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EDUCATIONAL TECHNIQUE

Relative Energy Deficiency in Sport (REDs) Curriculum for Collegiate Athletic Trainers: An Educational Technique

Kelly Slovin, MS, RDN*; Kelly Jones, MS, RD, CSSD, LDN†
*Kelly Slovin Nutrition, New York, NY; †Kelly Jones Nutrition, Newtown, PA

Context: Since the consensus statement on relative energy deficiency in sport (REDs) was released in 2014, little research has been done to increase awareness to expand prevention and early detection efforts. Collegiate athletes have a high risk for the health and performance consequences of REDs due to busy schedules and social pressures, yet knowledge about the syndrome is limited among collegiate athletic staff. As integral members of the support staff for college athletes, it is important for athletic trainers (ATs) to have a strong understanding of REDs and an ability to recognize potential risk factors to play a role in prevention and early detection.

Objective: To provide prevention and intervention strategies for REDs in college athletes.

Background: The goal of this curriculum is to offer standardized REDs education to collegiate ATs so they can more easily identify at-risk athletes. With proper training, ATs can refer these athletes to appropriate medical professionals for evaluation and treatment.

Description: Registered dietitians (RDs) can use this technique to educate collegiate ATs about REDs. Athletic trainers can help bridge the gap between college athletes and the limited access they have to an RD.

Educational Advantage(s): Early referral to a sports medicine physician and RD for further evaluation and treatment increases athletes' health and ability to excel in their sport. This curriculum in particular bridges the gap between scientific literature and commercial programs designed to spread awareness of REDs.

Conclusion(s): Increasing REDs awareness with this novel curriculum could help athletes avoid injury and illness, including potential long-term health consequences of REDs.

Key Words: Low energy availability, curriculum development, student athlete nutrition, athletic trainer nutrition, REDs awareness

Ms Slovin is currently Title at Kelly Slovin Nutrition. Address correspondence to Kelly Slovin, MS, RDN, Kelly Slovin Nutrition, 217 E 70th St, Unit 26, New York, NY, 10021. kelly@kellyslovinnutrition.com.

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Relative Energy Deficiency in Sport (REDs) Curriculum for Collegiate Athletic Trainers: An Educational Technique

Kelly Slovin, MS, RDN; Kelly Jones, MS, RD, CSSD, LDN

KEY POINTS

- College athletes are at high risk for relative energy deficiency in sport due to their unique environment and limited sports nutrition education.
- Implementing a relative energy deficiency in sport curriculum for athletic trainers may help bridge the gap for athletes who have little to no access to a registered dietitian.
- The recommended curriculum contains a presentation to educate athletic trainers (ATs), screening tools for AT use, an educational handout for athletes, and a manual to guide ATs through the use of these materials.

INTRODUCTION

Underfueled collegiate athletes are at risk for a variety of health and performance consequences, the complexity of which is described by the International Olympic Committee consensus on relative energy deficiency in sport (REDs).[1] Athletes may experience low energy availability (LEA) when, over time, their energy expenditure exceeds their energy intake, leading to insufficient energy for normal physiological function alongside the demands of heavy training.[2] Therefore, they may be at risk of developing physiological and psychological symptoms that can affect both their health and athletic performance.[2–4]

Both intentional and unintentional actions can put athletes at risk for LEA, where intake is less than 30 $kcal \cdot kg^{-1} \cdot d^{-1}$.[2–4] These include eating disorders (EDs), exercise addiction, lack of evidence-based nutrition knowledge, lack of time to cook and prepare food, inadequate cooking skills, postexercise appetite suppression, a competitive mindset between teammates to look and train a certain way, or pressures from social media or coaches to have a specific body type or diet.[2,5] Collegiate athletes, in particular, are at high risk for LEA due to lack of nutrition knowledge, social pressures, and busy schedules that lead to such actions as listed above.[5–7] Not only are EDs more common among the athlete population, but the gender gap of EDs is likely lesser in athletes than in general populations.[5,6] While LEA can occur without an ED, underdiagnosis of EDs may contribute to poor identification and delayed intervention.[5] This can have significant impacts on health outcomes of LEA, specifically resulting in long-term health consequences.[4]

The female athlete triad is a condition that has been used to describe the symptoms that arise when a female athlete experiences LEA, menstrual dysfunction, and low bone mineral density.[8] However, since LEA can affect all genders, REDs has recently been used for diagnosis instead. It is an expanded concept of the female athlete triad, defined as impaired physiological or psychological function, or both, as a result of problematic LEA.[3] This syndrome encapsulates the full spectrum of symptoms that can arise from prolonged or severe LEA and is gender inclusive to account for risks for and effects of LEA on nonfemale athletes.[3,9] Decreased muscle glycogen stores have been seen after just 3 days of endurance training in a state of LEA and are correlated with overall decreased performance.[5,10]

Proper treatment and intervention can mitigate the health and performance consequences of REDs and restore an athlete's ability to excel in his or her sport. The bulk of intervention practices for REDs focuses on increasing energy intake, decreasing exercise energy expenditure, or both.[11] It is also beneficial for these recommendations to be relayed to coaches from the sports medicine team versus from the athlete.

The clinical team involved in treatment can vary and may include a sports medicine physician, sports dietitian, exercise psychologist, a sports psychiatrist, or all of the above, depending on the athlete's condition and specific symptoms he or she is experiencing.[11] This multidisciplinary team should be involved in the decision of whether an athlete is fit to continue activity and when he or she is fit to return to play if activity was ceased. Coach and family involvement should be considered on an individual basis.[3]

A number of questionnaires have been validated for various populations regarding LEA, REDs, the female athlete triad, and EDs.[12] However, due to the unreliable nature of self-reported questionnaires, they should simply be used as screening tools for risk factors that can flag the need for further clinical investigation.[12] Screening tools can be valuable for early detection and diagnosis of REDs, especially if given annually during sports physicals or seasonally via athletic staff.

It is evident that collegiate athletes have limited knowledge on nutrition practices for performance. Female lacrosse players have been seen to significantly underestimate their nutrient and caloric needs, while National Collegiate Athletic Association (NCAA) female volleyball players reported "lack of time" as the most common reason for skipping meals.[13,14] Before nutrition intervention, 83% of participants reported that their nutrition knowledge came from the media, the Internet, a coach, or a trainer.[14] National Collegiate Athletic Association Division III (DIII) male football players also report relying on coaches, the Internet, and athletic trainers (ATs) for their nutrition knowledge.[15]

While a registered dietitian (RD) on staff can play a valuable role in filling the gap of nutrition knowledge, Torres- McGehee et al found that 58.2% of collegiate athletes who participated in their study had access to an RD.[16] Athletes' primary choice for nutrition resources in this study were ATs and sports conditioning specialists.[16] For this reason and since ATs are more likely to be around collegiate athletes at every level compared with RDs, ATs should be trained in REDs identification so they can quickly make referrals to an RD. Athletic trainers and strength and conditioning specialists who participated in the aforementioned study reported using academic journals, college nutrition courses, RDs, and physicians to obtain nutrition knowledge for their athletes.[16] This

Table 1. Step by Step Overview of Educational Technique

Phase	Components
1. Pilot curriculum development	• Literature review • Develop learning objectives • Develop presentation and screening tools • Create online surveys for potential participants and experts in the field • Purposive sampling • Distribute surveys • Collect survey responses
2. Review of curriculum	• Analyze feedback • Develop themes of survey responses • Edit curriculum based on survey responses • Create manual on how to interpret screening tools[a]

[a] Screening tools can be viewed in Appendices A and B.

shows promise that they would be open to learning from dietitians when seeking new information.

Educating athletic staff members on sports nutrition practices can be beneficial regardless of whether an RD is on staff. If an RD is available, he or she may have less direct contact with athletes versus other staff members who see athletes daily. Educating athletic staff about sports nutrition practices has been shown to improve nutrition behaviors among athletes, even if these athletes do not meet directly with an RD.[7]

Kroshus et al found that Division I (DI) institutions are more likely to have screening and referral programs than Division II (DII) and DIII.[17] Division I schools were most likely to refer athletes with menstrual dysfunction or bone injury to an RD, while DII schools were more likely to refer athletes to a sports medicine physician.[17] These professions are both important referrals for REDs, depending on the cause and symptoms. Understanding the wide range of signs and symptoms of REDs would be beneficial knowledge for ATs to help their athletes seek proper treatment.

Research regarding education of collegiate athletes and their support staff on REDs is limited. In a cross-sectional study, Lodge et al compared the knowledge of the female athlete triad and REDs in female collegiate cross country athletes with coaches and ATs.[18] They found that athletes' knowledge of the female athlete triad and REDs was lower than that of ATs and coaches.[18] Authors of another cross-sectional study, looking specifically at collegiate ATs, found that only 32.98% had heard of REDs, while nearly all participants had heard of the female athlete triad.[17] Since REDs is an expanded concept of the female athlete triad, knowledge and understanding is imperative for identifying the broader spectrum of signs and symptoms that can present with REDs. No researchers to date have explored what information should be taught to collegiate ATs to increase awareness and offer resources to screen for signs and symptoms.

Therefore, the goal of this educational technique is to offer standardized REDs education for collegiate ATs so they can better identify at-risk athletes and refer them to appropriate professionals. It is important that staff members are adequately trained on when to refer to an RD, regardless of whether they have one on staff. By understanding the risk factors of REDs, the health and performance consequences, and how to screen for it, ATs can play a vital role in early detection and getting their athletes the help they need.

CURRICULUM DESIGN AND IMPLEMENTATION

Objectives

The purpose of this educational technique is to develop and present a curriculum for collegiate ATs about REDs in college athletes, with goals to (1) educate collegiate ATs about REDs, including the causes, signs, symptoms, and treatment and (2) provide collegiate ATs with materials to apply their new knowledge and aid in prevention and intervention of REDs. Since it is a curriculum development project, the university determined that this research did not meet criteria for approval of an institutional review board.

Curriculum Development

To develop a curriculum that bridges the gap between scientific literature and current commercial programs, a thorough design process using qualitative research can improve quality.[19] The design of our curriculum consisted of 2 major phases: pilot curriculum development and analysis of feedback for the finalized curriculum. An outline of the design process can be viewed in Table 1.

Phase 1: Pilot Curriculum Development. The development of the pilot curriculum began with a review of current literature to ensure the ability to provide the most up-to-date research. We reviewed scientific literature about REDs that was published between 2012 and 2023 on the PubMed database. The next step was to develop learning objectives. Bloom's taxonomy was used in the development of the learning objectives to create a level of understanding for the participants to act upon their new knowledge. An example of the learning objectives we created can be viewed in Table 2.

The health belief model (HBM) inspired the framework for the curriculum we developed. The HBM predicts acceptance of new health behaviors by addressing susceptibility and severity of a health concern as well as the benefits and barriers of adopting the new behavior.[20] Regarding educating collegiate ATs about REDs, these 4 variables of the HBM outline the overarching components that should be addressed in the educational presentation. The presentation and screening

Table 2. Example of Learning Objectives for Curriculum

Section	Learning Objectives
1. What is REDs	• Differentiate REDs and the female athlete triad • Understand potential causes of low energy availability • Understand the potential short term and long-term health consequences of REDs • Understand the potential performance consequences of REDs
2. Screening	• Recognize signs and symptoms of REDs • Recognize signs and symptoms of eating disorders and disordered eating • Implement screening tools for athletes at risk of REDs
3. Treatment and intervention	• Understand common courses of treatment for athletes with REDs • Connect the role nutrition education has in REDs treatmentConnect the role nutrition education has in REDs treatment • Pinpoint when an athlete should be referred to another professional
4. Nutrition support	• Understand the importance of all 3 macronutrients in an athlete's diet • Recognize the high nutrient needs of a collegiate athlete and the frequency of eating required to meet those needs • Identify terms and phrases that could negatively impact an athlete's relationship with food

tools were then developed using the previously stated literature and learning objectives.

We used purposive sampling to invite experts in the field and potential participants to provide feedback on the curriculum. Experts in the field were RDs who work in sports nutrition and had a prior understanding of REDs, including experience working with athletes with REDs. Potential participants were ATs working at a collegiate institution. Four experts in the field and 7 potential participants provided qualitative feedback on the pilot curriculum. Prior knowledge of REDs was not an inclusion or exclusion criterion for AT participants. The survey did not provide any identifying information to the participants.

Phase 2: Analysis of Feedback and Finalized Curriculum. Some of the changes we made because of the survey responses included adding a slide about EDs and disordered eating and providing more examples of long-term health consequences of REDs. Examples of the survey responses can be viewed in Table 3. Our final curriculum included a 1-hour educational presentation, 1 symptom tracker, 1 assessment questionnaire, and 1 nutrition handout for athletes. It also included a manual on how to interpret the symptom tracker and questionnaire.

The presentation of the final curriculum covers a thorough definition for REDs, including the potential health and performance consequences. It is intended to emphasize the importance of early detection and treatment of REDs. The presentation also

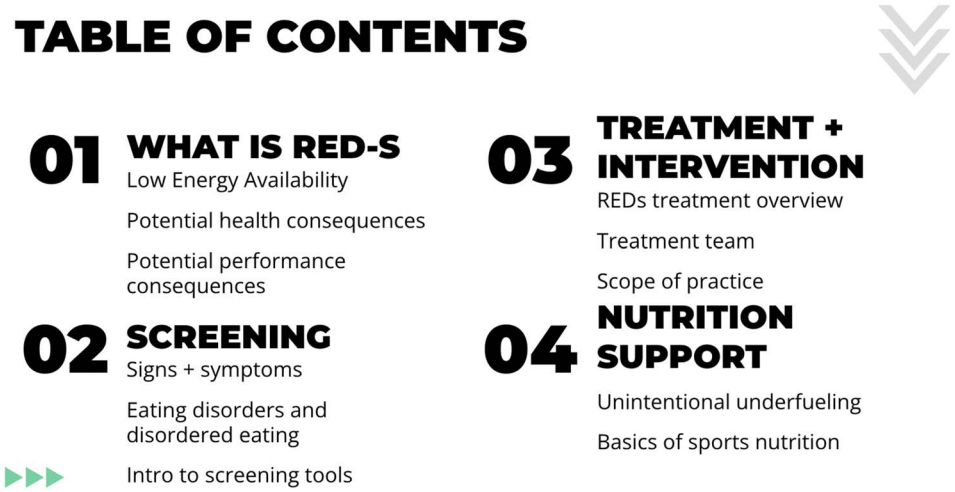
Table 3. Survey Responses From Potential Participants and Experts in the Field

Question	Sample Responses[a]
What are the strengths of this presentation?	AT: It is informative without being redundant or lengthy. AT: The presentation is simple and well laid out. It gives a good background of REDs which many ATs may not have experience with (especially male dominant sports). RD: I like that you put causes. Many training and coaches often think "athletes just need to eat more," but so often, there is a mental or outside barrier limiting them from eating more. At the college level, it can even come down to their meal plan selection or dining hall hour limitations.
What are the weaknesses of this presentation? Is there anything that could have been expanded on?	AT: Maybe just giving a few examples of long-term health consequences. RD: I think you could create a slide on what disordered eating versus [ED] is. Many staff may not be clear on this and only associate there being a "problem" if they hear/see the "classic" signs of an ED. I would suggest highlighting what signs of disordered eating could be. RD: I would include information about what signs and symptoms separate REDs from a clinical ED.
Do you have any questions about unclear material?	AT: Are certain symptoms more important to look out for than others?

Abbreviations: AT, athletic trainers; ED, eating disorder; RD, registered dietitian.

[a] Potential participants are collegiate ATs and experts in the field are sports dietitians (RDs).

Figure 1. Table of contents.



includes common signs and symptoms of REDs as well as those of EDs and disordered eating. It goes over what is involved in treatment for athletes with REDs and highlights scope of practice. Finally, it touches on the nutrition information that will be provided to athletes via the nutrition handout. The topics reviewed in the presentation can be viewed in Figure 1.

Curriculum Implementation

The presentation can be implemented by RDs as a continuing education course for collegiate ATs on an individual or departmental level. This includes training ATs on how to use the screening tools. The symptom tracker is a tool for ATs to provide to their athletes on a regular basis to ensure that they are checking in with athletes. It can help them notice any changes in how an athlete is feeling or if any symptoms should be addressed that may otherwise go unnoticed.

After baseline data from the symptom tracker at preseason for all athletes, the assessment questionnaire can be used if (1) the AT has concerns based on the symptom tracker and would like more information or (2) the AT has concerns that an athlete may be at risk for REDs based on symptoms he or she is presenting with and would like more information. The information gathered from the assessment questionnaire allows the AT to make a more informed decision on who to refer the athlete to. It is not to be used for any specific diagnostic testing.

The nutrition handout is a tool for ATs to provide to their athletes, which can be viewed in Figure 2. Since prior researchers have shown that athletes trust their ATs for nutrition advice, it is an important tool to provide to ATs as a part of this material.[16] It allows ATs to provide a trustworthy resource to their athletes without stepping outside of their scope of practice. Our handout reviewed the importance of including all 3 macronutrients in an athlete's diet and focuses on nutrient timing. It also included examples of what a day of eating would look like for college athletes, based on the nutrient timing it describes.

The presentation we developed was broken down into 4 key sections: (1) what is REDs, (2) screening, (3) treatment and intervention, and (4) nutrition support. This presentation is to be used as the primary education component of the curriculum. Athletic trainers can participate in this educational presentation and be trained on how to use the provided screening tools and resources. This new knowledge can then be implemented in their practice, alongside the screening tools for prevention and intervention measures.

ADVANTAGES AND DISADVANTAGES

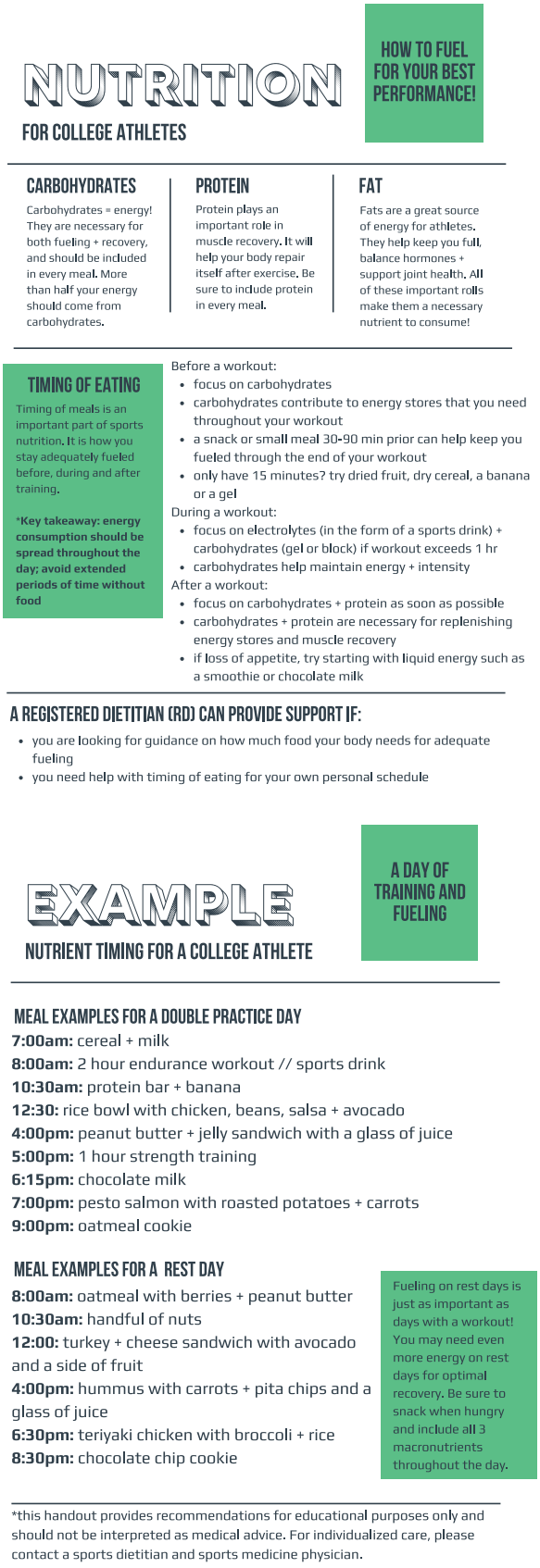
The curriculum we developed provides research-based, standardized education for collegiate ATs to increase knowledge and awareness of REDs. It includes a presentation, screening tools, a nutrition education handout, and a manual, developed to educate participants on REDs detection, prevention, and intervention strategies. While not yet put into practice, this curriculum stands out from commercial programs since it contributes to addressing the gap in scientific research around REDs education. Authors of current literature have discussed the lack of knowledge and awareness of REDs among collegiate athletic staff, but little research before this study has been done to aid in increasing that awareness.[16,17]

This curriculum takes a unique approach to prevention and intervention of REDs among collegiate athletes. It addresses the fact that collegiate athletes are at high risk for REDs and that these athletes trust their ATs for nutrition information.[5,7,8,21,22] It is evident that this curriculum can benefit programs with and without an RD on staff; providing nutrition education to athletic staff who see athletes on a regular basis, such as ATs, has been shown to improve nutrition behaviors of athletes.[7]

Advantages

A primary advantage of the development of this curriculum is that it is specifically designed for collegiate ATs who see athletes on a regular basis and are a trusted source for these athletes.[5] Athletic trainers can help bridge the gap between students and RDs when direct contact is limited. A secondary advantage of the development of the curriculum is the use of experts in the field and potential participants to strengthen the content. Their feedback played a vital role in finalizing the curriculum.

Figure 2. Nutrition.



This curriculum benefits collegiate ATs by providing resources that they can implement in their practice to streamline REDs screening, without asking them to step outside their scope of practice. An advantage this curriculum has for collegiate athletes is having a REDs informed provider on staff. Not only does it have the potential for early detection of REDs, but it also provides these athletes a trusted resource for when they feel something may be wrong.

Disadvantages

A disadvantage of this educational technique is that it would require a second round of research to test for efficacy. While qualitative feedback on the pilot curriculum can strengthen the final curriculum, it does not determine how it will perform in the field. The efficacy of our curriculum cannot be determined at this time, and therefore, a conclusion cannot be drawn about the effectiveness of the curriculum for student-athletes with REDs risk factors.

The second disadvantage identified for this educational technique is that the HBM cannot predict adherence to a new health behavior.[20] The use of the HBM does not ensure AT participants will integrate their new learnings into practice.

Next Steps

To strengthen this curriculum and provide standardized REDs education to collegiate ATs, it should be tested for efficacy. Using the curriculum in the field would offer insight into 2 key factors: (1) ATs' adherence to using their new knowledge in their practice and (2) effectiveness of the curriculum on REDs prevention and intervention in collegiate athletes. Once it is tested for efficacy, we recommend this curriculum be turned into a continuing education course for ATs for ease of implementation with their busy schedules.

CONCLUSIONS

This educational technique offers a new perspective for prevention and intervention strategies for REDs in collegiate athletes. We are confident that it is one of the first in the field to address the lack of REDs awareness among collegiate athletic support staff, particularly ATs. The curriculum we developed not only provides research-based education materials but also screening tools and resources to be used to aid in REDs prevention and early detection. The next step for this curriculum is to test it in the field and observe its efficacy. Future researchers on REDs awareness should focus on educating coaches and athletes as well as provide more sport-specific resources for REDs education.

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Appendix A. Symptom Tracker

Please check the box that indicates the frequency you experience each symptom.

	Never	1×/mo	1×/wk	2–5×/wk	Everyday	Multiple times/day
Fatigue						
Anxiety						
Irritable						
Stress						
Sadness						
Weak						
Loss of appetite						
Stressful thoughts about food						
Feel out of control around food						
Worried about weight						
Worried about body image						
Headache						
Joint pain						
Lightheaded						

Appendix B. Assessment Questionnaire

*This handout is for athletes to fill out if there are concerns for REDs or if their symptom tracker indicates they may be at risk.

Physical Activity

What does a normal week of training look like as a schedule?

Do you do any physical activity outside of team training? If yes, what type of activity and how often?

Do you feel like you have less, the same, or more energy than you used to?

Do you feel like you have enough energy to complete your workouts?

Do you feel like you perform your best during training and games?

Please check the box that indicates your energy level at various points throughout a workout.

Energy Level	Low	Medium	High
At the beginning of practice or training			
In the middle practice or training			
After a practice or training			
After competition			

Injury History

Have you experienced any injuries that prevented or limited your training? If yes, please list the injury and when it occurred.

Have you ever played through an injury?

Have you ever had a stress fracture?

Have you missed any training sessions or games due to injury? If yes, for how long?

Have you missed any training sessions or games due to illness?

Eating Patterns

Do you follow a specific diet? If yes, what diet?

☐ Commercial diet (Weight Watchers, Jenny Craig, etc)
☐ Low carb/keto
☐ Fasting/skipping meals
☐ Vomiting/diuretics
☐ Liquid diet/cleanse
☐ Paleo diet
☐ Low calorie
☐ Macro counting
☐ Other _____

Are there any specific foods you avoid or "eliminate" from your diet?

Do you take any supplements (vitamins, minerals, protein powder, etc)? Please include if any of them have been prescribed by a professional.

Please list any fluctuations in weight (intended or unintended) since high school.

Has a physician ever indicated that you have a nutrient deficiency? If yes, please list the nutrient(s).

Please check the following box that indicates your frequency.

	Never	Sometimes	Always
Do you ever worry about where your next meal is going to come from or if you will be able to afford it?			
Do you ever feel like you don't have enough time to eat?			
Do you ever skip meals?			
Do you ever feel guilty for eating?			
Does deciding what to eat make you feel stressed?			
Do you feel confident in the kitchen? Do you feel confident with your cooking skills?			

Mental Health

Please check the following box that indicates your frequency.

	Never	Sometimes	Always
Do you feel stressed?			
Do you feel irritable or easily annoyed?			
Do you find it difficult to focus?			
Do you feel sad?			
Do you have difficulty making decisions?			

Do you feel supported by your coaching staff?

Do you ever feel pressured to lose weight?

If applicable:

Menstruation

When was your last period?

Has your period ever ceased for 3+ months? If yes, how many months did it last, and is it happening now?