

Original Research

High Prevalence of Low Back Pain in College Rifle Athletes

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Background

The sport of rifle places unique physical demands on its athletes relative to other collegiate sports, including maintaining lumbar-straining positions for extended time. Anecdotal reports of low back pain (LBP) are common among collegiate rifle athletes, but the prevalence of LBP in this population has not yet been established in the literature.

Purpose

The purpose of this study was to survey collegiate rifle athletes to quantify the prevalence and impact of low back pain in this population and identify possible contributing factors including the COVID-19 pandemic. It was hypothesized that over 50% of athletes would report an episode of LBP due to participation in collegiate rifle events.

Study Design

Cross-Sectional Study

Methods

Athletes at least 18 years of age who were members of a collegiate rifle program during the 2019-2020 season were surveyed via an online questionnaire. The questionnaire included four sections: (a) demographics, (b) presence of LBP, (c) the impact of pain episodes on daily activities, and (d) shooting stance and training characteristics.

Results

Responses from 114 athletes were collected. A total of 101 (89%) respondents indicated having experienced at least one episode of LBP. Of those, 24% also missed at least one day of training or competition during the 2019-2020 season because of LBP. During the COVID-19 pandemic, 60% were unable to receive the same level of medical care while 69% experienced equal or greater pain levels. An association between sex and LBP was statistically significant ($p < 0.001$).

Conclusion

There is a high prevalence of LBP in collegiate rifle athletes. It is necessary for Athletic Training staff and other medical professionals to be aware of this for prevention and treatment, as it has significant impacts including missed playing time. More research on predisposing factors such as sex and training duration or positional characteristics would benefit management of this injury.

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Level of Evidence

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INTRODUCTION

Low back pain (LBP) is the most common form of musculoskeletal pain and is a major cause of activity limitations, disability, health provider visits, and health care costs.¹ Athletes have been observed to experience higher rates of LBP than the general population.²⁻⁵ While the one-year prevalence of LBP for the general population has been reported as high as 56%, for elite athletes in any sport at the university and Olympic levels the one-year prevalence has been reported to be as high as 81%.¹⁻⁵ Anecdotally, many elite rifle athletes including those competing at the collegiate level have been cited to suffer from bouts of acute and persistent LBP.⁶⁻⁹

LBP can impact these athletes' participation, performance amongst teammates, scholarship acquisition, and potential Olympic berths.^{7,9} However, there is a paucity of evidence in the scientific literature regarding injury surveillance and injury prevention for this unique athletic population. A systematic review found only three studies focused exclusively on injury surveillance in summer Olympic-style shooting events like those contested at the collegiate level, and only two studies focused on adolescent or university-aged athletes that include shooting athletes.^{3,4,6,8,10,11}

Though previous studies have examined the rate of injury and prevalence of LBP for shooting sports athletes, they have important limitations. The investigation by Vol-ski et al. is the only study that distinguishes between shooting disciplines (rifle, pistol, shotgun) in its methodology, rather than simply listing "shooting" as the sport, however, this study does not distinguish between events within disciplines.⁶ None of the former studies pertain specifically to NCAA athletes or events, though multi-sport studies by Muller et al. and Noormohammadpour et al. focus on adolescent and university athletes outside of the United States.^{3,4} This lack of specificity allows for the reported prevalence of LBP in rifle athletes, particularly within the collegiate population, to be influenced by athletes in the other shooting disciplines whose injury rate may differ due to the athletic and equipment requirements unique to their events.⁸

Low back pain in athletes has been shown to correlate with a lack of strength of the trunk muscles (i.e., internal and external obliques, transversus and rectus abdominis).^{2, 12} Other muscles that have been implicated as dysfunctional in LBP include the posterior spinal muscles, including the erector spinae and multifidi.^{13,14} Olympic-style rifle shooting requires strength in the trunk muscles for uses that are atypical compared to other sports.⁹ Rifle athletes utilize their trunk in a static manner, requiring these muscles to provide stabilization and static control for optimal performance, rather than coordination with arm and leg movement as seen in other sports.^{7,15-17} This positioning requires lumbar rotation and hyperextension which places stress on the spine and pelvis, illustrated in [Figure 1](#).⁶ Further, athletes may hold these positions for over an hour at



Figure 1. Depiction of a traditional Olympic-style rifle shooting stance.

A traditional right-handed shooting stance with a .22 caliber smallbore rifle that would be used in collegiate competition. The same position is used for the .177 caliber air rifle event.^{15,16}

a time.^{15,18} These unique physical demands of rifle athletes may predispose them to a higher risk of LBP and potential recurrent episodes of LBP. Improper form or trunk strength deficits, particularly in the aforementioned muscle groups, may exacerbate this risk.⁶

Given that LBP may both have a significant impact on athletic opportunities as well as result in a chronic injury with potentially lifelong physical and financial consequences, obtaining information regarding prevalence and relevant factors can guide medical professionals, coaching staff, and sports governing bodies in the surveillance, prevention, and treatment of LBP in these athletes. The purpose of this study was to survey NCAA and collegiate club rifle athletes nationally to quantify the prevalence and impact of LBP in this population and identify possible contributing factors of LBP, including the COVID-19 pandemic which occurred during the time of data collection. The COVID-19 pandemic was caused by the novel SARS-CoV-2 virus and resulted in vast but varying term shutdowns, and modifications of colleges, athletics programming, and non-emergent medical services.¹⁹

This is the first known study to investigate injury patterns of LBP specifically in collegiate rifle athletes, particularly the prevalence of this injury. Ultimately this work will help guide future research investigating the prevalence of LBP and its effects on rifle athlete performance. It is hypothesized that over 50% of NCAA and collegiate club ri-

fle athletes will report an episode of LBP due to participation in collegiate rifle events, thereby warranting further investigation and surveillance of injury in this understudied athletic population. This study also seeks to investigate the effects of the novel COVID-19 pandemic on LBP in this population, including factors such as access to medical care or training facilities which may have influenced such impact. It is hypothesized that greater than half of respondents would report changes to their baseline LBP and reduced access to medical care previously received for LBP during the pandemic.

METHODS

This was a cross sectional, observational study, using an online survey via Qualtrics Survey Software (QualtricsXM, Provo, UT) available from July 8, 2020 to March 27, 2021. The project and study protocol were reviewed and approved by the Institutional Review Board. Consent was obtained via affirmative response to a required element on the first page of the questionnaire. All survey data were stored in a secure cloud-based folder accessible only to study personnel. No identifying information was connected to the results of the survey.

SURVEY DEVELOPMENT

The survey was designed to best reflect the most pertinent consequences of LBP for a student athlete, including impact on both training and other team related obligations as well as day to day activities, and factors relevant specifically to the sport of rifle. Two authors developed the initial survey, which was further refined utilizing feedback from the remainder of the study team. The drafted survey was developed from: 1) relevant questions selected from several validated LBP questionnaires (Japanese Orthopaedic Association Back Pain Evaluation Questionnaire, Örebro Musculoskeletal Pain Questionnaire, Oswestry Low Back Pain Disability Questionnaire)²⁰⁻²² and 2) concepts deemed important by the authors to evaluate in the study population, which included questions related to shooting position characteristics and how they may influence the prevalence or severity of LBP. Additionally, as the survey was being administered during the early COVID-19 pandemic at a time which significant activity restrictions were in place in many locations, several questions were developed which focused on the impact of the pandemic on LBP in the study population and were included throughout the questionnaire. Following development, study personnel accessed the survey to verify functionality and usability on both mobile and desktop devices.

DESCRIPTION OF PRIMARY SURVEY ELEMENTS

The survey was comprised of four sections: *Personal and Athletic Background*, *Pain Background*, *Pain Influence on Activity*, and *Athletic Information*. The first section contained demographic information regarding age, overall time spent participating in the shooting sports, and other activities

that may be pertinent to the presence of back pain including COVID-19 pandemic related changes to physical activity and enactment of stay-at-home orders in the athlete's primary location of residence during the pandemic. The first of these pandemic-specific questions was adapted from a study by University College London entitled "Health Behaviours During the COVID-19 Pandemic," as changes to an athlete's physical activity routine were considered during survey design as playing a potential role in pandemic-related changes to pain.²³ The *Pain Background* section assessed the presence and parameters of a participant's back pain, while the *Pain Influence on Activity* section assessed the extent of influence a participant's back pain had on daily activities. The *Athletic Information* section built a general description of the participant's standing position during rifle competition. As there is no known validated survey regarding rifle shooting positions, the authors designed the questions in the two sport-related sections of the survey specifically for this study.

For this survey, LBP was defined as pain "in the area between the inferior margin of the 12th rib and inferior gluteal folds."¹ In the *Pain Background* section, respondents were asked whether they had ever experienced LBP in conjunction with rifle training or competition, along with an accompanying image illustrating the defined "low back" region.²⁴ This section also contained two questions pertaining to the COVID-19 pandemic and its effects on both severity of pain and access to medical care. The latter of these two questions was based on data from a Kaiser Family Foundation poll indicating as many as 48% of respondents or members of their households have experienced delayed healthcare due to the pandemic, as this would be likely to extend to collegiate athletes who are no longer able to access their campus resources.²⁵

Those individuals responding affirmatively to having experienced LBP in conjunction with rifle training or competition were next given access to the *Pain Influence on Activity* section. Those who responded negatively to having a history of LBP were not able to access this section and were directed to the final *Athletic Information* segment. This section also contained a question regarding changes in the athlete's planned training routine during the COVID-19 pandemic, which added context to perceived changes to pain increases or decreases. Presence of LBP history was the only required element of the study questionnaire following consent to participate.

SETTING AND SUBJECTS

A web link to complete the survey was disseminated via email by program coaches to potential participants. Inclusion criteria of participants were: 1) any current member of an NCAA or collegiate club level rifle program, 2) at least 18 years of age, and 3) former members of such teams who participated in the 2019-2020 season but had since completed their athletic eligibility or graduated from the university. Subjects were not excluded on any other basis provided they met the eligibility criteria.

DATA COLLECTION

To recruit participants, the Head Coach of each team, identified using the “Team Homepages” at ncaarifle.org, the “Collegiate Shooting Sports Directory” at compete.nra.org, and the individual web pages for each rifle program, was emailed to request participation of their program.^{26,27} Following approval, a link to access the study questionnaire was then sent to the coach who distributed this to their team members via a forwarded email. A total of 23 programs received this link. The online survey was active and available to participants for a period of approximately 8.5 months, a time frame which encapsulated one complete NCAA athletic season.

DATA ANALYSIS

Descriptive and frequency analyses were performed on the survey responses. The presence of LBP, rifle shooting career length, and training volume was expressed as a percent rounded to the nearest tenth. The extent to which LBP impacted everyday activities and characteristics of the rifle shooting position were expressed through either percent or mean, median and standard deviation, dependent on whether the survey question yielded quantitative or qualitative responses. All surveys with at least one question of the study questionnaire, excluding the consent page, containing a response were included. Non-responders at the item level were not included in analyses of individual question responses, so as to avoid potential bias from imputation on quantitative survey items.

A tertiary analysis to examine the association between sex (male, female) and the presence of low back pain (yes, no) was conducted via a chi-square test of independence. Due to small expected frequencies in 50% of the cells, with a minimum expected count of 0.11, the Fisher-Freeman-Halton Exact Test was employed to ensure valid results. This test is suitable for contingency tables where the assumption of the standard Pearson Chi-Square test is violated due to low cell counts. The significance level was set at 0.05 for all statistical tests.

RESULTS

The questionnaire was sent to 23 NCAA and collegiate club level rifle programs (15 NCAA; seven collegiate club), a participation rate of 50% of contacted programs (46 total; 27 NCAA, 19 collegiate club). A total of 117 individual responses were collected from athletes affiliated with these programs. Three responses were discarded: two due to ineligibility and the third being a duplicate response, resulting in a total of 114 surveys included in analysis. This pathway of response collection is illustrated in [Figure 2](#).

Over 60% (70/113) of respondents to the gender question identified as female, with one participant electing not to respond to this question. The gender breakdown of respondents can be seen in [Table 1](#). The median age of respondents was 20 years old, with more than 50% (63/114) indicating being in either their first or second year of col-

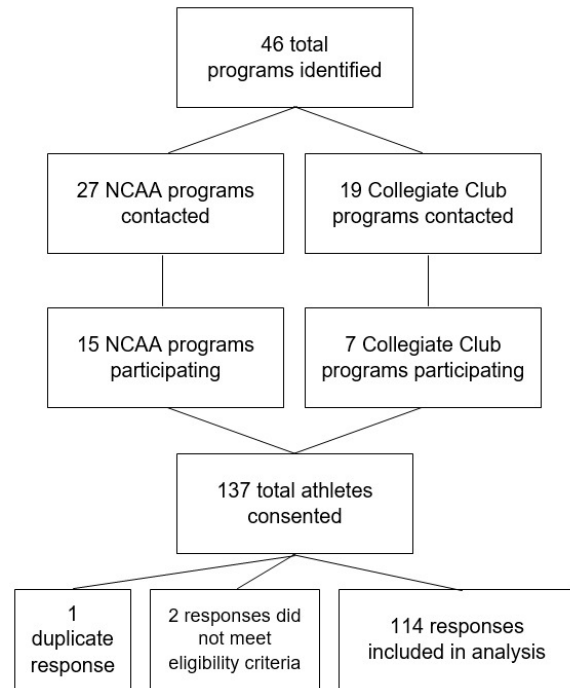


Figure 2. Flow diagram of recruitment and participation.

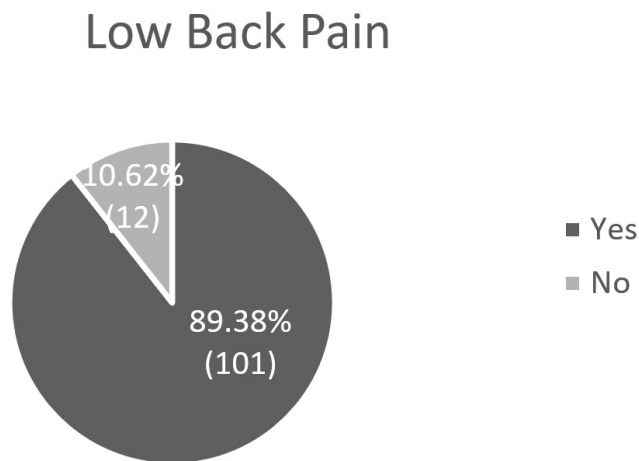
lege. At the collegiate level, the median number of years participated in rifle shooting was two, out of a maximum possible of five. For overall career length in rifle shooting, inclusive of participation in non-NCAA type rifle disciplines such as BB gun and sporter programs, the median was six years. These characteristics in addition to training details are also depicted in [Table 1](#).

At least one episode of LBP in conjunction with training or competition was indicated by 89% (101/113) of athletes ([Figure 3](#)). One participant did not answer this question. Of the remaining 12 athletes who reported not having experienced LBP, only one identified as female, with the other 11 identifying as male. Thus, 74% (32/43) of male respondents reported having experienced LBP in comparison to 99% (69/70) of female respondents. The results of the Fisher-Freeman-Halton Exact Test demonstrated this to be a statistically significant difference in the presence of LBP between the sexes ($\chi^2(2) = 16.37$, $p < 0.001$). Of athletes who had experienced LBP, 73% (73/100) of those indicated the location of their pain was bilateral. The median percentage of the previous collegiate rifle season for which respondents estimated that they experienced episodes of LBP was 40.

As many as 24% (33/98) of those experiencing LBP reported having missed at least one day of training or competition during the previous collegiate rifle season due to their LBP. Of those who experienced LBP, the mean duration of the 2019-2020 playing season which these athletes estimated themselves to have experienced pain was 45% ($n=100$). This pain also impacted activities critical to team participation such as travel, with 49% (48/98) reporting increased LBP with travel. Additionally, 61% (60/98) endorsed occasional sleep disturbances due to pain and 27% (26/98)

Table 1. Demographics and Training Characteristics

	History of LBP (n=101)	No history of LBP (n=12)	All respondents (n=114)
% Male	31.68 (n=32)	91.67 (n=11)	37.71 (n=43)
% Female	68.32 (n=69)	8.33 (n=1)	61.40 (n=70)
Age, years (SD)	19.71 (1.23)	20.08 (1.24)	19.75 (1.23)
Overall rifle career length, years (SD)	6.44 (3.08)	4.50 (4.44)	6.24 (3.28)
Collegiate rifle career length, years (SD)	2.01 (1.09)	2.18 (1.40)	2.03 (1.11)
Weekly training sessions, days (SD)	3.61 (1.40)	2.69 (1.39)	3.5 (1.44)
Training session length, min (SD)	126.52 (59.61)	95.91 (80.62)	123.72 (62.04)


Figure 3. Respondents indicating a history of Low Back Pain

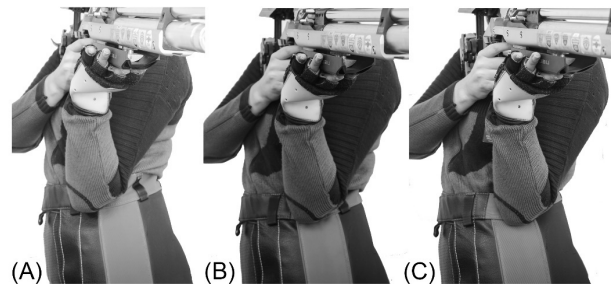
reported having to modify their work, training, or competition routine because of LBP.

With respect to shooting position characteristics, 88% (100/114) reported using a right-handed stance. Over 75% (79/105) of those who answered further questions about their shooting position reported a support hand position using an open palm, with several variations in hand and forearm rotation among these responses. Additionally, 59% (62/105) place the support elbow directly on top of the hip, and 63% (66/105) report thrusting their leading hip fully toward the target (Figure 4, Figure 5). An overview of participant shooting position characteristics in more detail is shown in Table 2.

Since the onset of the COVID-19 pandemic in March 2020, 69% (69/99) of respondents who had experienced LBP reported continuing to experience the same or higher levels of pain as previously reported in this period. One participant who had experienced LBP elected not to answer this question. Of those who reported receiving medical care for their LBP, 60% (27/45) indicated being able to receive only some or none of the care they had received prior to the pandemic.


Figure 4. Typical support hand positions for Olympic-style rifle competition.

(A) Fist-style hand position in which the rifle rests on the knuckles. (B) Open palm hand position with fingers pointing in the direction of the target. This was selected as the most common hand position among both athletes with and without history of LBP. (C) Open palm hand position with fingers pointing behind the athlete, parallel to the firing line.


Figure 5. Typical support elbow placements for Olympic-style rifle competition.

(A) Elbow position ahead of the hip. (B) Elbow position directly on top of the hip. This was selected as the most common elbow position among both athletes with and without history of LBP. (C) Elbow position behind the hip.

DISCUSSION

The purpose of this study was to assess the prevalence of low back pain in the collegiate rifle athlete population and investigate factors which may contribute to its presence or absence. This is the first study to identify the prevalence of LBP in this group. Most respondents (89%) indicated a history of LBP in conjunction with training or competition in rifle. Though the present study reflects the experiences of only a portion of this population, these athletes represent a large number of its members based on roster sizes of the programs identified during the recruitment

Table 2. Shooting Position Characteristics in Athletes with and without History of LBP

Shooting position characteristic		History of LBP (%, n=93)	No history of LBP (%, n=12)
Hand position	Fist	18.3	25.0
	Palm - Fingers facing back	14.0	16.7
	Palm - Fingers facing target	54.8	33.3
	Other hand position	12.9	25.0
Elbow position	Ahead of hip	37.6	25.0
	On top of hip	57.0	75.0
	Behind hip	5.4	0.0
		History of LBP (%, n=92)	No history of LBP (%, n=12)
Shoulder alignment	Left shoulder lower	37.0	41.7
	Right shoulder lower	21.7	33.3
	Shoulders neutral	41.3	25.0
Hip thrust	All the way	66.3	41.7
	Part way	31.5	50.0
	Directly above feet	2.2	8.3

process.^{26,27} These rosters indicate fewer than 400 athletes compete in rifle through the NCAA annually; the total number of non-NCAA collegiate club athletes is less standardized year-to-year and therefore unclear, but between 60 and 80 additional athletes from as many as 19 identified club programs compete in the Intercollegiate Rifle Club National Championships annually, the highest level non-NCAA collegiate rifle competition.

The results of this study suggest a high prevalence of LBP in collegiate rifle athletes. These results align with a 2011 study on injuries in Turkish Shooting Championship participants which asserted that one of the most common areas of injury during shooting competition was the lower back.¹⁰ Only one study, published in 1986, specifically investigated LBP in rifle and pistol athletes, and found a significant correlation between performance on a functional screen and LBP.⁶ When viewed in the context of the current study, this may provide a framework for future research regarding the role muscular dysfunction or weakness of the trunk plays in this injury.

There are no known studies regarding LBP in the collegiate rifle athlete population, though there are several multi-sport studies regarding athlete injury rates and incidence of LBP that include shooting sports. One of these multi-sport studies, focusing on elite German athletes, indicated a 12-month prevalence of LBP in as many as 87% of respondents from the shooting sports and lifetime prevalence of 95%, which is consistent with the 89% prevalence rate determined by the present study.² This is in contrast, however, with the results of a systematic review by Harr et al. showing a low prevalence of overall injury in shooting athletes at the Summer Olympic Games, less than 10%. It is likely that injuries reported at competition events are more acute and not reflective of chronic conditions such as LBP, a limitation which is also noted by Harr et al.⁸

Nearly one quarter (24%) of athletes with LBP in this study have had to miss playing time in the form of training or competition for this injury. Overall, athletes with LBP spent an average of 45% of the previous playing season experiencing this pain. These results suggest that this injury places a high burden on the collegiate rifle athlete population, as many athletes are missing time or otherwise struggling with LBP throughout a large portion of their competitive season both on and off the playing field. Details regarding the traditional NCAA Rifle playing season timeline and that of the 2020-2021 season impacted by COVID-19 pandemic restrictions are highlighted in [Figure 6](#) and [Figure 7](#).

This study also sought to examine factors that may be implicated in LBP, including characteristics of the shooting position. The most common shooting position characteristics among respondents indicated the use of a right-handed shooting stance with significant hip thrust towards the target, elbow placement ahead of the hip towards the anterior ribcage, and a variant of the open palm support hand position. Despite the fact that these positions can be highly variable athlete to athlete, the listed characteristics are representative of those found in instructional materials for both beginner and high level athletes.^{16,29,30} These shooting positions place increased unilateral strain on the lumbar spine and require adequate trunk strength and proper technique and standing positioning ([Figure 1](#)).⁷ Though there are athletes able to use these positional variations without subsequent LBP, this study shows that many athletes using these positions do experience LBP. Therefore, it may be worth examining the common positions for alternative options that maintain accuracy while reducing physical strain. It may also be of use for athletic training and strength training professionals who work with these athletes to design workout and rehabilitation programs that account for these common positions and the unilateral

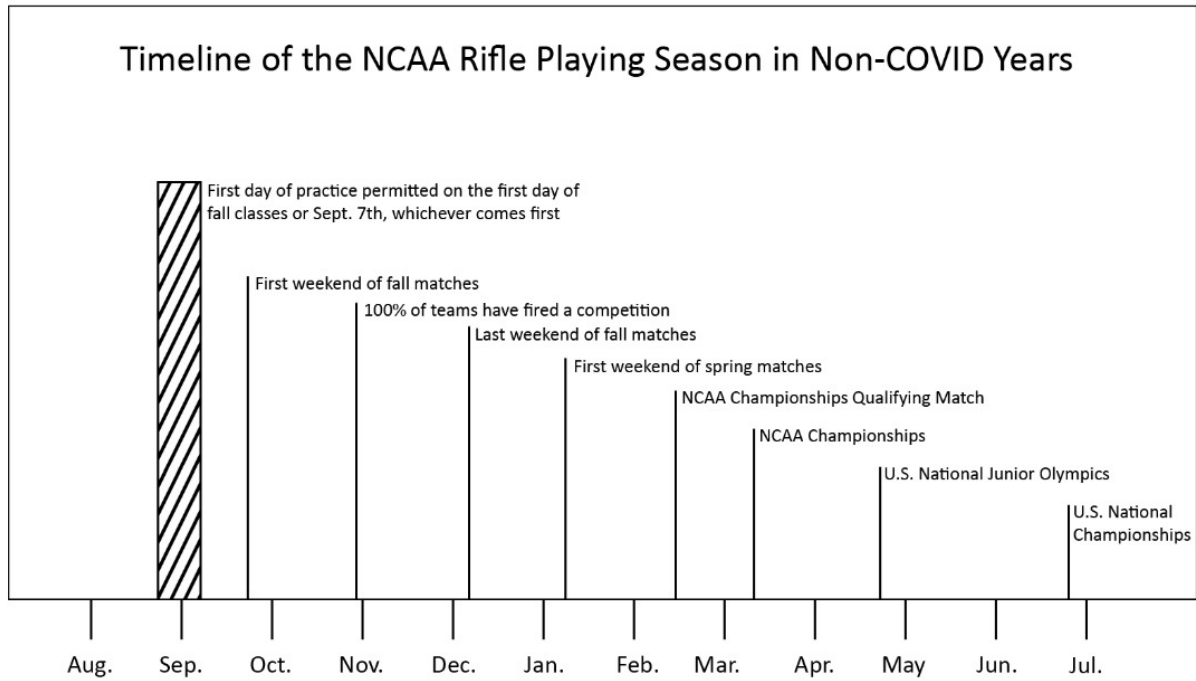


Figure 6. Timeline of a typical NCAA Rifle Playing Season prior to 2020-2021.

The season is separated into a fall segment and a spring segment, with a maximum number of 13 regular season competitions followed by the NCAA Championships Qualifying Match and NCAA Championship Tournament.²⁸ Many collegiate rifle athletes additionally participate in the U.S. National Junior Olympics and U.S. National Championships following the NCAA-sanctioned season, resulting in year-round competition.

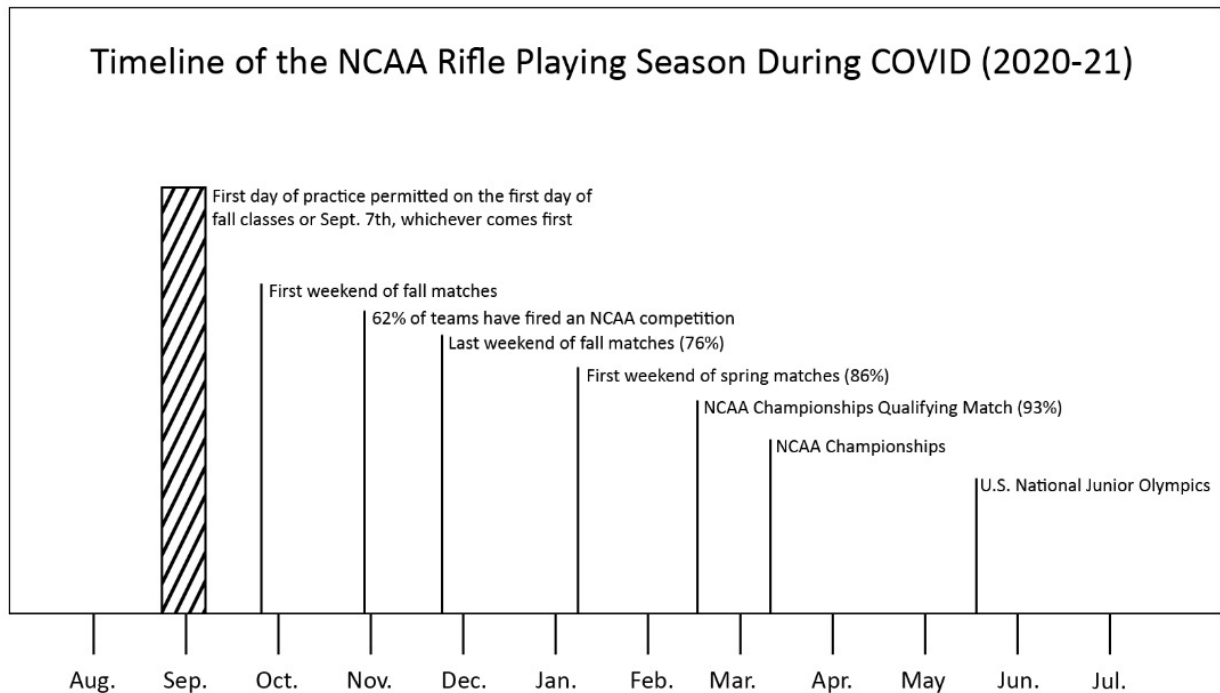


Figure 7. Timeline of the 2020-2021 NCAA Rifle Playing Season

The NCAA Rifle playing season operated under an approximately normal timeline, though notably the fall half of the season ended about two weeks earlier than during other years.²⁶ Additionally, the number of teams competing in NCAA competition on any given weekend was much fewer than in the 2019-20 season.

strain they place on the lower back and joints. More specifically, it may be prudent for these programs to focus on core strength and stability, as dysfunction or weakness of the trunk muscles has been implicated in LBP. It may also be of

benefit for coaching staff to focus on making athlete-specific positional adjustments based on reported pain to mitigate the risk of further injury.

Worth noting is that although the pool of respondents with no history of LBP is small, as only 12 out of 113 who indicated a sex, 92% (11/12) of these individuals identified as male, a relationship which was found to be statistically significant via Fisher-Freeman-Halton Exact Test ($\chi^2(2) = 16.37$, $p < 0.001$). The higher prevalence of LBP in females seen in this study is compatible with the results of a systematic review by Harr et al., in which the incidence of all injuries in summer Olympic-style shooting events, like those used in NCAA competition, was higher in women than men.⁸ The Olympic-style standing shooting position relies heavily on pelvic positioning and stability. It is possible that these positions induce more strain in women due to the wider pelvic structure seen in female anatomy, and differences in muscle, fat, and bone density between the sexes, as suggested by Fett et al.² Although rifle is a co-ed sport for championship purposes at the collegiate level, no less than seven out of the nearly 30 current NCAA Rifle programs sponsor female-only teams while others maintain female-dominant co-ed rosters.²⁶ This pattern suggests a need for further investigation into the significance of this relationship, given the large proportion of female participants in the sport.

The study also investigated the impact of the Covid-19 pandemic on LBP in the collegiate rifle athlete population. During the first year of the pandemic, spanning from March 2020 until closure of the survey in March 2021, most participants with history of LBP reported the same or increased levels of pain. While not all respondents with history of LBP were receiving medical care for this injury at the time of the pandemic, more than half of such athletes were unable to receive the same level of medical care compared to prior to March 2020. These results highlight that the Covid-19 pandemic may have been detrimental to the rehabilitation of this chronic musculoskeletal injury.

LIMITATIONS

There were several limitations to this study that should be considered. First, the cross-sectional nature of the study design limits the potential interpretation of factors relating to the development of LBP. Athletes are likely to change their techniques and training volume over time, something that cannot be fully captured by a cross-sectional survey. Future cohort studies may assess the incidence or recurrence of LBP in rifle athletes over the course of a collegiate season or career while also tracking such changes.

Second, recall bias is an important consideration in any cross-sectional study which uses a survey tool for measurement, as it relies on the memory of the participant to obtain accurate data.³¹ However, it is unlikely that participants who responded affirmatively to having experienced LBP incorrectly recalled this information. Rather, it is more

likely that those who stated they did not experience LBP failed to recall an episode of LBP that did not result in substantial cost or activity limitation and thus may have led to under-reporting. Additionally, selection bias may have played a role in the distribution of respondents with and without history of low back pain.³² Athletes who have experienced low back pain may be more likely to participate in a study exploring this phenomenon than those who do not have such history. Despite this potential for selection bias, these respondents still represent a substantial portion of rifle athletes competing at the NCAA and collegiate club level, making awareness of this data an important step.

Additionally, there are limitations to the tertiary statistical analysis regarding the relationship sex and LBP. The overall sample size of respondents with no LBP is quite small, only 12 athletes. There was also an unequal distribution of respondents of each sex, with nearly double the number of female respondents compared to male. This makes generalization of these results challenging despite a statistically significant relationship being identified. However, this relationship is worth acknowledgement as nearly a quarter of NCAA Rifle programs feature exclusively female rosters.

Lastly, this survey was administered during the early months of the COVID-19 pandemic.¹⁹ This may have negatively impacted the response rate as many programs were still under various pandemic-related restrictions, and some programs did not compete at all in the season during which responses were collected.²⁶

CONCLUSIONS

The results of this survey indicate a high prevalence of LBP in the collegiate rifle athlete population, particularly in female athletes. LBP resulted in impacts to both athletes' daily lives and their sport participation, including loss of training and competition time. The COVID-19 pandemic additionally impaired these athletes' ability to maintain medical care for LBP. Future studies investigating novel stance modifications and further characterizing the epidemiology and time course of this injury in collegiate rifle athletes should be pursued. Further investigation of the relationship between sex and prevalence of LBP in this population may also be of value, given the large proportion of female participants in the sport.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

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