Original Article

Exercise participation and subjective well-being of collegiate athletes during COVID-19 Pandemic

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ABSTRACT

While the NCAA grapples with how to return to sport during the COVID-19 pandemic, knowledge of the current exercise habits and well-being of collegiate athletes can better inform strength and conditioning professionals how to adjust periodization plans for the coming year. As collegiate athletes attempt to train independently, there is an opportunity to survey the athletes who normally participate in organized strength and conditioning programs. This study aims to understand current independent exercise regimes and explore current well-being measures such as fatigue, sleep, mood, soreness, and stress. Coaches may be facing massive levels of detraining or potentially the rest and recovery desperately needed for a rejuvenated return to sport. In this study, 237 collegiate athletes (mean age = 19.75, SD = 1.18) completed an online survey measuring exercise participation and well-being. Exercise habits indicate a statistically ($p < .05$) and clinically significant increase in frequency ($t(234) = 4.36$, $p = .000$, ES = .32), intensity ($t(235) = 5.31$, $p = .000$, ES = .47), and duration ($t(234) = 6.54$, $p = .000$, ES = .47) of exercise sessions overtime during the COVID-19 pandemic quarantine. Perceived psychological well-being also increased as time went on during quarantine with an improvement in fatigue ($Z = 3.42$, $p = .001$, ES = .22), sleep quality ($Z = 4.59$, $p = .000$, $ES = .30$), stress ($Z = 6.53$, $p = .000$, ES = .42), and mood ($Z = 5.86$, $p = .000$, ES = .38). It appears there was a potential adaptation to quarantine that improved athletes' exercise participation and perceived well-being but concerns for periodization strategies, motivation, and possibility of detraining remain for strength and conditioning professionals in the transition to the return to sport.

Keywords: Cessation of training; Detraining; Motivation; Periodization; Resilience.

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INTRODUCTION

The coronavirus (SARS-CoV-2/ COVID-19) pandemic created a global crisis causing accelerated morbidity and mortality with no proven vaccines or medication to mitigate the risk or severity of the illness. The COVID-19 virus can be transmitted by direct contact with an infected person with more than 27 million cases and over 900,000 deaths worldwide as of September 6, 2020 (WHO). Athletic events came to an abrupt halt with the risk of transmission of the virus heightened in the close nature amongst players and spectators. With university closures, daily training and the athletic season of 2020 and potentially 2021 is drastically interrupted. The potentially significant reduction in training and physical performance capacity could render athletes at a loss of competitiveness for return to sport (Andreato, Coimbra, & Andrade, 2020). The quarantine also created an isolated and restricted condition for most athletes, which can negatively affect mental health and psychological well-being (Brooks et al., 2020).

The COVID-19 pandemic and subsequent quarantine created stressors such as potential fears of infection, frustration and boredom, financial struggle, and lack of information and supplies (Brooks et al., 2020). In addition, athletes may have been subjected to varying degrees of academic stress: the transitions to online learning, relocation and travel as campuses rapidly closed, emotional angst associated with seasons ending prematurely, and potentially more serious impacts of the COVID-19 pandemic. High levels of stress also correlate with burnout, and reduced feelings of athletic identity and athletic satisfaction (Lee, Kang, & Kim, 2017). Sudden discontinuation of training and competition can have severe ramifications for mental health in athletes (Hull, Loosemore, & Schwellnus, 2020). Without organized team workouts or practices and elevated stress levels, there may be an increased likelihood of injury (Mann, Bryant, Johnstone, Ivey, & Sayers, 2016). The odds of an injury restriction during high academic stress can be twice as high as during times of low academic stress. Injury rate relating to psychological stress can come from hormonal changes associated with experiencing acute stress. The ratio of cortisol and testosterone is altered during acute psychological stress creating a catabolic effect on body tissues (Rano, Fridén, & Eek, 2019). The stress accompanied by the COVID-19 pandemic can affect recovery and effectiveness of any training completed independently by the athlete.

The uncertainty of the environment for training may lead to necessary adjustments in programming strategies. Physiological adaptations of motor skills, structural components, and metabolic function should be considered to enhance function and optimize performance (Smith, 2003). Therefore, strategies of periodization should be considered to maximize such components for performance at specific times. Periodization has been defined as a logically sequenced method of manipulating training variables to enhance physical abilities and increase the potential of specific performance goals (Stone et al., 1999). Primarily, periodization program enables athletes to be in prime condition for competition while managing fatigue and preventing overtraining. In most sports, the annual training plan is typically structured into macro, meso-, and micro-cycles that progress from extensive to intensive workloads and general to specific tasks. The macro- and mesocycle can contain 3 phases: (a) preparation (general and special), (b) competition (peaking and maintenance), and (d) transition. Each of these phases has different goals and requires different degrees of variation (Haff & Nimphius, 2012; Stone et al., 1999). Each macro and mesocycle generally begins with a high volume and low intensity of training and ends with high intensity and low volume of training. Therefore, the practitioner can direct the athlete's adaptations toward specific strength traits by manipulating volume and intensity variables and/or selecting the appropriate exercise (Plisk & Stone, 2003; Stone et al., 1999). However, traditional periodization models need to be re-evaluated for strength and limitations to adjust to the COVID-19 pandemic. Specifically, traditional periodization models entail a considerable preparatory period to develop physiological constructs that provide a foundation for the following phases. If this phase is

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not properly implemented later phases may not be as effective. Since COVID-19 has altered the structure of seasonal sports and the use of facilities, the strength coach need to account for the limitation of traditional periodization models. Planning for the upcoming season will need to consider the needs of the sport, resources available, schedule changes, sequencing of physiological adaptations and their residual effects.

The COVID-19 pandemic has placed unique stress on the collegiate athlete by removing or adjusting their regular physical training regime. The principle of detraining can be defined as a partial or complete reversal of physiological adaptations that arise from regular physical training (Mujika & Padilla, 2000a). The reversibility of training has the potential to lose training-induced adaptations that could alter or compromise the collegiate athletic performance in a sport that they have worked extensively to achieve. Detraining can be classified into short term or long term detraining, which are characterized by < 4 weeks of insufficient training stimuli and > 4 weeks respectively (Mujika & Padilla, 2000a, 2000b). Short term detraining has been shown to potentially have a negative impact on the cardiorespiratory, metabolic, neuromuscular, and endocrine systems (Mujika & Padilla, 2000a). Long term detraining has been associated with further reversal of physiological training adaptations (Mujika & Padilla, 2000b). The impact of long-term detraining can decrease sports performance related to endurance and force production, due to a reduction of training stimulus needed to facilitate adaptation (Mujika & Padilla, 2000b). Although training adaptations have been shown to decrease from a lack of stimuli, levels of performance may remain above control or previous levels in highly trained athletes, thus supporting the notion of not entirely losing various physiological adaptations to exercise (Lemmer et al., 2000; Mujika & Padilla, 2000b). Strength detraining effects has also been shown to be statistically similar between gender (Lemmer et al., 2000). Unlike gender, age appears to have a potential impact on strength detraining effects with older adults showing larger decreases in isokinetic strength (Lemmer et al., 2000). Latella and Haff (Latella & Haff, 2020) offer a more expansive overview of the neuromuscular effects of prolonged cessation of training.

Prevention of COVID-19 infection is a priority in student-athletes. Acute and chronic exercise have long been accepted as a means for physiological and subjective stress reduction (Jackson, 2013; Ozano, 2008). Moderate regular exercise also helps to reduce the severity of infections and the number of symptom days and is associated with a lower influenza-associated mortality rate (Wackerhage et al., 2020). While moderate exercise boosts immunity cells, the immune system can temporarily be suppressed or compromised by strenuous or prolonged exercise during the "*open window syndrome*" (Wackerhage et al., 2020), suggesting a preventative reduction in duration and intensity of exercise during the pandemic (Toresdahl & Asif, 2020). Higher intensity activity can also disrupt circadian rhythms (Buxton, L'Hermite-Balériaux, Hirschfeld, & Van Cauter, 1997). Poor sleep quality and a lower amount of sleep can also be associated with a higher risk for illness when exposed to a virus, making sleep a priority for student-athletes during the COVID-19 pandemic (Cohen, Doyle, Alper, Janicki-Deverts, & Turner, 2009).

This study aims to assess collegiate athletes' subjective experience of well-being during the COVID-19 quarantine as well as their exercise patterns to understand their perceived current physical and mental status. Strength and sport coaches can use the results garnered in this study to prepare athletes with appropriate advice and guidance if still in quarantine and better transition their athletes into competition upon return to sport.

MATERIALS AND METHODS

Experimental approach to the problem

An electronic survey was created by the authors via Google Forms. The survey consisted of 26 questions in open- and closed-question response formats. Participants identified their sport, age, sex, and environment during quarantine and exercise behaviors and well-being at the beginning of the COVID-19 quarantine and current conditions. Exercise behaviors were assessed using average frequency, duration, and intensity. Session intensity was assessed using session rate of perceived exertion (sRPE) using a modified Category Ratio (CR) (0-10 scale) (Barnes, 2017; Herman, Foster, Maher, Mikat, & Porcari, 2006). Evidence supports the validity and reliability in collegiate athletes of sRPE CR10 scale when compared with physiological measures such as $\%VO_{2peak}$ (R^2 = 0.76), $\%HR_{peak}$ (R^2 = 0.74) and $\%HR_{reserve}$ (R^2 = 0.71) (Herman et al., 2006), and measures of internal load utilizing Banisters TRIMP and Edwards TRIMP (CR10: r = 0.83 and 0.83) (Scott, Black, Quinn, & Coutts, 2013). Well-being was assessed using a questionnaire displayed in Table 1 with one question, each reporting fatigue, mood, sleep quality, general muscle soreness, and stress. These survey questions successfully predicted staleness defined by physiological stress measures (76% variance in predicted staleness scores and 85% of the variance in predicting plasma catecholamine levels) (Hooper, Mackinnon, Howard, Gordon, & Bachmann, 1995) and performance on countermovement jump (CMJ) (McLean, Coutts, Kelly, McGuigan, & Cormack, 2010). There was an opportunity for open-ended reflection of athlete status at the end of the survey.

Table 1. Well-being survey questions adapted from Hooper et al.(Hooper et al., 1995).

	5	**4**	**3**	**2**	**1**
Fatigue	Very fresh	Fresh	Normal	More tired than normal	Always tired
Sleep Quality	Very restful	Good	Difficulty falling asleep	Restless sleep	Insomnia
General Muscle Soreness	Feeling great	Feeling good	Normal	Increasing in soreness/ tightness	Very sore
Stress Levels	Very relaxed	Relaxed	Normal	Feeling stressed	Highly stressed
Mood	Very positive mood	A generally good mood	Less interested in others &/or activities than usual	Snappiness at teammates, family, and co-workers	Highly annoyed/ irritable/ down

Subjects

Results showed that 237 student-athletes completed the survey, 74 male (31.2%) 163 female (68.8%) with a mean age of 19.75 years old (SD = 1.18). Table 2 and 3 describe sport participation, academic rank, environment, start month for pre-season training, and location during the quarantine. The study was approved by the Institutional Review Board (IRB), and that the subjects were informed of the benefits and risks of the investigation prior to signing an institutionally approved informed consent document to participate in the study.

Procedures

The survey was distributed using snowball sampling, with a brief description of the study and link to the Google Form. The survey was sent to college coaches, strength and conditioning staff, athletic directors, athletes, and affiliates and utilization of social media posts promoting the survey. Data was collected over a 6-week period (May 29th, 2020 – July 5th, 2020).

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Table 2. Demographic data.

Measure	**Mean**	**SD**	
Age	19.75	1.18	
Measure	**Item**	**Value**	**Percentage**
Sex	Male	74	31.2
	Female	163	68.8
Year	Sophomore in 4-year	65	27.4
	Senior in 4-year	56	23.6
	Junior in 4-year	55	23.2
	Freshman in 4-year	37	15.6
	Junior college	8	3.4
	Other	16	6.8

Table 3. Activity and sport descriptive.

Measure	**Item**	**Value**	**Percentage**
Sport (top 9)	Soccer	30	12.7
	Lacrosse	30	12.7
	Softball	26	11
	Basketball	25	10.5
	Track and Field	19	8
	Swimming and Diving	17	7.2
	Volleyball	15	6.3
	Rugby	15	6.3
	Baseball	12	5.1
Environment	Suburban	152	64.1
	Rural	43	18.1
	Urban	42	17.7
Month pre-season (top 5)	August	95	40.4
	September	49	20.9
	June	30	12.8
	July	27	11.5
	January	15	6.4
Location	Indoors	20	8.4
	Outdoors	37	15.6
	Both indoors and outdoors	177	74.7
	I am not currently performing any workouts	3	1.3

Statistical analyses

Descriptive analysis for all population demographics was performed. A paired sample dependent t-test was performed to assess changes in exercise patterns of frequency, duration, and intensity of workouts at the start of quarantine and current exercise participation. A Wilcoxon Signed-Rank Test was performed to assess changes in well-being scores of fatigue, sleep, soreness, stress, and mood at the start of quarantine and current well-being scores. MANOVAs were performed for the effects of sex, sport, and academic year on duration, frequency, intensity, and well-being variables. All statistical analyses used an alpha level of $p \leq .05$, indicating significance. The effect size was provided where appropriate. A priori indicated an adequate sample size of 128 participants.

RESULTS

Exercise habits

All exercise variables of frequency, duration, and intensity increased over time. There was a significant increase in frequency from start (mean = 4.65, SD = 1.78) to now (mean = 5.16, SD = 1.41); $t(234) = 4.36$, $p = .000$, ES = .32). Exercise duration of sessions increased significantly over time as well (mean = 52.33, SD = 24.95) to now (mean = 67.13, SD = 32.89); $t(234) = 6.54$, $p = .000$, ES = .47). Survey respondents also significantly increased their intensity of their sessions measured through sRPE from start (mean = 5.85, SD = 2.22) to now (mean = 6.8, SD = 1.77); $t(235) = 5.31$, $p = .000$, ES = .47).

Well-being

The Wilcoxon Signed-Rank Test indicated that sleep quality, the experience of stress, and general mood improved significantly from pre-test ranks to post-test ranks. Sleep quality pre-test ranks increased from a rating of "*difficulty falling asleep*" (Mdn = 3) at the start of quarantine to current rating of "*good*" (Mdn = 4), *Z = 4.59, p = .000, ES = .30*, with fewer reports of "*restless sleep*" and "*insomnia*". The experience of stress improved from a rating of "*highly*" and "*very stressed*", in pre-test ranks (Mdn = 2) at the start of quarantine to "*normal*" and "*relaxed*" in the current post-test ranks (Mdn = 3), $Z = 6.53$, $p = .000$, ES = .42. Mood improved from pre-test ranks (Mdn = 3) at start of quarantine to current post-test ranks (Mdn = 4), $Z = 5.86$, $p = .000$, ES =.38 with a large decrease in "*highly annoyed/irritable/down*" rating over time, and an increase in "*a generally good mood*" and "*very positive mood*". There was a smaller yet still significant improvement in perceived fatigue from pre-test ratings (Mdn = 3) at start of quarantine to post-test ranks (Mdn = 3), $Z = 3.42$, $p = .001$, ES = .22, with more respondents feeling "*normal*" and "*fresh*" and fewer respondents feeling "*more tired than normal*". General soreness however, showed no significant change from the start of quarantine (Mdn = 3) to current ranks (Mdn = 3), $Z = .63$, $p = .53$, ES = .04.

Multivariate

There was no significant difference between sexes and reported exercise habits ($F = 2.11$, $p = .100$, ES = .03) or well-being ($F = 1.51$, $p = .19$, ES = .03). Separate MANOVAs revealed non-significant differences between sports and reported exercise habits ($F = 1.51$, $p = .07$, ES = .06) or well-being ($F = 1.45$, $p = .06$, ES = .06) or year/academic level and exercise habits ($F = 1.40$, $p = .19$, ES = .02) or well-being ($F = .80$, $p = .67$, ES = .02). Neither sex, sport, or academic year affected frequency, intensity, and duration of exercise or fatigue, sleep quality, soreness, stress, or mood.

Open-ended responses

Qualitative analysis of open-ended response question

Participants were asked at the end of the survey: "*Are there any other thoughts you can share regarding your exercise patterns and athletic activity during the COVID-19 quarantine?*" This question generated 98 responses out of a total of 242 survey responses. Table 4 outlines the major themes of athlete concerns, motivation increases with increased access, location/access remain unchanged, loss of motivation, injury, self-motivation, new ideas for exercise, and comments on detraining effects.

Limitations

Session RPE has limitations in novices and early on in an intervention; if athletes responding to the survey have never used sRPE before, they may incorrectly perceive their exertion (Crawford, Drake, Carper, DeBlauw, & Heinrich, 2018). Furthermore, sRPE was not reported in real-time after a workout but assessed using subjective averages, which threaten the reliability and validity. The well-being questionnaire is often used as a repeated measure to investigate changes over time in individuals. This survey utilized this

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questionnaire as a general indicator of well-being across the group to inform general patterns. The response rate could have possibly been reduced due to various furloughs of athletic department staff across the United States, limiting the dissemination of the survey.

Table 4. Qualitative analysis of open-ended response question.

Theme	**Comments**
Concerns and access	Family, concern for communicability of COVID greatly affect exercise patterns, uncertain times excuse not to train hard, prevent infection transmission. No space to complete workouts, no access to weights, need the gyms to open back up. Tired of doing at-home workouts, less motivation to workout at home. Hard to get into "normal routine," frightened of COVID-19, very stressful to balance working out, stick skills, and homework all while family is doing work/schoolwork as well.
Motivation increased as facilities opened	As gyms opened up, generally happier, no excuses when life is getting back to normal, feel more motivated as things begin to come back to normal, intensity and duration increasing with businesses opening up and COVID cases declining. The opening of golf practice facilities highly influenced my exercise patterns, I became highly active once they opened. Dealing with the sudden cut-off of athletics and transition to online classes paired with rainy new england spring weather slowed my physical activity, since I do not have a lot of gym equipment at home and I enjoy working outside - now that classes are over and the weather is nicer my workouts have been much more consistent. With limited access to resources, workouts were shorter and less strenuous. In the early stages of COVID - now that fitness facilities have reopened workouts are more strenuous, take longer, and I have access to way more equipment. I felt myself with more energy and less anxiety when I could start exercising more.
No change in access	Location didn't close down – happy to maintain exercise regimen. As a XC and distance track athlete I was beyond grateful that for the most part I was able to keep doing my training to near full capability during quarantine. Running kept me sane, it gave me something to do and look forward to consistently during a time of much uncertainty. I live in Florida so my exercise facilities remained open during the quarantine. Not much changed between quarantine and now.
Loss of motivation	No motivation despite being provided workouts by athletic department, no consistency, impossible to stay motivated with minimal equipment and resources, less motivated and unorganized, miss the structure, feel tired before starting workout, useless, 0 motivation, some days I don't feel like exercising but try to push myself to do something, no motivation to workout whatsoever, I like lifting heavy weights - struggling because cannot hit maxes, frustration to gyms being closed and lack of athletic equipment being available, less motivated to work out with limitations of body weight exercise, getting used to exercising at home was a rough one, feeling sluggish but have made an attempt to keep my body moving almost every day, very hard to keep motivated, hard to be motivated when doing same types of routines and mostly on my own, throughout quarantine I have been less and less motivated to exercise, I have started to lose hope, motivation is

	lost, less excited and motivated to workout, working out with no goal in mind, very accustomed to having my days filled with time-dependent responsibilities - without set practices, it was difficult to navigate planning my day while still having class, difficult to adjust to less structured schedule during quarantine. miss competitive environment, working out with others.
Injury	Injury at beginning of quarantine so didn't exercise. Injured while at home doing workouts so it's been hard trying to rehab without having my trainers from school. Injured at the beginning of quarantine and so wasn't able to exercise as much. Activity level has gone down is because resting an injury and don't have as strict of a schedule as in school.
Self-motivated	Start day with exercise, basically maintained a consistent schedule, exercise is my coping mechanism for everything that is going on, workout immediately after work, discipline, routine, patience, increased intensity during quarantine because more time and not in season. Exercise was one of the only things that was in my control during quarantine, so I really focused on it and I feel that I made good progress. This is why now I workout and make a schedule/to-do list everyday to help me continue to tackle quarantine. During the quarantine I've had more and better sleep which has led to an improvement all around in my training.
New exercise ideas	Used a lot of new ideas, worked out with friends on zoom, stay motivated and feel part of a team, push each other, a lot of more cardio than weight lifting, online workouts to stay active. I have been doing less sports-specific activities, but have been exercising in other ways even more. Had to change my activities slightly during quarantine and use what was available. Doing the best I can with the equipment I have.
Detraining/periodization	Gained so much fat from doing nothing that I will never ever take a hiatus like I did before. With track and field losing our outdoor season, it was hard to transition to quarantine training. In a time when we were supposed to be peaking, we were doing maintenance workouts. Then during our normal "time off," it didn't feel like we needed it because we didn't actually have a season of racing. If we hadn't taken this time off, though, we would be very burnt out by the time we are supposed to start racing again in December.

DISCUSSION

The survey results show a statistically significant increase in frequency, duration, and intensity of exercise sessions over time, indicating a potential adaptation to the pandemic conditions. Well-being and psychological resilience also improved over time during quarantine, with sleep, stress, and mood improving significantly. Athletes were able to adapt to the quarantine conditions to eventually return to physical activity levels over time, suggesting a potential increase in autonomous motivation for exercise (Reinboth & Duda, 2006). Improvement in perceived psychological ratings may have impacted the increase in exercise activity with improved motivation, mood, and lower stress levels. Interchangeably, Steptoe and Butler (Steptoe & Butler, 1996) found vigorous physical activity has been shown to improve subjective well-being. This potential reciprocal relationship will be studied in future studies. General soreness, however, did not improve, indicating the recovery methods employed while at school potentially assisted in the experience of soreness.

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Responses to the open-ended question indicated that some students were not affected by COVID-19-related closures, an increase in motivation as facilities opened, and the necessity to build self-efficacy to maintain motivation. Some concerns that arose from the qualitative analysis include a loss of motivation to exercise without teammates and practices, an increase in fat mass, accessibility of equipment and space, and injuries due to independent exercise. Similarly, concerns for coaches and strength and conditioning professionals include program compliance, accurate monitoring of load, submaximal and maximal stimuli conducive to performance, and accessibility for space and equipment for sport-specific activity (Jukic et al., 2020). Understanding of unique circumstances and environments and how they affect each athlete physically and psychologically, some athletes may be more affected by the pandemic than others. Group and individual workouts via live-streaming video may be beneficial to improve social connection and monitor form to prevent injury. The pandemic and pro-longed cessation of organized sport offer a unique opportunity to improve wellness indicated in well-being ratings increasing over time and a focus on improving mindset, education on nutrition and performance, recovery, and injury prevention (Jukic et al., 2020; Latella & Haff, 2020).

CONCLUSIONS

Based on the findings and published literature, a program during the pro-longed cessation of training to maintain physical performance can include minimal stimuli for strength and power maintenance (Latella & Haff, 2020), small doses of vigorous activity to support well-being (Steptoe & Butler, 1996), but monitoring the overall volume of high-intensity exercise to avoid weakening of the immune system (Wackerhage et al., 2020). An undulated model may be more effective and efficient over a traditional model for strength and power athletes given the variable nature of training during quarantine (Plisk & Stone, 2003; Williams, Tolusso, Fedewa, & Esco, 2017). Undulated periodization allows for more dynamic variations throughout a micro-cycle and mesocycle, compared to a flat workload and novel stimulus of traditional periodization (Plisk & Stone, 2003). Thus, preparing with fluctuation may better prepare the athlete for competitive stress and over a long duration (Gamble, 2006). With limitations to delivering a structured program in person, a proposed plan to prepare athletes for the upcoming season would include clear guidelines of an undulated program to follow with several exercise variations to address variable accessibility to equipment. Live-streaming video workouts performed as a group create a strong connection with teammates which also may improve exercise motivation (Deci & Ryan, 2012). Upon the return to normal sport season, a thorough needs analysis is necessary to assess each individual athlete's training status and preparedness. Progressive overload should be monitored carefully to avoid injury risk due to pro-longed detraining. In the current circumstances, the improved perceived sleep quality and experience of stress may create a small buffering effect to illness and should continue to be emphasized upon return to training (Cohen et al., 2009). Improved well-being during quarantine cannot be overlooked for future off-season programming. The improvement in sleep quality, stress levels, mood, and fatigue can have lasting implications for improved performance and resilience for the upcoming season.

AUTHOR CONTRIBUTIONS

Susannah Reiner developed and designed the study concept and implementation and performed the statistical analysis. Glenn Harrison Smith and Rick Davis contributed to research found in the introduction and copyediting the final manuscript. All authors assisted in data collection, discussed the analysis of the results, and contributed to the writing of the manuscript.

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No potential conflict of interest was reported by the authors.

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