reported running-related musculoskeletal injuries. Minimal research has investigated the prevention of MTSS with limited evidence supporting few preventative measures. The purpose of this study is to gain a better understanding of which method of warming up could yield the most promising results for the prevention of MTSS in high school cross country athletes and to use this information to further educate coaches and athletes on the most efficacious protocols to implement in the future. **METHODS:** Participants were recruited via communication with high school cross country coaches and included male and female high school cross-country runners (14-18 years). Data was collected through an electronic Qualtrics Survey. Data was analyzed using Chi-square Goodness of Fit tests and Tests of Independence. **RESULTS:** Chi Square Tests of Independence revealed significant associations between the MTSS and: 1) strengthening exercises ($p = 0.023$); and 2) wearing proper running shoes ($p = 0.007$). For treatment methods, MTSS was significantly associated with icing ($p = 0.020$), using pain relief cream ($p = 0.020$), using a roller ($p = 0.020$), wearing proper running shoes ($p = 0.0284$), stretching ($p = 0.004$), and strengthening exercises ($p = 0.004$). Additionally, MTSS was also associated with Body Mass Index ($p = 0.025$). **DISCUSSION:** This information regarding prevention and treatment techniques can be used to better educate coaches on which athletes are more prone to developing MTSS and how a factor (e.g., wearing

proper running shoes) can affect all their athletes. Additionally, coaches and parents may benefit from understanding the optimal body weight needs for their athlete as too low of a body weight was seen to be associated with increased occurrence of MTSS in the current study.

VITA

EDUCATION

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B.S. in Exercise Science – Mahurin Honors College Graduate
Honors CE/T: *The Effect of Warm-Up Protocols on the Occurrence
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PROFESSIONAL EXPERIENCE

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Professional CAREgiver
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AWARDS & HONORS

- Summa Cum Laude, WKU, May 2021
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PROFESSIONAL MEMBERSHIPS

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INTERNATIONAL EXPERIENCE

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INTRODUCTION

Medial Tibial Stress Syndrome (MTSS) is among one of the most frequently reported running-related musculoskeletal injuries (Lopes et al., 2012). This syndrome is widely known in the running community as “shin splints.” MTSS is defined as a stress injury of the bone that includes microfractures over the anterior tibia and tibial periostitis (Arnold & Moody, 2018). The intent of this project is to examine the varying measures taken to warm-up an athlete and evaluate how each measure relates to a corresponding presence or absence of MTSS.

Minimal research has been conducted on the prevention of MTSS with limited evidence in support of a few preventative measures such as shock-absorbing insoles (Shaffer & Uhl, 2006). Pre-performance stretching has been evaluated; however, no conclusive evidence exists on its efficacy in prevention (Shaffer & Uhl, 2006). Researchers have suggested that further studies on the prevention of lower extremity stress reactions is needed to implement appropriate interventions accordingly (Shaffer & Uhl, 2006). More recent research has revealed the following as potential risk factors for developing MTSS: increased weight, female sex, previous running injury, higher navicular drop, and greater hip external rotation with the hip in flexion (Reinking et al., 2017).

Keeping those variables in mind, it is imperative to examine how specific warm-up protocols could potentially contribute to the prevention of MTSS. There is currently no common standard for warm-up protocols in high school cross country programs;

therefore, these protocols need to be identified and evaluated to see if there is any correlation between “warming up” and the occurrence of MTSS.

Furthermore, previous research has determined that BMI has a U-shaped relationship to overuse injuries, such as MTSS, in young adults. This indicates that individuals who are either underweight or overweight are at an increased risk for injury of the musculoskeletal system (Taanila et al., 2015). Yard & Comstock (2011) also found that in US high school athletes, the largest proportion of fracture injuries occurred in athletes whose BMI classification was underweight. These findings need to be further investigated to determine if both underweight and overweight athletes are at a higher risk for developing MTSS.

The current study will be evaluating if there are any significant correlations between specific warm-up protocols and the presence or absence of MTSS to gain a better understanding of what protocol, if any, would be best to implement in high school cross country practice warm-up recommendations.

Purpose of the Study

The following is the purpose of this study:

1. The purpose of this study is to gain a better understanding of how certain methods of warming up could yield promising results for the prevention of Medial Tibial Stress Syndrome in high school cross country athletes and to use this information to further educate coaches and athletes on the most efficacious protocols to potentially implement in the future.

Research Question

The following are the research questions for this study:

1. Which (if any) warm-up protocols yield the most promising results for the prevention of Medial Tibial Stress Syndrome in high school cross country athletes?
2. Does Body Mass Index of high school cross country athletes influence the occurrence of Medial Tibial Stress Syndrome?

Hypothesis

The following are the hypotheses for this study:

1. It is hypothesized that at least one of the warm-up protocols assessed in the current study will be significantly associated with a decreased occurrence of Medial Tibial Stress Syndrome.
2. It is hypothesized that Body Mass Index will be significantly associated with occurrence of Medial Tibial Stress Syndrome.

Delimitations

The following are the delimitations of this study:

1. Participants from three different high schools were recruited for this study.
2. Participants' ages ranged from 14-18 years old.
3. All participants were required to complete a statement of informed consent prior to participating.
4. Participants under the age of 18 were required to obtain consent from a parent or guardian before receiving access to their informed consent document.

Limitations

1. The sample size was smaller than the researcher anticipated. This is the major limiting factor of the study.

2. The sample size was limited to three high school cross country teams in one geographical region of Kentucky.
3. The Warm-Up and MTSS Questionnaire did not specify if the participants were currently experiencing MTSS or if they had only experienced them in past seasons.

Assumptions

1. Participants provided accurate and honest information with regard to their answers on the questionnaire.
2. Participants understood the lay terms describing select physical activities within the survey.

METHODOLOGY

Participants

Fourteen high school cross country runners between the ages of 14 and 18 were recruited for this study (boys, $n = 7$; girls, $n = 7$). The average BMI for this sample was 20.37 kg/m^2 (considered within the “normal” range). The average 5K time for the participants was 21 minutes and 57 seconds (21:57).

Research Design

This study was a retrospective investigation of high school cross country athletes' experiences with or without MTSS during their season(s) of cross country. The participants completed a 3-minute, electronic survey to communicate these experiences.

Variables

The independent variables in this study were types of warm-up protocols, preventative measures for MTSS, treatment methods for MTSS, and Body Mass Index (BMI). The dependent variable was occurrence of MTSS.

Equipment

The “equipment” used for this study was the electronic MTSS and Warm-up questionnaire (Appendix D).

Initial Screening and Testing Methods

Initial Screening

Participants were recruited via email. Each participant provided his/her electronic informed consent to participate in the study (Appendix C). The Institutional Review Board of Western Kentucky University approved the research protocol (Appendix B).

Testing Methods

The investigator contacted the high school cross country coaches via email. After explaining the purpose and intent of the study, the coaches provided written consent over email for their athletes to participate. The coaches then provided the investigator with a list of emails. This list included the emails of their athletes and the emails of the parents of athletes younger than 18 years old. An Opt-Out Informed Consent form was sent to all parents whose athletes were underage. Upon receiving no responses to the Opt-Out Informed Consent, the investigator then forwarded the survey link to the athletes. Before being able to begin the survey, the athletes had to read the Informed Consent document tailored to them and indicate if they wanted to be a part of the study or not. Upon expressing assent, the athletes were admitted into the electronic survey.

Statistical Analyses

Prior to data analyses, all data was analyzed for normal distribution. A Chi-square Goodness of Fit test was used to determine frequencies of occurrences for MTSS. Chi-Square Tests of Independence were used to examine the association between categorical variables (MTSS and prevention/treatment methods). An alpha level of $p \leq 0.05$ was used to determine statistical significance. All statistical analyses were conducted via the

Statistical Package for Social Sciences (SPSS) software for Windows version 21 (SPSS Inc., Chicago, IL).

RESULTS

Fourteen participants (15.86 ± 1.46 years; $BMI = 20.37 \pm 3.36$) completed the MTSS questionnaire. Descriptive statistics for participants are shown in Table 1 (Appendix A).

Chi-Square Goodness of Fit test revealed no significant difference between observed and expected frequencies for occurrence of MTSS ($\chi^2(2) = 1.857, p = 0.395$). Test of Independence showed no statistically significant association between MTSS and Warmup Type ($\chi^2(6) = 4.030, p = 0.673, \phi = 0.379$). Additionally, no significant association was shown between MTSS and if participants warmed up prior to activity regardless of warmup type ($\chi^2(2) = 3.949, p = 0.139, \phi = 0.531$).

Chi-Square Tests of Independence revealed significant associations between the MTSS and using the following prevention methods: strengthening exercises ($\chi^2(2) = 7.571, p = 0.023, \phi = 0.735$) and wearing proper running shoes ($\chi^2(2) = 9.800, p = 0.007, \phi = 0.837$) (Appendix A: Table 2).

For treatment methods, MTSS was significantly associated with icing ($\chi^2(2) = 7.778, p = 0.020, \phi = 0.745$), using pain relief cream ($\chi^2(2) = 7.778, p = 0.020, \phi = 0.745$), using a roller ($\chi^2(2) = 7.778, p = 0.020, \phi = 0.745$), wearing proper running shoes ($\chi^2(2) = 7.143, p = 0.028, \phi = 0.714$), stretching ($\chi^2(2) = 11.096, p = 0.004, \phi = 0.890$), and strengthening exercises ($\chi^2(2) = 11.278, p = 0.004, \phi = 0.898$) (Appendix A: Table 3).

Additionally, MTSS was also associated with Body Mass Index (BMI) ($\chi^2(4) = 11.100, p = 0.025, \phi = 0.630$).

DISCUSSION

No significant associations were shown between specific warm-up protocols or warming up in general and Medial Tibial Stress Syndrome (MTSS) in high school cross country runners. Several reasons may exist to explain the lack of association between warming up and MTSS occurrence. One limitation may be the small sample size ($n = 14$) used in the current study. Additionally, although the current study examined cross country runners from three separate high schools, future research may want to increase the number of schools being examined as well as the number of runners. This may give researchers a better idea of how warm-up methods may differ not only from runner to runner but from school to school (or coach to coach).

Although no significant associations were seen between any of the warm-up protocols and the occurrence of MTSS, there may be external factors influencing this relationship between warm-up methods and occurrence of MTSS. One of these external factors may be the type of shoe that the cross-country runner is wearing. A significant association was shown between quality of running shoe for both the prevention and treatment of MTSS and the occurrence of MTSS. This is a strong indicator that the shoes a runner wears are crucial for the athlete's musculoskeletal health (Kozinc & Sarabon, 2017; McKenzie, Clement, & Taunton, 1985). With this knowledge, coaches and parents may be able to minimize the risk of MTSS for their student athlete. With all athletes wearing the proper footwear to minimize the occurrence of MTSS, researchers may be able to get a better picture of which warm-up methods aid in decreasing the risk for

MTSS better; however, if a percentage of high school cross-country runners are not in the proper footwear, the relationship between warm-ups and MTSS occurrence may be more difficult to distinguish. Strengthening exercises for both the prevention and treatment of MTSS were also shown to be significantly associated with the occurrence of MTSS. Specific types of strengthening exercises should be further investigated to determine which of these are the most efficacious in the prevention of MTSS.

Specifically, for the treatment of MTSS, significant associations also existed between the occurrence of MTSS and: icing, using pain relief cream, using a roller, and stretching. The significant associations between the occurrence of MTSS and these treatment methods were to be expected, as the cross-country runners who were not currently experiencing MTSS indicated that they did not engage in any of these treatments.

The current study also showed a significant association between body mass index (BMI) and occurrence of MTSS, indicating that cross-country runners with a below normal BMI ($\text{BMI} < 18.5 \text{ kg/m}^2$) had greater occurrences of MTSS. Previous research has also shown that a BMI less than or equal to 18 kg/m^2 (classified as “underweight”) has been correlated to increased prevalence of injuries, specifically in female runners (Amoako, Nassim, & Keller, 2017). Further, research has also shown that individuals may be at an increased risk for injury with a higher-than-normal body weight (Mueller & Maluf, 2002). Based on previous research, it appears that an optimal weight exists for these athletes, and for coaches and parents, this is an invaluable piece of information and an extremely useful and important factor to consider for the prevention of MTSS. If coaches are made aware of their athletes that are underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$), they

may consider these athletes to be at a higher risk for developing MTSS; therefore, more preventative measures (e.g., making sure the athlete has quality running shoes) could be taken from the start of the season to better combat and prevent this exceedingly common running-related injury.

In conclusion, the findings of this study should be used to insight further investigation on the topic of Medial Tibial Stress Syndrome and what coaches and athletes can do to prevent it. Further research is needed on the underweight population being at an increased risk for MTSS and why that occurs physiologically. Future research should also consider repeating the measures of this study with a larger, more diverse sample of participants (including, but not limited to: race, ethnicity, geographic location). Investigating the occurrence, prevention, and treatment of MTSS, which is an extremely common running injury in high school cross country athletes, is important for improving longevity of these individuals as cross-country athletes so that they may continue to train and compete as adults. More research on this topic is crucial to helping athletes and recreational runners alike in having a better overall experience with this sport.

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Yard, E., & Comstock, D. (2011). Injury patterns by body mass index in US high school athletes. *Journal of physical activity and health*, 8(2), 182-191.

APPENDIX A: TABLES

N	Age (yrs)	BMI	Occurrence of MTSS (Current)	Occurrence of MTSS (Previous)	Occurrence of MTSS (Never)
14	15.86 ± 1.46	20.37 ± 3.36	3 (21%)	7 (50%)	4 (29%)

Table 1. Participant characteristics.

Table 2. Association between MTSS and prevention methods

	χ^2	df	<i>p</i>	ϕ
Insoles	1.215	2	0.545	0.295
Tape	1.556	2	0.459	0.333
Strengthening exercises*	7.571	2	0.023	0.735
Stretching	2.858	2	0.24	0.452
Compression	1.077	2	0.584	0.277
Shoes*	9.8	2	0.007	0.837

*Statistically significant association between prevalence of MTSS and prevention method

Table 3. Association between MTSS and treatment methods

	χ^2	df	<i>p</i>	ϕ
Insoles	4.278	2	0.118	0.553
Ice*	7.778	2	0.02	0.745
Pain cream*	7.778	2	0.02	0.745
Roller*	7.778	2	0.02	0.745
Shoes*	7.143	2	0.028	0.714
Tape	2.333	2	0.311	0.408
Stretching*	11.096	2	0.004	0.89
Compression	3.733	2	0.155	0.516
Strength exercises*	11.278	2	0.004	0.898

*Statistically significant association between MTSS and treatment method

APPENDIX B: IRB APPROVAL



*INSTITUTIONAL REVIEW BOARD
OFFICE OF RESEARCH INTEGRITY*

DATE: February 3, 2021

TO: Makayla Mack
FROM: Western Kentucky University (WKU) IRB

PROJECT TITLE: [1698393-2] The Effect of Warm-Up Protocols on the Prevalence of Medial Tibial Stress Syndrome in High School Cross Country Athletes

REFERENCE #: IRB 21-143

SUBMISSION TYPE: Amendment/Modification

ACTION: APPROVED

APPROVAL DATE: February 3, 2021

EXPIRATION DATE: May 10, 2021

REVIEW TYPE: Full Committee Review

Thank you for your submission of Amendment/Modification materials for this project. The Western Kentucky University (WKU) IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Full Committee Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding followed by a *signed/implied* consent form. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. Please use the appropriate reporting forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

This project has been determined to be a MINIMAL RISK project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of May 10, 2021.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact Robin Pyles at (270) 745-3360 or irb@wku.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Western Kentucky University (WKU) IRB's records.

APPENDIX C: IRB FORM



OPT-OUT INFORMED CONSENT DOCUMENT

Project Title: The Effect of Warm-Up Protocols on the Prevalence of Medial Tibial Stress Syndrome in High School Cross Country Athletes

Investigator: Makayla Mack, Exercise Science, Email: makayla.mack969@topper.wku.edu

Faculty Advisor : Dr. Kayla Baker, WKU Exercise Science Department, kayla.baker@wku.edu

Your student is being asked to participate in a project conducted through Western Kentucky University. The University requires that you sign the consent and return if you **DO NOT** want your student to participate in the study. If this form has not been signed and returned it will be assumed that you have given your student permission to participate.

A basic explanation of the project is written below. Please read this explanation and email the researcher any questions you may have. If you then decide to **NOT** allow your student to participate in the project, please sign this form and return. You should keep a copy of this form for your records.

- 1. Nature and Purpose of the Project:** The purpose of this study is to gain a better understanding of which method of warming up could yield the most promising results for the prevention of Medial Tibial Stress Syndrome (“shin splints”) in high school cross country athletes. We plan to use this information to further educate coaches and athletes on the most effective methods to put in place in the future.
- 2. Explanation of Procedures:** This survey should take around 3 minutes to complete. Your student will answer 12 questions. For some questions, the student can choose multiple answers or write in an answer.
- 3. Discomfort and Risks:** There are no risks or discomfort associated with participation in this study.
- 4. Benefits:** The benefits of participating in this study will include the sharing of the results by the investigator to the coaches and participants of this study. This information could benefit the team in making more educated decisions on their approach to preventing “shin splints” in the future.
- 5. Confidentiality:** Participants will only be identified by a participant number in this study. Records will be viewed, stored, and maintained in private, secure files only accessible by the investigator and advising faculty for three years following the study, after which time they will be destroyed.

WKU IRB# 21-143
Approved: 2/03/2021
End Date: 5/10/2021
Full Board Review
Original: 2/03/2021

6. **Refusal/Withdrawal:** Refusal to participate in this study will have no effect on your standing on the team or any future services you may be entitled to from the University. Anyone who agrees to participate in this study is free to withdraw from the study at any time with no penalty.

You understand also that it is not possible to identify all potential risks in an experimental procedure, and you believe that reasonable safeguards have been taken to minimize both the known and potential but unknown risks. If a medical emergency does occur, you understand that you are responsible for any costs incurred, including but not limited to the services of Emergency Medical Technicians, emergency room care, hospitalization, etc. We strongly encourage you to ensure that you have adequate health insurance coverage or other means of satisfying any costs for which you will be liable.

PLEASE SIGN AND RETURN THIS FORM IF YOU DO NOT WANT YOUR STUDENT TO PARTICIPATE IN THE STUDY

Signature of Participant

Date

Witness

Date

THE DATED APPROVAL ON THIS CONSENT FORM INDICATES THAT
THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY
THE WESTERN KENTUCKY UNIVERSITY INSTITUTIONAL REVIEW BOARD
Robin Pyles, Human Protections Administrator
TELEPHONE: (270) 745-3360



WKU IRB# 21-143
Approved: 2/03/2021
End Date: 5/10/2021
Full Board Review
Original: 2/03/2021

**INFORMED ASSENT DOCUMENT
FOR RESEARCH INVOLVING MINORS**

I, _____, understand that my parents have given permission for me to participate in a study concerning _____, under the direction of _____.

My participation in this project is voluntary, and I have been told that I may stop my participation in this study at any time. If I choose not to participate, it will not affect my grade (treatment/care, etc., as appropriate) in any way.

Signature _____ Date _____

THE DATED APPROVAL ON THIS CONSENT FORM INDICATES THAT
THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY
THE WESTERN KENTUCKY UNIVERSITY INSTITUTIONAL REVIEW BOARD
Robin Pyles, Human Protections Administrator
TELEPHONE: (270) 745-3360



WKU IRB# 21-143
Approved: 2/03/2021
End Date: 5/10/2021
Full Board Review
Original: 2/03/2021

APPENDIX D: WARM-UP AND MTSS QUESTIONNAIRE



What is your (the participant's) initials (first and last)?

What is your (the participant's) age?

What is your (the participant's) height (in feet and inches)?

What is your (the participant's) weight (in pounds)?

Do you (the participant) warm-up before practice and/or competition?

- Yes, before both practice and competition
- Yes, but only before practice
- Yes, but only before competition
- No, I do not warm-up before either

If you answered "yes" to Question 5, how long do you typically warm-up for?

- 1-5 Minutes
- 6-10 Minutes
- 11-15 Minutes
- 16-20 Minutes

How do you typically warm-up?

- Static stretching (holding a stretch for more than a few seconds; example: standing or seated reach for the toes)
- Dynamic stretching (active stretching that involves constant movement; example: walking lunges or leg swings)
- Light jogging
- Other (type in your warm-up if it is not listed above)

Have you ever experienced or are you currently experiencing "shin splints" (pain on the middle/front part of your lower leg)?

- Yes, I am currently experiencing shin splints
- Yes, I have experienced them before, but not currently
- No, I have never experienced shin splints

If you do NOT currently have shin splints, do you do any of the following immediately before running to PREVENT getting shin splints?

- Not Applicable/I currently have shin splints
- Wearing in-soles/inserts in your running shoes
- Placing athletic tape over your shins (example: KT Tape)
- Strengthening exercises for the muscles around your shins (example: toe taps)
- Stretching your calves/muscles around your shins
- Wearing compression sleeves around your lower leg
- Wearing shoes that give adequate support/still have a good "tread" on the bottom of the shoe
- Other (type in anything else you do to prevent shin splints if it is not listed above)

If you have ever experienced shin splints or you are currently experiencing shin splints, what measures have you taken to TREAT shin splints?

- Not Applicable/I have never experienced shin splints
- Wearing in-soles/inserts in your running shoes
- Icing your shins after practice
- Applying creams for pain relief (example: IcyHot, Aspercreme, Bengay)
- Pressing a roller along your shins (example: foam roller, shin roller)
- Buying more supportive running shoes
- Placing athletic tape over your shins (example: KT Tape)
- Stretching your calves/muscles around your shins
- Wearing compression sleeves around your lower leg
- Strengthening exercises for the muscles around your shins (example: toe taps)
- Other (type in anything else you do to treat shin splints if it is not listed above)

What is your Personal Record for THIS SEASON (Fall 2020) on a standard, 5K cross country course (in minutes and seconds)?

Please list any other sports you are participating in this fall/at the same time as cross country:

