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How can we better engage female athletes? A novel approach to health and performance education in adolescent athletes

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ABSTRACT

Objectives To evaluate the impact of a video series versus online pamphlets/blog posts on Female Athlete Triad (Triad) and Relative Energy Deficiency in Sport (REDs) knowledge in high school female runners.

Methods Runners from 10 US schools were cluster-randomised into groups to either watch videos or read pamphlets on Triad/REDs, nutrition, menstrual cycle, bone health and mental health. Changes in knowledge and interest were assessed using generalised estimating equations.

Results Forty-five runners were in the video intervention group (mean age=16.0) and 39 in the control (mean age=15.7). Both groups showed knowledge gains for all topics, except for mental health, where knowledge was already high. The intervention group's knowledge increase (means=75.7 and 93.3) was not significantly higher than the control's (means=77.9 and 93.6) (p=0.149). However, the intervention group had stronger scores on behavioural impact, information novelty and interest (means=3.77, 3.93 and 4.14) compared with the control's (means=3.36, 3.48 and 3.52) ($p \leq 0.05$, $p \leq 0.05$ and $p \leq 0.001$).

Conclusion Both videos and pamphlets improved knowledge of Triad/REDs and female athlete science, however videos had a greater influence on athletes' engagement and behavioural intentions.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ High school female athletes have low knowledge of the Female Athlete Triad (Triad) and Relative Energy Deficiency in Sport (REDs), and few educational interventions discuss both concepts in an engaging format driven by role models.

WHAT THIS STUDY ADDS

⇒ Both videos and online handouts significantly increased Triad, REDs, and health and performance knowledge, however the videos better captivated the interest and engagement of high school female athletes.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

⇒ Future efforts should explore engaging methods to deliver female athlete science and should consider using compelling storytelling from a diverse range of athletes and experts.

INTRODUCTION

Female athletes are still under-represented in sports research—in more than 5000 manuscripts published in six sports medicine and exercise science journals, 34% of the participants were women, and only 6% of the publications exclusively studied female athletes.[1] Currently, the field of female athlete research is growing, with strong efforts to counter under-representation. Similar efforts are needed to translate this growing body of research, so that athletes, parents and coaches can better access evidence-based sports science. Previous studies have shown that widespread knowledge of the Female Athlete Triad (Triad) in high school athletes and coaches is low.[2 3]

The Triad is the inter-relationship of low energy availability with or without disordered eating, menstrual dysfunction and low bone mineral density (BMD).[4] When queried about the Triad across three studies, high school athletes answered less than 50% of questions correctly.[3 5 6] Despite low knowledge on the Triad, the Triad is a common syndrome seen in high school athletes. In a cross-sectional survey of 78 international and US high school athletes, more than 50% were categorised as moderate or high risk on the Female Athlete Triad Cumulative Risk Assessment.[7]

Studies are assessing ways to improve Triad knowledge through translational research. A study in female high school athletes assessed changes in Triad knowledge after participation in a 10 min video featuring expertise from registered dietitians, athletes and coaches.[8] In this study, postintervention Triad

knowledge was significantly higher in the intervention group compared with the control group. Studies have also examined digital interventions centred around improving knowledge on Relative Energy Deficiency in Sport (REDs), which includes multiple physical and mental health consequences related to low energy availability.[9] A 16-week online lecture and individual athlete-centred nutritional counselling intervention improved REDs sports nutrition knowledge in female endurance athletes compared with a control group but had weak evidence for improving dietary behaviours.[10]

Despite the success of prior Triad and REDs interventions, to-date, no studies have combined Triad and REDs education. Furthermore, no studies have expanded Triad and REDs education to include other important female athlete science topics such as fuelling, the menstrual cycle, bone health and mental health, presented within the context of improving performance and optimising athletic longevity. Given that understanding female athlete science is a paramount first step for preventing Triad and REDs endpoints, it is important to enhance both knowledge and behavioural patterns among high school female runners. We believe that discussing both the Triad and REDs and highlighting the relationship between Triad/REDs and female athlete science topics might help athletes grasp the importance of adequate fuelling and treating their bodies well for long-term health and performance. To test this, we designed a female athlete science educational programme that was engaging, fun and informative, using compelling storytelling from a diverse range of athletes and experts.

The aim of this study was to evaluate the role of a five-part video module series in improving Triad/REDs and female athlete science knowledge in female high school runners compared with a control group accessing online educational materials covering the same topics. The five modules covered Triad/REDs fundamentals, nutrition principles, bone health, the menstrual cycle and mental health. Each video module contained animated education sections and inspirational stories from interviews of professional athletes or role models. Our primary hypothesis was that the video intervention group would gain more knowledge than the control group and our secondary hypothesis was that the video intervention group would receive higher ratings of capturing interest, impacting behaviour and providing new information than the control group. Finally, we wanted to understand how athletes in this study were acquiring health information to determine how to best share our video module series to the general population after study completion.

METHODS

Study population

The study population consisted of high school varsity and junior varsity female track and field athletes. To be eligible, participants had to be 14–18-year-old gender-identifying women or nonbinary individuals enrolled in high school and members of their high school's varsity or junior varsity cross-country teams in fall 2022.

Athletes were recruited from 10 geographically diverse high schools across the USA, which were identified through recruiting emails sent to coaching organisations including the Women's Running Coaches Collective and the Positive Coaching Alliance as well as social media recruitment on Instagram and Twitter. We worked with coaches to set up 15 min informational Zoom sessions on study procedures. Athlete and parent email addresses were obtained from the coaching staff to send out follow-up recruiting information over email. Enrolment was optional and was not required for team participation or competition. Each participant provided informed written consent. All athletes were compensated with a US$30 gift card for participation in the study and completion of all the modules. For athletes under age 18, parents first completed the consent form, and the athlete completed the assent form. The study was approved by Stanford University's institutional review board (IRB) (IRB#62042). Participants and the public were not involved in the design, reporting or translation of this research.

Randomisation

We used matched-pair cluster randomisation to assign participants to the intervention and control groups, with the high school serving as the unit of randomisation. Prior to recruiting athletes, we asked coaches to share the number of athletes they had on their cross-country team. We assigned high schools to intervention and control groups based on team size, matching teams with equal or relatively equal athlete numbers. After pair matching, teams were randomly assigned to either the control or intervention study arm via the REDCap randomisation tool.

Study procedures

All study participants were assigned a study ID for deidentified engagement and completed an online Qualtrics survey at baseline. Validated surveys including the dietary restraint and pathologic behaviour sections of the Eating Disorder Examination Questionnaire[11] and the Low Energy Availability in Females Questionnaire[12] were included in the survey. Additional questions assessed injury and medical history, prior sports participation and current training regimen (online supplemental appendix 1).

Intervention group procedures

The intervention group was assigned to watch five educational video modules over the course of a week. Participants would log into our study website with an assigned study ID/password to access the videos and could view the videos on their own schedule, including in a back-to-back format if best for their time. Participants were sent up to three reminder emails if they had outstanding readings or materials left to complete. These

videos ranged from 7 min to 10 min long and were created to educate athletes on important topics related to female athlete health and well-being. The videos contained: (1) an opening inspirational quote by a professional athlete or role model in sport to introduce the topic, (2) a lesson on the science, terminology and research on the topic from physicians and experts in the field and (3) interviews from professional athletes and role models in sport who elaborate on their own journey and experiences.

Video 1, 'The Female Athlete Triad and REDs', discusses the purpose of the modules and provides an overview of low energy availability and how it serves as the foundation of Triad/REDs outcomes, with interviews from an obstacle racer and professional chef. Video 2, 'Nutrition for Health and Performance', delves into the topic of proper fuelling and important macronutrients for athletes, with interviews from a professional mountain bike racer and an Olympic weightlifter. Video 3, 'Building Strong Bones', examines bone biology and ways to optimise bone health, with interviews from an ultramarathoner and professional track and field athlete. Video 4, 'Periods are Powerful', dives into the basics of the menstrual cycle and emphasises the importance of menstruation in development and as an indicator of energy availability, with interviews from two professional track and field athletes. Video 5, 'Mental Health and Body Image', talks openly about mental health, including resources for reaching out for help and ways to extend compassion to oneself and others, with interviews from a professional cyclocross athlete and a food and fitness blogger (Link to Videos).

Control group procedures

The control group was assigned to view five online educational pamphlets, readings or blogs over the course of a week. These online materials covered the same five educational principles included in each of the video modules. Participants would log into the study website with an assigned study ID and password to access the educational materials by module. Participants were sent up to three reminder emails if they had outstanding readings or materials left to complete.

Primary outcome measures

Our primary outcome measure was the change in knowledge on the five educational principles (Triad/REDs, nutrition, bone health, menstrual cycle and mental health) included in our video modules and online materials in the intervention and control groups. As part of the baseline survey, all study participants completed a knowledge assessment, with five questions per educational principle. Participants were instructed to answer questions without using the assistance of online materials, asking friends or using other methods to acquire information. After completing the assessment, participants were not provided with correct answers or their scores. After viewing each video module or accessing the online materials, participants then repeated the same knowledge assessments with the same instructions.

Secondary outcome measures

Our secondary outcome measures included the engagement and interest in the video modules versus online materials. After viewing individual video modules or accessing the online materials, participants completed a three-question survey assessing interest in the material, potential for the material to impact their behaviour, and whether they acquired new information from the material on a 1–5 Likert scale. In addition, we assessed how participants acquired their health information prior to the study with a survey asking them to select their top resource and top social media source for health information.

Pilot study and sample size calculation

We conducted a pilot study and presented our videos to 34 high school female athletes to gather feedback on video design and measure previdео and postvideo knowledge assessment to power our pair-matched cluster-randomised control study. We used the same baseline surveys and knowledge assessments incorporated in our current study. In this pilot study, mean knowledge scores across all five modules were 78.9% (SD=10.7) at baseline, which increased to 96.8% (SD=3.4) (from athletes with complete data) following the video intervention, representing a 17.9% gain. However, athletes were not compensated for participation, and 15 (44%) of athletes dropped out. We believe that the high dropout rate could be attributed to the long duration of the study (5 weeks), which took place during the summer when students were not checking their emails as regularly, and, thus, we shortened our current study to span 1 week and added compensation for completing the study. Although we did not have a control group incorporating educational pamphlets, readings or blogs in our pilot study, we hypothesised that this group would gain less knowledge and estimated a 10% gain.

Our target sample size for this study was 80 athletes with an enrolment ratio of 1:1. We determined that with 40 athletes in the intervention group and 40 athletes in the control group, we would have an 84% power to detect an 8% improvement in knowledge between the control and intervention groups. This was based on using a difference in means test for the comparison and assuming an alpha of 0.05. To account for study dropout, we used 44% as our dropout rate.

Statistical analysis

Our primary outcome measures were the change in knowledge scores (difference from baseline to follow-up assessments) as well as the ratings of engagement and interest following the education delivery. We assessed the differences in these measures between our intervention and control groups using generalised estimating equations to account for the cluster randomisation, and thus

the correlated nature of our participants within cluster. For the health information survey, we combined intervention and control group participant data together and assessed descriptive statistics. Participants who missed ≤two total questions across all knowledge quizzes were included in the analysis and scores were determined from the per cent correct on the answered questions. Participants who failed to complete all modules were classified as drop out. Our statistical analysis and presentation are consistent with the CHAMP statement.[13]

Variables including online surveys and video knowledge quizzes were hosted in Qualtrics and entered and combined into a database using the secure, web-based Research Electronic Data Capture (REDCap) tools hosted at the Stanford Center for Clinical Informatics.[14] Deidentified variables were eventually exported and stored on Box. The data analysis for this study was generated using SAS Software University, V.9.4 (Cary, North Carolina) and Python V.3.8.3 (python.org).

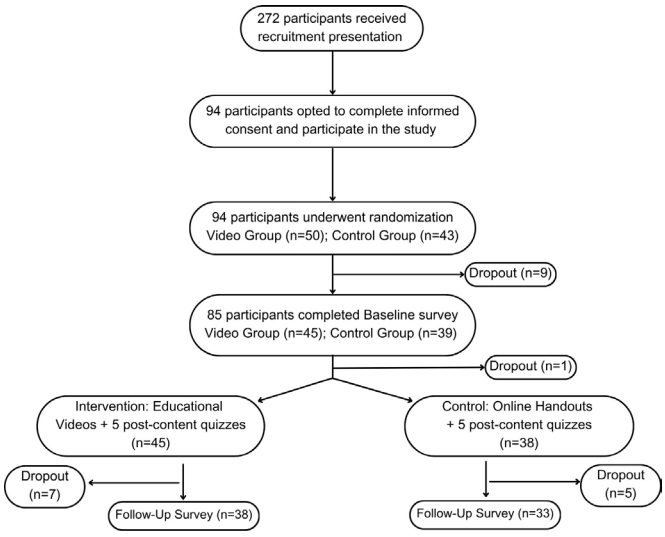

Figure 1 Flow diagram of the progress through the two-group cluster randomised control trial.

Equity, diversity and inclusion statement

Given the gender gap in sport science research, we wanted to provide educational resources to high school female athletes to help support a parallel gap in sports science research translation. We recruited from high schools across the USA and focused on recruiting schools in different geographic regions, with diverse racial/ethnic and socioeconomic breakdowns. We hope that our research efforts will encourage future studies to investigate the value in creating videos and materials featuring role models in sport to engage young female athletes. One of our primary goals in video design was for female athletes to feel like they could see themselves in sport through the perspectives of our role models. Our videos were reviewed by a diversity consultant to make sure we were promoting inclusion in sport by representing role models with diverse racial/ethnic backgrounds, ages, sport types and body types. In the process, we also included and mentored junior researchers to help build interest in establishing careers focused on female athlete research.

RESULTS

Study population

Forty-five high school female runners were randomised to the intervention group and 39 were randomised to the control group. Seven participants in the intervention group (16%) and six participants in the control group (15%) completed the baseline survey but failed to complete all the modules. The remaining participants in the control group (n=33) and the intervention group (n=38) completed all the modules and assessments with the exception of three participants who missed ≤two total questions across all knowledge quizzes (figure 1).

The average age in the intervention group (mean=16.0, SD=1.4) and the control group (mean=15.7, SD=1.0) was similar. The majority of participants in the intervention (88.9%) and control groups (64.1%) were white, though the control group had more racial diversity (table 1). The percentage of participants with a history of diagnosed eating disorder and BMD was similar in the control and intervention groups, while the control group had more participants (24.4%) with a diagnosed bone stress injury than the intervention group (10.3%). Most participants in the intervention (68.9%) and control (59.0%) groups reported regular periods, and around 20% in both groups were unsure what constituted regular periods (table 1).

Knowledge scores at baseline and following content delivery

Both the control group and intervention group had significant increases in knowledge from baseline to follow-up for all modules except for the mental health modules, where the mean baseline score was already high (control mean=98.5, SD=6.1; intervention mean=98.0, SD=6.8). The intervention group (baseline mean=75.7, SD=10.1; follow-up mean=93.3, SD=6.6) did not have significantly greater knowledge changes compared with the control group (baseline mean=77.9, SD=11.0; follow-up mean=93.6, SD=7.0) (p=0.149) (table 2). Participants had the lowest baseline knowledge on the menstrual cycle and the bone health modules in both the control and intervention groups (table 2).

Interest and impact of the educational methods

The intervention group had significantly higher mean Likert scale ratings of behavioural impact, new information and interest across all five modules compared with the control group, with a combined score of 3.77, 3.93 and 4.14 compared with the control group's combined score of 3.36, 3.48 and 3.52, respectively (p≤0.05, p≤0.05 and p≤0.01). In both groups, the mental health module was rated the lowest out of the modules on information acquisition (intervention mean=3.41, control

Table 1 Descriptive characteristics of the study population at baseline in each study phase, mean ± SD or N (%)

	Control group		Intervention group	
Characteristic	N	Mean±SD or %	N	Mean±SD or %
Age (year)	39	15.7 (1.0)	45	16.0 (1.4)
Gender				
Female	38	97.4%	43	95.5%
Male	0	0%	0	0%
Other	1	2.6%	2	4.4%
Race				
White	25	64.1%	40	88.9%
Black	0	0%	0	0%
Asian	3	7.7%	1	2.2%
More than one race	8	20.5%	3	6.7%
Unknown/not reported	3	7.7%	1	2.2%
Years running track	39	3.4 (2.1)	45	3.4 (2.0)
Age menarche				
Never menstruated	1	2.6%	0	0%
11 years or younger	6	15.4%	7	15.6%
12–14 years	30	76.9%	36	80.0%
15 years or older	2	5.1%	2	4.4%
Regular periods				
Yes	23	59.0%	31	68.9%
No	8	21.1%	4	8.9%
Not sure if regular	7	18.4%	9	20.0%
Prefer not to answer	1	2.6%	1	2.2%
Oral contraceptive use				
Yes	1	2.6%	5	11.1%
No	38	97.4%	40	88.9%
Diagnosed eating disorder				
Yes	4	10.3%	5	11.1%
No	35	89.7%	40	88.9%
Diagnosed BSI history				
Yes	4	10.3%	11	24.4%
No	35	89.7%	34	75.6%
History of low BMD				
Yes	0	0%	0	0%
No	39	100%	45	100%

BMD, bone mineral density; BSI, bone stress injury.

mean=3.00), but still scored relatively high on interest (intervention mean=4.13, control mean=3.67) (table 3).

Participants' top-ranked sources for acquiring health information

Half of all participants predominantly acquired health information from parents (24.7%) or from coaches (25.9%), whereas one-quarter of participants acquired information from online sources, including social media (12.9%) and online non-social media sources such as blog posts or professional organisations (12.9%). Fewer participants predominantly received health information from physicians/trainers (7.1%) or from teachers (4.7%).

When queried specifically on sources of social media for acquiring health information, most participants in our cohort used Instagram (29.4%) or TikTok (20.0%). None of our participants used Facebook or Twitter and 30% of our participants did not use any form of social media for acquiring health information (table 4).

Table 2 Knowledge scores for control and intervention groups at baseline and following content delivery

	Control group			Intervention group			
Module	N*	Baseline score±SD	Follow-up score±SD	N*	Baseline score±SD	Follow-up score±SD	P value
Triad/REDs	33	78.8 (19.9)	97.7 (7.3)	38	74.3 (26.3)	96.7 (10.4)	0.891
Nutrition	33	81.8 (21.0)	93.2 (14.4)	40	79.4 (17.8)	94.4 (13.3)	0.638
Bone health	33	75.8 (22.1)	92.4 (13.2)	39	68.6 (22.7)	94.2 (12.1)	0.371
Menstrual cycle	33	54.5 (21.2)	87.9 (18.9)	38	58.8 (24.4	81.8 (21.0)	0.113
Mental health	33	98.5 (6.1)	97.0 (10.4)	38	98.0 (6.8)	99.3 (4.1)	0.063
Overall	33	77.9 (11.0)	93.6 (7.0)	38	75.7 (10.1)	93.3 (6.6)	0.149

P values for the change in knowledge scores from baseline to follow-up between control and intervention groups were determined by a generalised estimating equations (GEE) model to account for cluster randomisation.
*Participants had to start all five quizzes to contribute to the overall baseline and follow-up average quiz score. Participants were categorised as missing if they skipped ≥3 quiz questions across all knowledge quizzes. Three participants who missed ≤two total questions across all knowledge quizzes were included in the overall analysis and scores were determined from the percent correct on the answered questions.
REDs, Relative Energy Deficiency in Sport.

DISCUSSION

We found that both the five-part video module series (intervention group) and the online educational materials (control group) improved Triad/REDs and female athlete science knowledge, with no statistically significant difference in knowledge gains between groups. However, our video modules had significantly higher Likert scale ratings of behavioural impact, information acquisition and interest across all five modules compared with the control group. Although we did not find significant differences in knowledge gains between the intervention and control groups, we are encouraged that both groups gained knowledge and that participants in the intervention group had stronger engagement with the video modules as measured by Likert scale ratings. Collectively, these findings support the idea that in addition to thinking about knowledge gains on Triad/REDs and female athlete science interventions, we should also design engaging interventions featuring stories and wisdom from diverse role models to better capture the interest of athletes. Future research should look at long-term behaviour outcomes of engaging Triad/REDs and female athlete science education interventions, including the impact on fuelling behaviours, body mindset and sport mindset.

Impact on knowledge scores

Both the intervention and control groups increased knowledge from baseline to follow-up for all modules except for the mental health modules, where the mean baseline scores were already high. These findings parallel recent studies that used a 10 min video intervention and a 16-week digital lecture/personalised counselling intervention to significantly improve Triad and REDs knowledge, respectively.[8 10] However, each study used different questions and formats to assess knowledge, and to date, there are no validated Triad/REDs knowledge instruments that are used across studies. In addition, our study included the addition of more general female athlete science education.

Table 3 Ratings on interest, potential impact on behaviour and new information from control and intervention groups following module completion

	Control group				Intervention group			
Module	N	Behaviour impact score	New information score	Interest score	N	Behaviour impact score	New information score	Interest score
Triad/REDs	33	3.21	3.70	3.27	40	3.45	3.95*	4.18***
Nutrition	33	3.64	3.39	3.52	41	3.76	3.78	4.15**
Bone health	33	3.39	3.82	3.48	39	4.00***	4.36**	4.03*
Menstrual cycle	33	3.15	3.52	3.67	40	3.78*	4.15**	4.25*
Mental health	33	3.42	3.00	3.67	39	3.90**	3.41	4.13**
Overall	33	3.36	3.48	3.52	38	3.77*	3.93*	4.14**

P values for the ratings between control and intervention groups were determined by a generalised estimating equations (GEE) model to account for cluster randomisation.
*p ≤ 0.05, **p≤0.01, ***p≤0.001.
REDs, Relative Energy Deficiency in Sport.

Table 4 Participants' top-ranked sources and social media platforms for how they currently acquire health information

	Health information
Source or platform	N* (%)
Source	
Teachers	4 (4.7)
Coaches	22 (25.9)
Social media	11 (12.9)
Friends/teammates	4 (4.7)
Parent/guardian	21 (24.7)
Physician/trainer	6 (7.1)
Sports performance or strength coach	2 (2.4)
Nutritionist	2 (2.4)
Online non-social media†	11 (12.9)
Books/textbooks	1 (1.2)
Other	1 (1.2)
Social media platform	
Instagram	25 (29.4)
TikTok	17 (20.0)
YouTube	10 (11.8)
Facebook	0 (0.0)
Pinterest	2 (2.4)
Twitter	0 (0.0)
Other	5 (5.9)
None	26 (30.6)

*Control and intervention participants are included together.
†Includes blogs, professional organisations and online magazines.

Short, online educational interventions may provide an accessible, lower cost method for athletes across different backgrounds. We were able to consolidate and validate wisdom from professional athletes and role models in the five video modules, exposing athletes to perspectives on female athlete science that participants may not experience from interacting with teammates, peers or even coaches. In a systematic review assessing 32 nutrition education intervention studies designed to improve knowledge in athletes, studies that used online content had greater knowledge increases and stronger retention of participants compared with non-technology-based interventions.[15] Future research should continue to explore different methods of delivering online Triad/REDs and female athlete science education with validated and consistent knowledge assessment instruments across each study. We should also continue to assess how incorporating inspirational stories from professional athletes who have experienced Triad/REDs alongside educational principles may impact short-term and long-term knowledge gains.

We hypothesise that the high level of baseline mental health knowledge in our participants could be related to an increase in open discussion surrounding mental health on social media or in school systems. In addition, our five mental health survey questions were not validated and could have been easier for athletes to answer compared with questions with more of a Triad/REDs science focus. In contrast to our findings, research indicates that there are few well-designed programmes for mental health literacy in youth athletes, and that researchers should focus on programmes for youth athletes that involve parent and coach engagement.[16] Future research should prioritise addressing mental health in tandem with physical health interventions for youth athletes.

Impact on interest

Our video modules had significantly higher Likert scale ratings of behavioural impact, information acquisition and interest across all five modules compared with the online educational material group and significantly higher ratings on acquisition of new information on three of five modules. Given that knowledge is a first step in changing behaviour and mindset but is often insufficient to do so alone, we wanted to think about the broader context of our intervention.[17] Outside of the research context, the higher interest ratings for the video may indicate that athletes would be more likely to engage with and act on resources that are designed to be interesting and entertaining, particularly in settings where engagement is a personal or team choice, without subsequent evaluation. We recognise that creating sustained behaviour change may require a more in-depth intervention that engages with participants individually, with goal-setting and long-term follow-up sessions. However, we were encouraged by our findings of stronger behavioural impact, information acquisition and interest in our video modules and hope that this interest may empower athletes to know how and when to ask for help or seek additional resources.

Participants' top-ranked sources for acquiring health information

We found that half of all participants predominantly acquire health information from parents or from coaches, with less than 10% predominantly acquiring health information from physicians or trainers and less than 3% from nutritionists. This parallels studies that indicate that athletes often rely on parents and coaches for key sources of nutrition and health education,[18 19] given that athletes may have limited access to registered dieticians, physicians, mental health professionals or athletic trainers. Parents and coaches may not have adequate knowledge and studies show that athletes with access to sports nutritionists/registered dieticians follow more established nutrition guidelines.[20] We believe this finding highlights the importance of Triad/REDs and female athlete science online education interventions for high school athletes. Future research should examine

dual interventions, with parallel educational content for parents and coaches.

In addition, we found that our participants predominantly used Instagram and TikTok as social media sources for acquiring health information and that 30% of our participants did not use any form of social media for acquiring health information. We collected this information to understand how to best release our five videos poststudy to reach more high school athletes. While we plan to distribute the videos on the FASTR Instagram account, we were also encouraged to see the number of athletes stepping away from social media for obtaining health information. Studies in adolescents indicate that longer daily social media use is tied to negative mental health outcomes as well as dysfunctional eating patterns.[21] Thus, we aim to create an online platform with our videos and educational materials for high school athletes that is outside the scope of social media and plan for follow-up studies on this platform. In our study, all participants had access to the internet and computers for education. Future research should explore how to deliver Triad/REDs education in areas that might have more limited computer access, including through team talks and coaching education. Researchers should also assess Triad/REDs perceptions and prevalence in areas with fewer resources to inform best intervention approach.

Limitations and strengths

The are some important limitations of our study. We assessed knowledge pre- and post-intervention using a 25-question assessment (five questions per video) that we created for this study. While we gave participants instructions to not use the internet or other sources for the assessment, we cannot control for their test-taking environment. Although we did not provide correct answers after the pretest, it is plausible that participants may improve on an assessment simply from having the opportunity to take the assessment again and recognising assessment questions. In addition, we assessed knowledge immediately postintervention—future studies should assess Triad/REDs and female athlete science knowledge at additional time points postintervention to understand how knowledge is retained in the long term.

We had significant dropout in our pilot study (44%), which improved to 16% in the intervention group and 15% in the control group in our primary study. We believe that shortening the study from 5 weeks to 1 week improved the participant retention and motivation in our primary study. However, we also added compensation for participants in our primary study. Although we had strong interest and engagement metrics in our primary study, it is also plausible that compensation impacted motivation, and that education efforts in high school athletes might be more challenging to conduct without compensation.

The strengths of our study include the development of five video modules featuring animated Triad/REDs and female athlete science education from experts, and inspirational content from 11 different professional athletes and role models. Our use of a control group and cluster randomised control trial study design enabled us to examine the impact of the video intervention compared with online educational materials. While both our intervention and control groups had knowledge gains, our five video modules better captivated participant interest and had stronger potential for behavioural impact. When considered with how participants access health information, we believe that the continued development of diverse types of educational materials for female high school athletes might improve knowledge, capture interest and facilitate lasting impacts on positive behavioural choices and mindsets.

CONCLUSION

This cluster randomised control trial found that both a five-part video series and online educational materials significantly improved Triad/REDs and female athlete science knowledge in high school runners. However, the five-part video series had higher ratings of interest and behavioural impact across all five modules. Future research should explore engaging and informative methods to deliver female athlete science content and should evaluate the impact of using compelling storytelling from a diverse range of athletes and experts.

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