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The purpose of this study was to examine the value of self-report rating of perceived exertion (RPE) measures as indicators of workload and potential injury incidence. Participants were one Division I intercollegiate male soccer team (n=28) from a Midwestern institution. RPE measures, using the Borg 0-10 category ratio scale, were taken after each team-related athletic activity throughout the 2019 fall soccer season. The RPE was multiplied by minutes of training to get session RPE (sRPE). Distance covered during practice in kilometers was recorded using Polar Team Pro monitors for each participant. Injuries were recorded by the athletic training staff.

Findings indicated that weekly cumulative distance in kilometers was highly correlated with weekly cumulative sRPE each of the fourteen weeks (r^2 mean: 0.55 ± 0.20, r^2 range: 0.15 for week 1 to 0.79 for week 5). When assessing the upper quartile of weekly aggregate sRPE scores (>2618 AU), risk ratio analysis suggested an increased risk of injury in the following week (RR=2.49, 95% CI=2.08-32.24). The findings demonstrate value of sRPE as an indicator of workload compared to objective measures in intercollegiate male soccer, but the relationship between sRPE and injury incidence is not as definitive.

THE VALUE OF SUBJECTIVE MEASURES IN TRAINING LOAD QUANTIFICATION AND INJURY INCIDENCE IN INTERCOLLEGIATE MALE SOCCER PLAYERS

by

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CHAPTER I

PROJECT OVERVIEW

Soccer teams at every level are looking to gain a competitive advantage. The number of injured players can influence wins and losses (Kitman Labs, 2016). A majority of injuries that occur in soccer are sprains and strains (Roos et al., 2017). Many of these injuries manifest from non-contact mechanisms and are considered preventable (Gabbett, 2010). A primary cause of these types of injuries is improper training protocols (Gabbett et al., 2016). Measuring workload to guide training protocol decisions and control potential injury has been done for many years in professional soccer and other team sports around the world (McCall et al., 2015; Rogalski et al., 2013; Veugelers et al., 2016; Windt & Gabbett, 2017). Training loads can be measured by using global positioning systems (GPS), heart rate monitors, accelerometers, video motion capture, blood tests, and other equipment-intensive methods. Total distance covered in activity is a commonly used training load measure in elite soccer settings with high reliability and validity (Akenhead & Nassis, 2016; Bourdon et al., 2017). Despite research backing this strategy, the cost of equipment diminishes the practicality for most soccer teams below the upper echelon of competition. Self-reported rating of perceived exertion (RPE) measures, as a component of session rating of perceived exertion (sRPE), have also been used to calculate training load. Session RPE is an individual's RPE for a training session multiplied by minutes of the session. Session RPE has shown moderate validity and reliability in elite soccer as a training load measure (Casamichana et al., 2013). This technique requires minimal costs and resources for implementation. However, college-aged individuals may be more susceptible to errors in self-assessment due to their age and lack of experience compared to professional athletes (Bourdon et al., 2017; Haddad et al., 2017). There has been literature relating sRPE to injury incidence in elite (Ehrmann et al., 2016) and youth (Brink et al., 2010) soccer populations. The relationship between sRPE and injury incidence in an intercollegiate male soccer population has been sparsely reported in literature.

Statement of the Problem

Male soccer has one of the highest injury rates among intercollegiate team sports (Kerr et al., 2015). There is minimal literature regarding workload quantification in this specific population. The student-athletes, coaches, sports performance personnel, and medical staff involved with intercollegiate male soccer would benefit from sensible and accessible methods of measuring training load to optimize player and team performance and potentially decrease potential injury.

Statement of Purpose

The purpose of this project was to evaluate self-report RPE measures as a practical strategy to quantify training load and proactively prevent injury occurrence in intercollegiate male soccer. Coaches, athletic trainers, and sports performance staff would be more informed making training decisions, creating an optimal environment for improved team performance and greater individual performance. Also, this may potentially decrease injury to student-athletes, resulting in improved quality of life for the participants during and after their intercollegiate athletic careers.

Aims

Aim #1: Evaluate the relationship between session rating of perceived exertion (sRPE) and distance covered during activity as measures of training load in intercollegiate male soccer players.

Aim #2: Evaluate the relationship between workload measures of sRPE and injury occurrence, as well as a relationship between weekly sRPE acute:chronic workload ratio (ACWR) and injury occurrence, in intercollegiate male soccer players.

Methods

In February 2019, a web-based tool using Ruby on Rails was created by computer science students at the primary investigator's institution to assist with data collection in this study. A pilot study was conducted with the male soccer team to test the response gathering capability of this tool. There was an 85% team-wide compliance rate over 9 weeks of the 2019 intercollegiate spring soccer season. That gave the primary investigator confidence to utilize the tool for dissertation data collection in fall 2019.

Participants

The intercollegiate male soccer team used was from a small, private NCAA Division I institution in the Midwest. The primary investigator met with the team at a pre-participation sports medicine compliance meeting prior to the first team-related athletic activity in the morning of August 13, 2019. The primary investigator went over study protocol, answered questions, and obtained informed consent from the team members. The participants were informed that their athletic eligibility, scholarship status, or standing on the team would not be influenced by their choice of participation in the study. Any student-athletes under the age of 18 at this meeting were not eligible for enrollment in the study.

Data Collection

Demographic information was collected, and anthropometric measurements were assessed for each participant by the institution's athletic training staff during the pre-participation physical examination. This was conducted the day before the first team-related athletic activity.

The participants recorded their RPE after every team-related athletic activity throughout the fall 2019 season. This was done via the web-based tool tested during the pilot study. The participants first selected their name from a drop-down menu for identification. Next, they were asked, "*What activity did you just complete?*" with the radio button options of Practice, Match, Weights, and Individuals/small group workout. The last statement for response was, "*How was your workout?*" This was answered with the Borg 0-10 category ratio RPE scale, complete with qualifying words. The second question terminology and RPE scale with qualifying words were derived from Foster et al. (2001). The data collection tool user interface, including the RPE scale and qualifying words, is in Appendix A. The participants submitted forms from any device with an internet connection.

The participants were encouraged to complete the RPE scale between 20 and 30 minutes after team-related athletic activity but could complete it outside of that time frame. The primary investigator sent group and individual messages on WhatsApp messenger to remind individuals to submit their entries when not initially completed. The responses populated to a database on a secure server, and the primary investigator was provided exclusive access to the database via a unique username and password. The data were exported into an Excel spreadsheet. These spreadsheets were stored electronically using a Box account, which was password protected. Only the primary investigator had access to the raw data files in Box. Box was configured for 1-Lock (low risk) data storage in accordance with the UNCG Data Classification Policy.

To calculate sRPE in practice, weight training, or individuals/small group workouts, the minutes of participation were taken from the Polar Pro Team app data and multiplied by the self-report RPE submission for the corresponding team-related athletic activity. To calculate sRPE during matches, minutes played by the participant stated on the official match box score were added to 45 minutes (Pustina et al., 2017). The 45 minutes represented pre-game warm-up and halftime activity. The sum of those numbers was multiplied by the RPE measure selected by the participant for that match. The sRPE measures were labeled in arbitrary units (AU).

The kilometers traveled during each team-related athletic activity throughout the study were measured with the Polar Team Pro individual monitors and recorded on the Polar Team Pro app. Participants wore monitors for every team-related athletic activity, consistent with team protocol. The 2018 and 2019 NCAA soccer rulebook, Rule 4.2.6, states that players may wear a device for monitoring and accumulating data, which can be used during the game. Therefore, no rules were compromised by using this technology.

The Bluetooth chest straps were docked to a base for data syncing and battery charging after participation. An assistant coach was responsible for regularly charging the devices and syncing data. Team-related athletic activities not recorded by the Polar Team Pro devices were excluded from the data collection.

An injury was defined using the NCAA-Injury Surveillance Program definition (Kerr et al., 2015; Roos et al., 2017). The definition was an injury (1) that occurred as a result of participation in an organized NCAA-sanctioned practice or competition and (2) required attention from an athletic training staff member or physician (Kerr et al., 2015; Roos et al., 2017). The primary investigator brought any specific questions regarding injury status of the participants to the institution's athletic training staff for clarification.

Analytic Approach

In order to determine a potential relationship between sRPE and distance covered, a Pearson correlation was conducted by comparing each participant's weekly cumulative sRPE workloads to each participant's weekly cumulative distance traveled in kilometers during training. The analysis was performed for each week separately. Statistical significance was set at $p=.05$.

There were multiple methods used to find a relationship between workload measures and injury. First, weekly cumulative sRPE workloads and injury during the subsequent week were examined for relationship with a risk ratio analysis. For reasons of completeness, the risk factor variables were categorized into high/low groups using both the median and upper quartile values of sRPE as the cut points (Saw et al., 2011). The lower weekly cumulative sRPE workload was the reference to investigate if higher loads were a risk factor for injury (Saw et al., 2011). A significant relationship was indicated when the 95% confidence interval did not contain 1.

The sRPE acute:chronic workload ratio (ACWR) calculation represented training adaptations regarding load variables over time. A four-week coupled ACWR was chosen to use for this study. This was found by taking the current weekly cumulative sRPE training load and dividing it by the average weekly cumulative sRPE training load for the latest four weeks, including the current week. ACWR was calculated beginning with the fourth week of training.

For injuries that occurred after the first four weeks, weekly sRPE ACWR and injury during the subsequent week were examined for a relationship with a risk ratio analysis. For reasons of completeness, the risk factor variables were categorized into high/low groups using both the median and upper quartile values of sRPE ACWR as the cut points (Saw et al., 2011). The lower sRPE ACWR group was the reference to investigate if higher loads were a risk factor for injury (Saw et al., 2011). A significant relationship was indicated when the 95% confidence interval did not contain 1.

Binary logistic regression was also performed to find a relationship between workload and injury. One logistic regression utilized the weekly cumulative sRPE as the independent variable. Another logistic regression used ACWR as the independent variable. Injury status (yes/no) for the subsequent week was the binary dependent variable for both analyses. A significant relationship was indicated when the 95% confidence interval did not contain 1. The log odds of the statistically significant coefficients were calculated using the lower quartile, median, and upper quartile as thresholds of the independent variable.

The Pearson correlation and binary logistic regression analyses were conducted using SPSS, version 26. The risk ratio analyses were calculated manually by the primary investigator.

Results

All individuals on the intercollegiate male soccer roster for the 2019 fall season were eligible at the start of data collection and consented to participate in the study. Data were collected for one NCAA male soccer fall championship season, spanning 13 weeks and 2 days from August 13, 2019 to November 13, 2019.

The intercollegiate male soccer team participants (n=28) were 20.5 ± 1.5 years old with 2.57 ± 1.2 years of collegiate soccer experience. Mean mass of participants was 76.40 ± 9.44 kg and mean height was 183.88 ± 8.24 cm.

There were 2129 team-related athletic activities completed among the 28 participants throughout the fall 2019 soccer season, leading to 351 individual weekly totals when examining sRPE workload. There were 1286 team-related athletic activities completed among the 28 participants week 4 and later of the fall 2019 soccer season, leading to 267 individual weekly totals when examining sRPE ACWR. The participants had an overall 100% compliance rate with submitting an RPE measure for each team-related athletic activity during the study. Participants not on the travel roster were automatically inputted with a 0 for team-related athletic activities conducted away from campus.

Distance Traveled and sRPE

The mean participant weekly sRPE workload was 1968.18 ± 971.66 AU. The mean participant practice session sRPE workload was 254.71 ± 61.87 AU. The mean match sRPE workload was 473.04 ± 331.01 AU across all participants; mean match sRPE workload was 688.50 ± 89.31 AU among participants who played any minutes in the match.

The mean participant weekly cumulative distance traveled was 22.59 ± 6.32 km. The mean practice session distance was 3.27 ± 0.43 km among all participants. The mean match distance was 7.30 ± 2.88 km among participants who played any minutes in the match.

Pearson correlation comparing participant weekly cumulative sRPE workload and participant weekly cumulative distance traveled in kilometers was statistically significant across all 14 weeks. The weekly average cumulative sRPE workload, average cumulative distance traveled in kilometers, r, and r^2 values for each week are found in Table 1.

Table 1. Weekly Average Session RPE and Kilometers Among All Participants

Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
sRPE	3767	2526	2196	1824	1817	2024	1761	2034	1527	1853	1574	1463	1090	706
km	37.30	28.20	26.90	21.80	21.10	23.50	21.90	26.50	20.40	24.60	20.60	17.10	13.80	4.40
r	0.40	0.47	0.83	0.69	0.89	0.84	0.70	0.59	0.86	0.73	0.82	0.83	0.70	0.85
r^2	0.16	0.22	0.70	0.48	0.80	0.70	0.49	0.35	0.74	0.53	0.67	0.70	0.48	0.72

Injury Incidence and sRPE, ACWR

There were 38 injuries recorded throughout the season. Overall, 20 participants sustained an injury, 10 of which sustained multiple injuries. Eight participants did not sustain an injury during the season. No injuries were recorded during the first week of training. Average weekly sRPE workload of the participants and number of injuries is in Table 2. The participant weekly sRPE and injury incidence the subsequent week is shown in Table 3.

Table 2. Average Weekly Session RPE per Participant and Number of Injuries

Avg Weekly sRPE	Injured
2850.786	1
2632.429	4
2498.643	2
2393.500	4
2379.286	2
2316.786	2
2293.286	3
2251.214	1
2229.143	1
2161.692	0
2132.143	1
2130.636	2
2102.000	0
2030.571	1
2005.786	3
1978.857	0
1784.214	3
1727.000	0
1660.615	0
1637.846	1
1513.000	1
1485.000	3
1261.000	0
1224.077	1
1207.154	0
1050.500	1
1025.500	0
744.000	1

Table 3. Participant Weekly Session RPE and Injury Incidence

	Weeks												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1	4064	3180	2787	2438	2038	2852	2478	2621	2620	2911*	2020*	1061	1193
2	4579	3472	2338	2026	2221	1297	1418	1428	889	1365	1303	1045	701
3	4269	2669*	2611	2104	2460	2843	2018	2612	1744	1406	1150	1282	1113
4	4670	3022*	2778	2153	3294	3168	1827	2327	1155	2618	1184	1775	1495
5	2531	1850	1321	1310	662	925	631	1441	575	904	332	603	816
6	3423	1925*	2256	998*	2288	1717*	1728	1939	1699	1881	1858	1329	1077
7	4446	2660	3280*	2360	2957	3218	2389	2633	2819	2249*	1988	1625	1175
8	3791	2792*	2707	1488	1891*	2540	1213	2404*	1865	571	2003	2376	1477
9	3624	2282	1349	1284	761	1007	1132	1378	516	1071	466	362	461
10	2756	1860	1504	1284*	1346*	1722	1225	1543*	1576	1315	1513	1606	927
11	3898	2399	1513	1684	1495	2671	2055	2730	2592*	2331	2399	2726	1631
12	3968*	2623	2587	1677	2333	2578	2241	2073	2329*	2257	2075	2527	1715
13	4415	2880	1805	1300	798	1632	1931	1864*	904	1733	596	771	663
14	3648	2087	1404	1228	675	1066	1303	1499	681	1328	717	437	320
15	4612	2938	2858*	2478	2718*	1301	1952	2575	2097	2328*	2271	1548	1512
16	2042	1575*	922	-	-	-	-	-	-	-	-	-	-
17	2570	1154	831	700	331	612	544	825	363	707	394	287	354
18	3288	1972	1306	1893	1039	894	1303	1323*	235*	1246	308	512	594
19	2891	2377	2552	2234	2422	2297	1300	2465	2386	2257	2199	1750	1513
20	3094	1767*	776	1090	570	1201	1259	1510	630	1144	588	483	550
21	4339*	3035*	3628*	2465	1788	3124	2086	3147	2859*	3092	2703	2883	740
22	5247	3923	3363	2657	3128	3112	3260*	2252	2058	2733	2386	3305	2055
23	2717	2142	2605	1874*	2767	2752*	1975	1777	2172	2456	2846	2660	1005
24	4559*	2776	3314*	2507	3015	3171	2209*	1560	473	2028	2606*	2501	1608
25	3481	3453	2334	2679	938	1247	2644	3349	1537	2528	1474	1059	1379
26	4369	2736	2989	2159	2844	2748	1826*	1490	-	-	-	409	1434
27	3830	2259	1882	1221	1288	1894	2116	2021	2201	2064	2459	2045	1107
28	4353	2928	1884	1952	1004	1064	1474	2123	722	1667	1079	529	809

NOTE: Session RPE in arbitrary units (AU), *=Injury in following week

The participant weekly cumulative sRPE workload upper quartile value was 2618 AU and the median value was 1939 AU. A risk ratio was applied using the weekly sRPE upper quartile as the cut point, and there was a statistically significant difference between the high and low groups (RR=2.49, 95% CI=2.08-32.24). Individuals who had a weekly sRPE workload higher than 2618 AU had about 150% increase in risk of injury incidence the following week compared to the individuals who had workloads lower than 2618 AU. The table for this risk ratio calculation is found in Table 4. A risk ratio was applied using the median as the cut point, and there was no statistically significant difference among the groups (RR=1.53, 95% CI=0.13-53.21).

Table 4. Weekly Session RPE Upper Quartile and Injury Incidence Risk Ratio

	Injury	**No Injury**	**Total**	**Risk Ratio**
Above 75%	17	69	86	0.20
Below 75%	21	244	265	0.08
Total	38	313	351	2.49

During the weeks where sRPE ACWR was calculated, the mean participant weekly sRPE ACWR was 0.89 ± 0.26. There were 24 injuries recorded during Week 5 and later, relevant to sRPE ACWR and injury.

The participant weekly sRPE ACWR upper quartile value was 1.06 and the median value was 0.90. When a risk ratio was applied using the upper quartile as the cut point, the higher sRPE ACWR group was not at a statistically significant increased risk of injury the subsequent week (RR=1.28, 95% CI=0.26-12.06). When a risk ratio was applied using the median as the cut point, the higher sRPE ACWR group was not at a statistically significant increased risk of injury the subsequent week (RR=1.99, 95% CI=0.74-31.60).

Binary logistic regression of weekly sRPE compared to injury in the subsequent week resulted in a statistically significant regression (β=2.656, SE=0.856, p=.002, 95% CI=2.645-76.658) when the data was scaled. The binary logistic regression line predicted the occurrence of injury and non-injury area under the ROC curve was .665 ($p<.001$, SE=0.043, 95% CI=0.581-0.749). The predictive value of the area under the ROC curve was 0.58; while statistically significant, the predictive capabilities of the logistic regression were slightly better than random. The log odds of the lower quartile, 1274 AU, were 7%, the log odds of the median, 1939 AU, were 10%, and the log odds of the upper quartile, 2618 AU, were 13%. Therefore, participants who had a weekly workload of 1274 AU had 7% odds of injury the next week, participants who had a weekly workload of 1939 AU had 10% odds of injury the next week, and participants who had a weekly workload of 2618 had 13% odds of injury the next week. Binary logistic regression of sRPE ACWR compared to injury in the subsequent week was not statistically significant ($\beta=1.489$, SE=0.833, $p=.074$, 95% CI=0.866-22.665).

Discussion and Implications

Self-report measures used in this study were readily completed by the participants, entailed minimal cost, and were easily manipulated for worthwhile information. The 100% compliance rate among the student-athletes could be attributed to multiple factors. First, the coaching staff had a vested interest in compliance, leading to a positive influence on student-athlete participation. Also, there were individualized methods to solicit responses from the participants. The data collection program included an email reminder system, which sent links to the RPE input form to the participants at regular times daily. The primary investigator sent daily individual and group messages via the WhatsApp messaging program to inform participants of missing entries. Ensuring submissions were completed consistently by participants maximized the value of the data to all stakeholders.

The first aim of the current study was to evaluate a relationship between RPE-based training load and distance covered during exertion. There were statistically significant correlations between weekly cumulative sRPE workload and weekly cumulative distance in kilometers among the participants every week. The statistically significant direct correlation between the subjective and objective measures was consistent with comparable literature involving male soccer (Casamichana et al., 2013; Gaudino et al., 2015), as well as other sports, genders, and skill levels (Haddad et al., 2017). These findings provide evidence for using sRPE in an intercollegiate male soccer population. With the literature showing value across genders, age groups, skill levels, and activities, the use of self-report RPE measures to find sRPE and inform training intensity decisions should become widespread practice throughout athletics.

This study included every player on the roster, including three goalkeepers. Other studies have excluded these players due to the different physiologic demands of their position compared to the field players on the team (Bowen et al., 2017; Owen et al., 2015). A Pearson correlation conducted excluding goalkeepers had similar r^2 values (r^2 mean: 0.53 ± 0.24; r^2 range: 0.05 for week 1 and 0.83 for week 5) throughout the study compared to the inclusive assessment.

The second aim examined a relationship between training load and injury incidence. There is no one training load measure that can predict injury in athletics (Borresen & Lambert, 2009; Halson, 2014; Meeusen et al., 2013). However, this study examined if sRPE could indicate increased injury risk in an intercollegiate male soccer population. The results showed higher weekly cumulative workloads increased risk of injury the subsequent week. These findings indicate possible value of sRPE in this population to detect injury risk. More research is warranted to give a definitive answer. Regardless of findings, collecting sRPE workload numbers can give valuable patient-centered information to the coaches, athletic training staff, and strength and conditioning personnel.

This study defined an injury in the same way as other epidemiological research with an intercollegiate athletic population (Kerr et al., 2015; Roos et al., 2017). This interpretation was more inclusive than others found in literature since it did not include time-loss as a factor of determining an injury. The statistical analyses considered injuries as separate data points, but multiple injuries within a participant are interrelated. Disregarding data following a participants' initial injury could eliminate the previous injury influence, but the impact of the data would be lessened due to fewer data points analyzed. With a more stringent definition, there would be fewer injuries, confounding the data analyses further. Future researchers examining injuries should balance the need for a practical definition of injury with inclusiveness to have robust numbers for data analysis.

When examining the results, sRPE ACWR measure did not manifest any statistically significant findings in relation to injury incidence. The many variations of calculating ACWR may be a reason for inconsequential findings. The primary investigator chose to use a coupled four-week average calculation commonly used in literature (Blanch & Gabbett, 2016; Bowen et al., 2017, 2019; Hulin et al., 2016; Malone et al., 2017). Little benefit has been found with using other time frames compared to a four-week average (Stares et al., 2018). Variability could have stemmed from the use of a coupled rolling average for this calculation (Lolli et al., 2019). Exponentially weighted moving averages have been proposed to better represent the fluid nature of fitness, and they only require one day to initiate the calculation (Williams et al., 2017). Future studies should compare the various calculations and their relationship with injury incidence.

There were noted limitations to this study. The first was the population being a single team from one institution. Despite the participant numbers being comparable to other research, it would be beneficial to compare results among different sports, genders, and skill levels with future research.

The two analyses performed to determine a relationship between workload and injury, binary logistic regression and risk ratio, were consistent with previous research (Windt et al., 2018). Both logistic regression and risk ratio treat daily workloads as independent data points. As fitness is a cumulative property, training load may not be appropriately represented using these analyses. Despite this, they allow for a broad view of the information and how to potentially utilize data for optimizing sports performance.

The logistic regression model poorly predicted injury incidence related to sRPE despite the significant statistical relationship. With injury occurrence accounting for around 10% and non-injury occurrence happening around 90% of the cumulative weekly exposures, the regression had low practical value. Further data collection with more robust injury occurrences would help to refine the model.

The findings of this study gave promise to utilizing sRPE in an intercollegiate male soccer population for training periodization. Having multiple subjective and objective measures to gauge workload is ideal. However, sRPE would be a practical way for teams without extensive resources to gain information regarding how their training protocols are being perceived among the participants. Using sRPE to indicate potential injury is not as clear-cut. While there were statistically significant findings related to this aim, the small number of injuries did not give a true indication of how well sRPE could infer injury incidence. The study results encourage future research examining self-report measure use in males and females, team and individual sports, and throughout all levels of intercollegiate athletics. Future research could shape an athletic environment where all teams, including youth, high school, and college, have the capability to monitor training load using self-report subjective measures. This could optimize team and individual performance while giving the participant an active role in training decisions.

CHAPTER II

DISSEMINATION

My primary target audience is intercollegiate male soccer student-athletes and intercollegiate male soccer coaches. This information will be disseminated in the form of a Power Point presentation in the Spring Semester 2020. Even though this project only looked at intercollegiate male soccer, I have a secondary target audience of other intercollegiate athletic teams with their coaching staffs and support personnel. The transcript for the presentation is below. The presentation slides can be found in Appendix B. An infographic summarizing the research distributed ahead of dissemination is found in Appendix C.

Presentation Script

Introduction and Background

Slides 1, 2, & 3. Hello, I am Troy Coppus. This presentation comes from my doctoral dissertation research through the University of North Carolina Greensboro. The motivation comes from my ten plus years working as an athletic trainer with multiple intercollegiate sports. In my clinical practice, I always wondered if there was a way to decrease student-athlete injury proactively. Functional Movement Screening and Lower Quarter and Upper Quarter Y-Balance Testing were two methods used. However, that took a lot of time, effort, and personnel to test the hundreds of student-athletes, keep the athletes compliant with preventative interventions, and conduct follow-up testing to note progress. Looking into this topic further, I found the concept of training load management and quantification. There were many ways to do this, from GPS monitoring, blood testing, accelerometer measures, heart rate monitors, video analysis, and other objective indicators. There were also many studies detailing the use of subjective rating of perceived exertion (RPE) as an indicator of load. RPEs are easy to understand for most student-athletes and can be collected using web-based tools without much effort by the participant or staff members. I saw this as a plausible option for the busy coaching staff, athletic trainer, and/or strength and conditioning professional in the college and high school ranks to get valuable information about the student-athletes. As I looked through literature, I found little research on the population that was most familiar to me, the college-aged student-athlete.

So, why would this population be important to research, especially a male soccer team? First, male soccer is one of the most injurious team sports in college athletics, behind football and maybe female soccer, depending on the source. More generally, current student-athletes have lower health related quality of life while injured during college. Preventing injuries can make a difference in improving the psychological well-being of an athletic population. And, it has been shown in professional soccer that the higher amount of payroll available for selection, the more successful that team is. While this has not been formally studied at the college ranks, having players missing from the roster due to injury is generally noted as a detriment to winning.

Looking at the long-term consequences of injury is probably evident to those of you in here who have been collegiate student-athletes. In veteran professional male soccer players, there was a higher incidence of knee osteoarthritis compared to age-matched military personnel. And, in general, former intercollegiate student-athletes have lower health related quality of life compared to individuals who were recreationally active in college. So, we have the "Why?"

*Slide 4***.** That leads into what I wanted to find: Can RPE be used to measure training load? Can RPE indicate a student-athlete at higher risk for injury? And, perhaps most importantly, can these things be accomplished with minimal resources?

Slide 5. Before going much further, there are a few things to define so that everyone understands what I am discussing. The first is RPE. Simply put, this is your answer to the question, "How was your workout today?" There are many different scales, but I chose a 0-10 scale for this project. Session RPE is simply the RPE times minutes of the activity. This represents the workload of a session. The last definition is how I interpreted injury for the purpose of the research. Essentially, if an injury was reported to a member of the athletic training staff, it was counted as an injury, outside of general soreness or a one-off issue.

Study Protocol

Slide 6 & 7. This study looked at one intercollegiate male soccer team throughout their 2019 fall NCAA championship season. There were 28 student-athletes on the team, and all consented to participate. Polar Team Pro devices were used for collecting kilometers and minutes of training. For matches, the RPE was multiplied by the minutes for the participant from the official box score plus 45 minutes, which represented pre-match and half-time activity. The participants were asked to complete an 0-10 RPE scale for every team-related athletic activity, which included practices, matches, weight room sessions, and individual/small group sessions. The web-based tool for data collection was created by computer science students on our campus for this project. The form interface used to complete the RPE is on the next slide. As is standard protocol, injuries were recorded by the athletic training staff.

And, something important to note before discussing the results is that the entire team had 100% compliance with submitting the RPE forms post-activity. It took some goading via WhatsApp to make sure, but it did happen. I am very thankful to the team and the coaching staff for the compliance, since it gives the numbers credibility.

Findings and Discussion

Slide 8. When answering the first question, I found weekly cumulative sRPE and weekly cumulative kilometers were very closely related. From this data, it can be said that the RPE are an adequate indicator of training load compared to a proven objective measure. Ideally, though, there are multiple data points collected regularly to get a full picture of the individual's workload. For example, a player can indicate they are at a high intensity using the RPE, but their heart rate measures, accelerometer measures, or distance traveled may not quite correspond to what they indicate. That could be a player not being fully aware of how to gauge their RPE. The player could also be inflating the RPE to influence training decisions or enhance their perceived work ethic to the coaching staff. Having both subjective and objective measures provides a checks and balances for the data. And remember, individuals tolerate training load differently because of many factors. Teammates could have similar sRPE while having vastly different kilometers traveled. The key is that the individual is tuned into their own training load perception so that the subjective measures are valuable.

Slide 9. When answering the second question, I found individuals who exceeded 2618 AU during a week were at 2.5 times the risk for injury the following week compared to those below that threshold. The 2618 AU was the upper quartile or 75th percentile of the 352 individual weekly cumulative sRPE loads. So, what does this all mean to a coach, player, athletic trainer, or strength and conditioning professional? To put it into perspective, I have made a hypothetical week to demonstrate what the threshold load looks like. You see the breakdown of the practice and match sessions in the table on the slide. This should look like a typical week of training with one match. This week exceeds the 2618 AU threshold by 3 units. You can see how easy it would be for weeks with two matches to exceed the threshold, considering the high amount of load that an individual can accumulate within a match. The same thought goes with two-a-day training sessions.

After seeing this workload on a player, the next question is, “What should we do?” Is shutting them down completely prudent? Of course not. You cannot expect someone to get better by sitting around. What the best course of action would be is to make sure those at-risk student-athletes are performing preventative interventions like stretches and strengthening exercises and recovery interventions including whirlpools, compression units, and manual therapy. These individuals should also have a heightened awareness for appropriate nutrition, adequate sleep amounts, and satisfactory hydration during the high workload weeks. As workloads gradually build, the individual should become more capable of withstanding increased loads with less risk of injury. Chronic moderate-to-high workloads have been shown to create an athlete less susceptible to injury over time in professional soccer and other elite-level team sports.

Slide 10. While there was a statistically significant finding, it is not enough to definitively say that the sRPE measures can point out when injuries will occur. What these results indicate, as we previously discussed, is that high workload weeks should tell the participant to do everything they can to remain healthy. As we saw with the hypothetical week, matches can carry a heavy workload. When you have two matches in a week, which happens often, you can see how the 2618 number can be reached quickly in someone who plays significant match minutes. Stretching, corrective exercises, modalities, hydration, sleep, diet, and any other practices that contribute to general well-being should be an even higher priority than normal during those weeks.

Slide 11. Can all these things be done without too much burden on coaching staff, strength & conditioning personnel, and/or sports medicine staff? Especially in a setting where monetary and staff resources are limited? I would say yes. There are many programs out there that entail little to no cost and are easily accessible, like Microsoft Excel and Microsoft Forms, that can facilitate a dashboard with reports available in real time. Having this data available in real-time after a training session would allow the coaching staff, strength and conditioning personnel, and athletic trainers a live look at each participants' workload status. These numbers could help coaches and strength and conditioning staff individualize the training decisions to optimize individual and team performance.

Future Considerations

Slide 12. The study I have discussed was only over a single intercollegiate team for one fall season. There are many studies over elite levels of athletics in all sorts of sports, but there are limited studies over high school and college athletics. I am hoping that my research expands to both male and female athletic teams in those settings to see if the information gathered would be valuable. I am unable to say if the numbers will demonstrate similar value in other populations. However, these findings, plus all previous literature, indicate potential benefits from this data, which should encourage others to explore their possibilities with other populations.

References and Conclusion

Slide 13-15. Thanks for your time, and please let me know if you have any questions.

CHAPTER III

ACTION PLAN

This dissertation project demonstrates value of gathering self-report data from an intercollegiate male soccer team to quantify training load. This information could be used by coaching staff to appropriately periodize training sessions, and strength and conditioning staff can create programming to adequately supplement the sport-specific activities. While the data analyses did not definitively show the potential for indicating potential injury incidence, athletic training staff could use the numbers to encourage extra preventative and recovery interventions to those with high training loads.

Short-Term Actions

There was an infographic presented to the male soccer team coaching staff in January 2020 that summarized the findings. The coaching staff was then presented the findings in a slide show done by the primary investigator to more thoroughly discuss the key results and practical takeaways in February 2020. The coaches were appreciative of the information, and they found it rather timely. There is currently deliberation among the NCAA to have the men's soccer season conducted over both fall and spring instead of only in the fall. The information may demonstrate the need to spread the season across both semesters because of the high weekly workloads placed on players with a fall-only championship season.

After compiling the information for the male soccer coaches, the primary investigator targeted the female soccer coaching staff, as well as any other interested coaches within the athletic department, to recruit teams for future data collection and analysis. In order to demonstrate the potential benefits, a narrated slide show presentation was distributed to these coaches for viewing, then a follow-up message was sent by the primary investigator to answer any questions and inquire about their interest. Creating interest within coaching staffs should assist with the recruitment and adherence of student-athletes for future data collection.

While coaches and players are the primary stakeholders with this information, the strength and conditioning personnel also have a vested interest in this information. The primary investigator will hold a discussion with the institution's strength and conditioning staff in the 2020 Spring Semester to discuss implications on their practice based on this information. The discussion will focus around the capabilities of sRPE to inform periodization and training load for optimal strength training programming.

Athletic training staff will be introduced to the results of the project with the infographic. The primary investigator will discuss the implications of the sRPE and injury risk indication portion of the study to the athletic training staff during the 2020 Spring Semester. The message presented will state there was a statistically significant finding with sRPE workload measures and injury risk. Practically, it makes sense that over a specific workload threshold, injury risk is increased. Despite this finding, more data needs to be collected with more injury instances to have a better idea of what the training load measures can indicate regarding injury incidence.

Long-Term Actions

In order to increase the impact of this information, I am anticipating proposing a podium presentation to the 2021 NSCA National Conference after collection of an entire academic year of data from the intercollegiate male soccer team. This could provide greater insights with a larger selection of data to examine. The submission would be due prior to March 2, 2021, so I could perform further data collection and analysis during the summer and fall of 2020 to address some of the noted shortcomings of my current project.

This data is most valuable when the appropriate stakeholders can access it with minimal delay. The primary investigator has worked on a template to make the data collection and analysis readily accessible using Microsoft Excel and Microsoft Forms. A long-term prospect for this project is to create a fully functional app that will house the data collection, data analysis, and real-time feedback to coaches, athletic trainers, and strength and conditioning professionals. The players would be enrolled under a coach and/or staff member to feed the appropriate RPE measures, as well as any other desired data to the app. Coaches could input the time of participation for the sRPE calculation. Those could generate reports for every individual on the team based on set formulas, and the coaches and staff could have personalized dashboards that display reports from the numbers supplied by the players. There are multiple products offered that do this and more already, but they are priced for the upper echelon of athletics. They also involve many sophisticated measures such as video motion analysis and several self-report surveys with mood state and various orthopedic patient related outcome measures. That would probably be too tedious for a high school or smaller college student-athlete population to complete on a regular basis. My hypothetical product would be geared towards youth, high school, or small college athletic populations. I believe there would be a willing market for this product, especially in the form of a cell phone app. Once a program with the data appearing in real-time is launched, the coaches and support staff would be able to respond to individual fluctuations in workload and customize training sessions to the needs of the student-athlete, creating an optimal training environment. A benefit for athletic training staff is that a real-time student-athlete dashboard for workload measures would be another way to utilize patient values in practicing evidence-based medicine.

An avenue for dissemination on a broad scale would be the United Soccer Coaches annual meeting every January. This would be a great way to reach many soccer coaches and administrators of all levels at once. After creating a version of the data collection tool for the masses, this would be the ideal marketplace to demonstrate the product and garner interest.

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APPENDIX A

DATA COLLECTION TOOL USER INTERFACE


Activity Form

Select Your Name

▼

What activity did you just complete?

- Practice
- Match
- Weights
- Individuals/small group workout

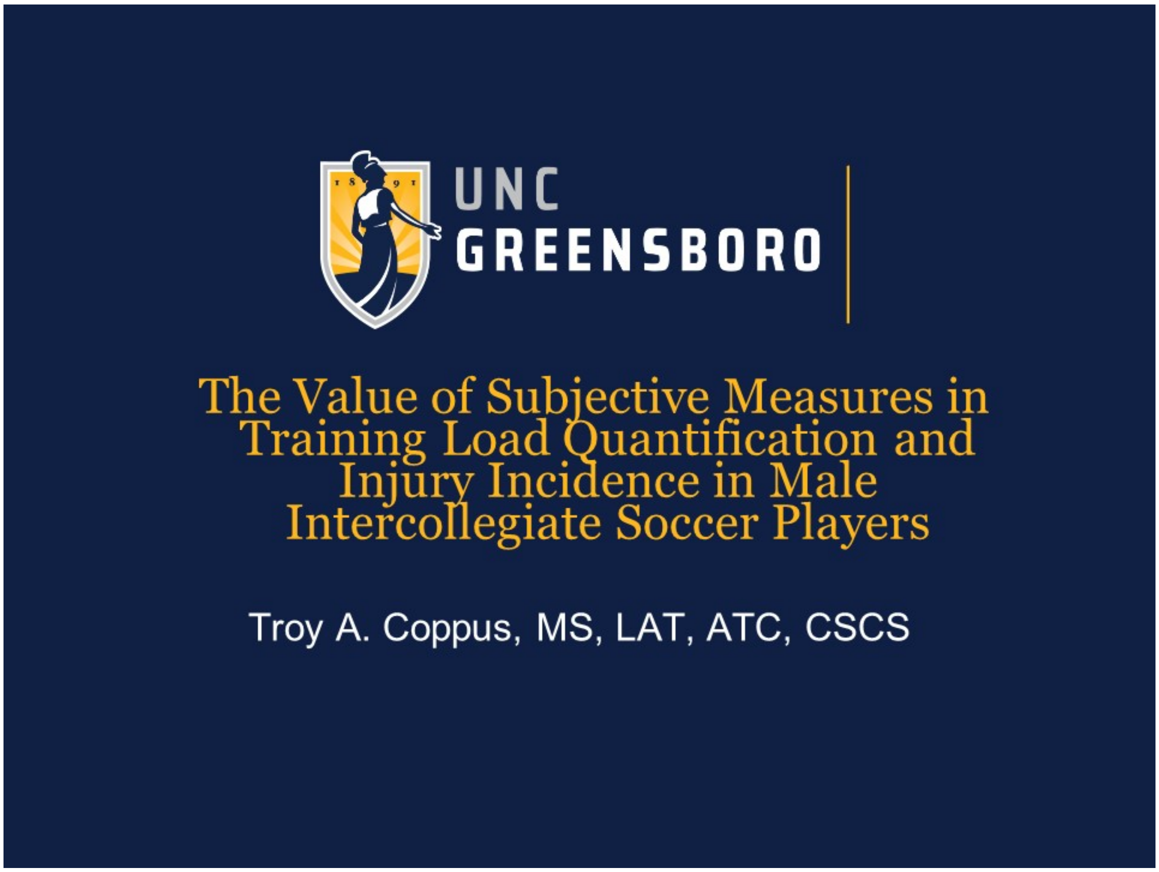
How was your workout?

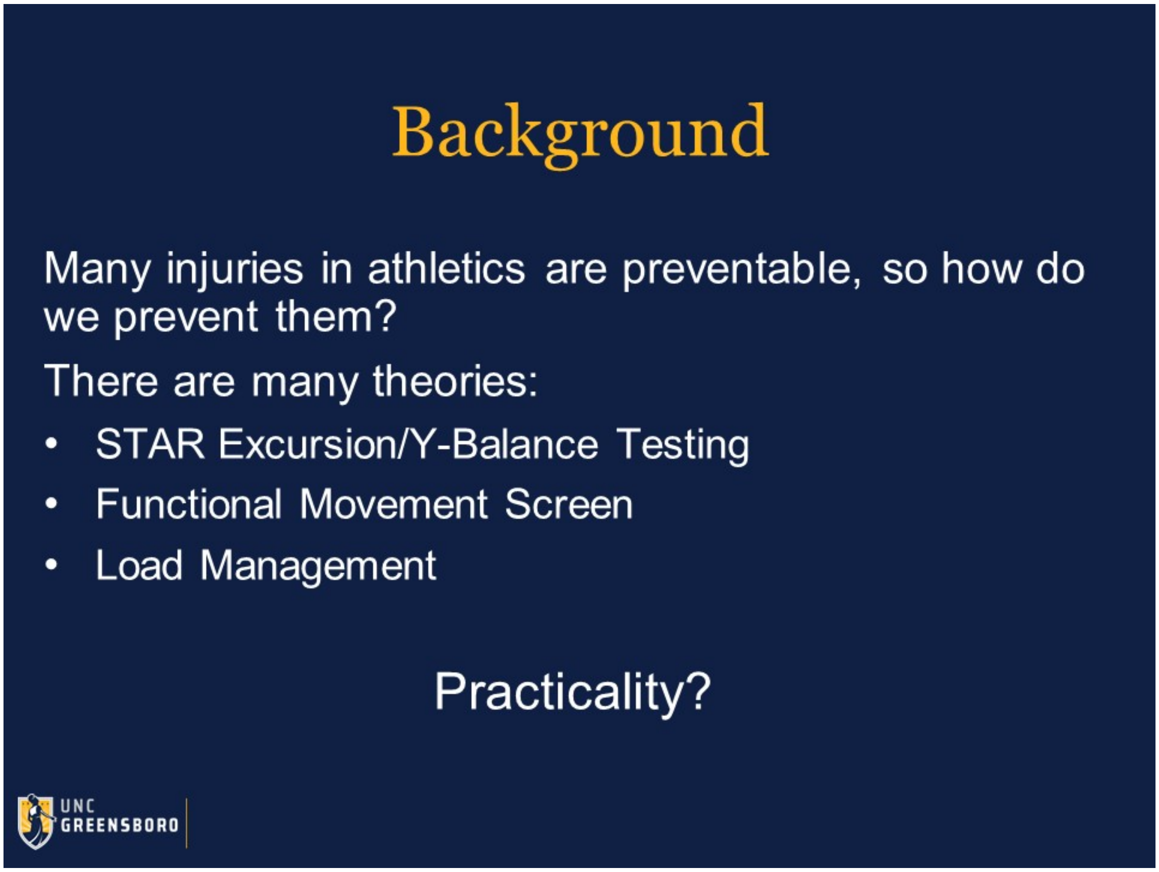
- 0 Rest
- 1 Very, Very Easy
- 2 Easy
- 3 Moderate
- 4 Somewhat Hard
- 5 Hard
- 6 -
- 7 Very Hard
- 8 -
- 9 -
- 10 Maximal

Save Form

APPENDIX B

POWERPOINT PRESENTATION SLIDES




Background
Many injuries in athletics are preventable, so how do we prevent them?
There are many theories:
• STAR Excursion/Y-Balance Testing
• Functional Movement Screen
• Load Management
Practicality?
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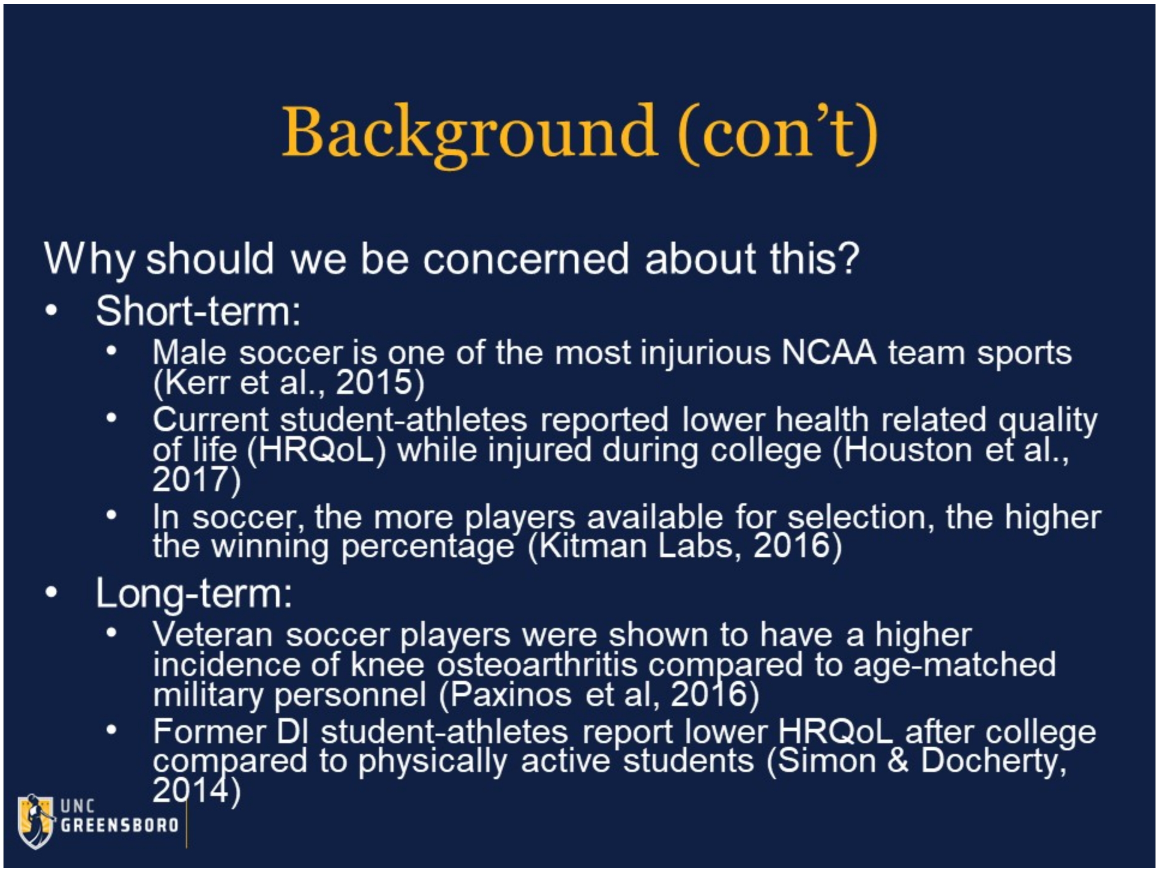
Background (con’t)
Why should we be concerned about this?
• Short-term:
• Male soccer is one of the most injurious NCAA team sports (Kerr et al., 2015)
• Current student-athletes reported lower health related quality of life (HRQoL) while injured during college (Houston et al., 2017)
• In soccer, the more players available for selection, the higher the winning percentage (Kitman Labs, 2016)
• Long-term:
• Veteran soccer players were shown to have a higher incidence of knee osteoarthritis compared to age-matched military personnel (Paxinos et al, 2016)
• Former DI student-athletes report lower HRQoL after college compared to physically active students (Simon & Docherty, 2014)
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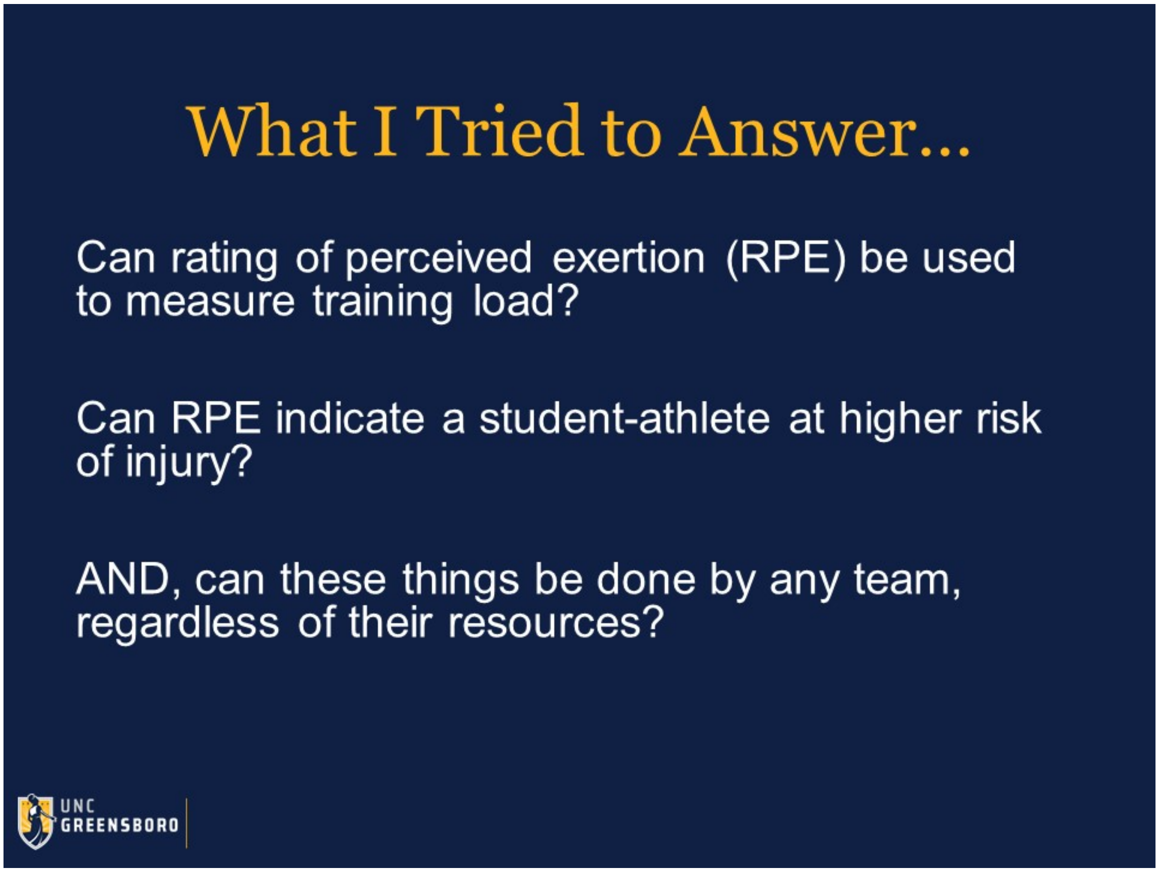
What I Tried to Answer…
Can rating of perceived exertion (RPE) be used to measure training load?
Can RPE indicate a student-athlete at higher risk of injury?
AND, can these things be done by any team, regardless of their resources?
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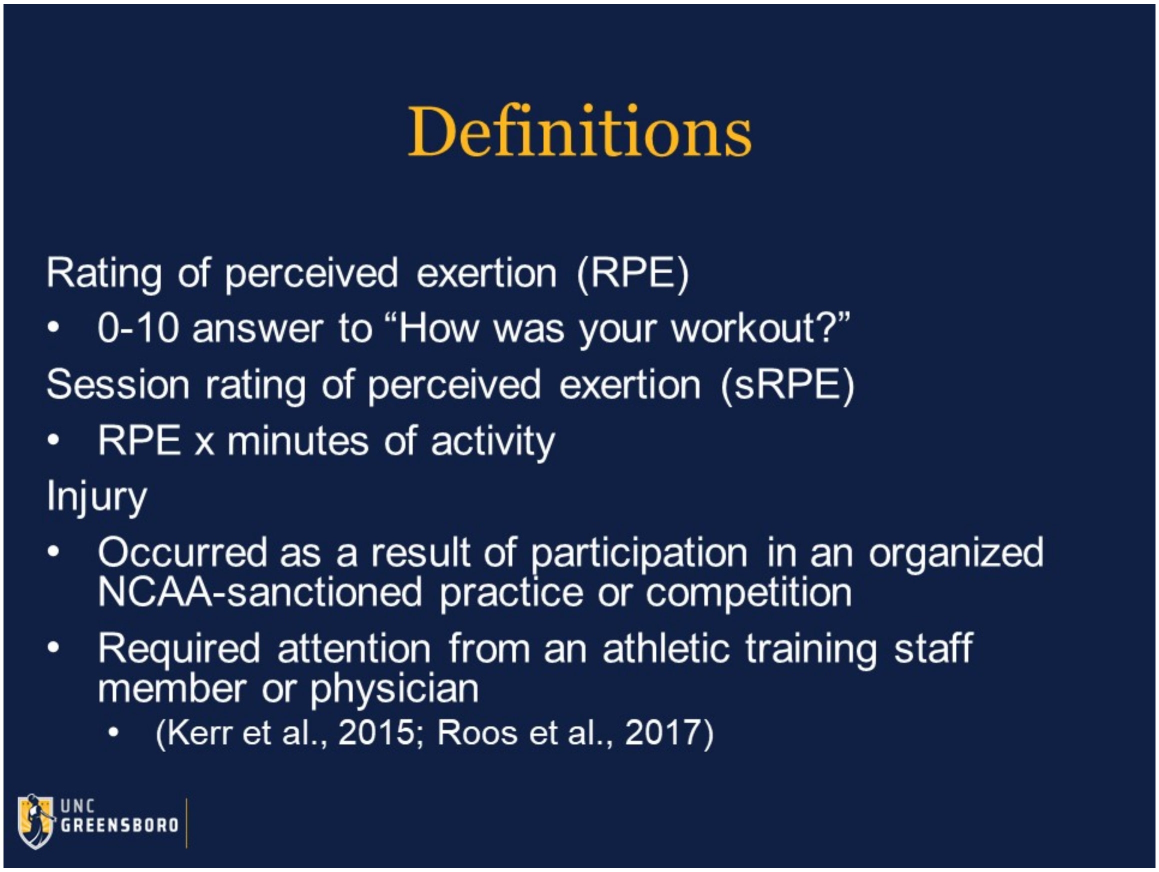
Definitions
Rating of perceived exertion (RPE)
• 0-10 answer to “How was your workout?”
Session rating of perceived exertion (sRPE)
• RPE x minutes of activity
Injury
• Occurred as a result of participation in an organized NCAA-sanctioned practice or competition
• Required attention from an athletic training staff member or physician
• (Kerr et al., 2015; Roos et al., 2017)
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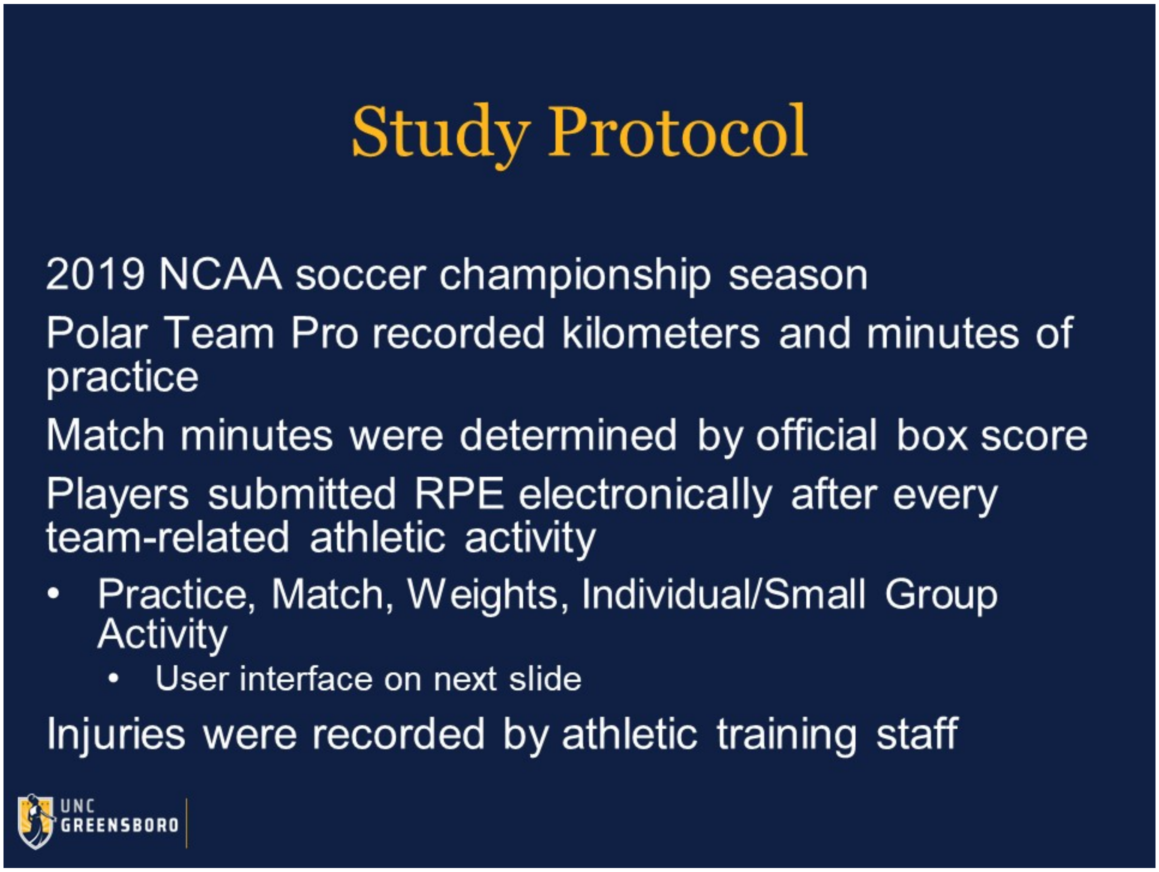
Study Protocol
2019 NCAA soccer championship season
Polar Team Pro recorded kilometers and minutes of practice
Match minutes were determined by official box score
Players submitted RPE electronically after every team-related athletic activity
• Practice, Match, Weights, Individual/Small Group Activity
• User interface on next slide
Injuries were recorded by athletic training staff
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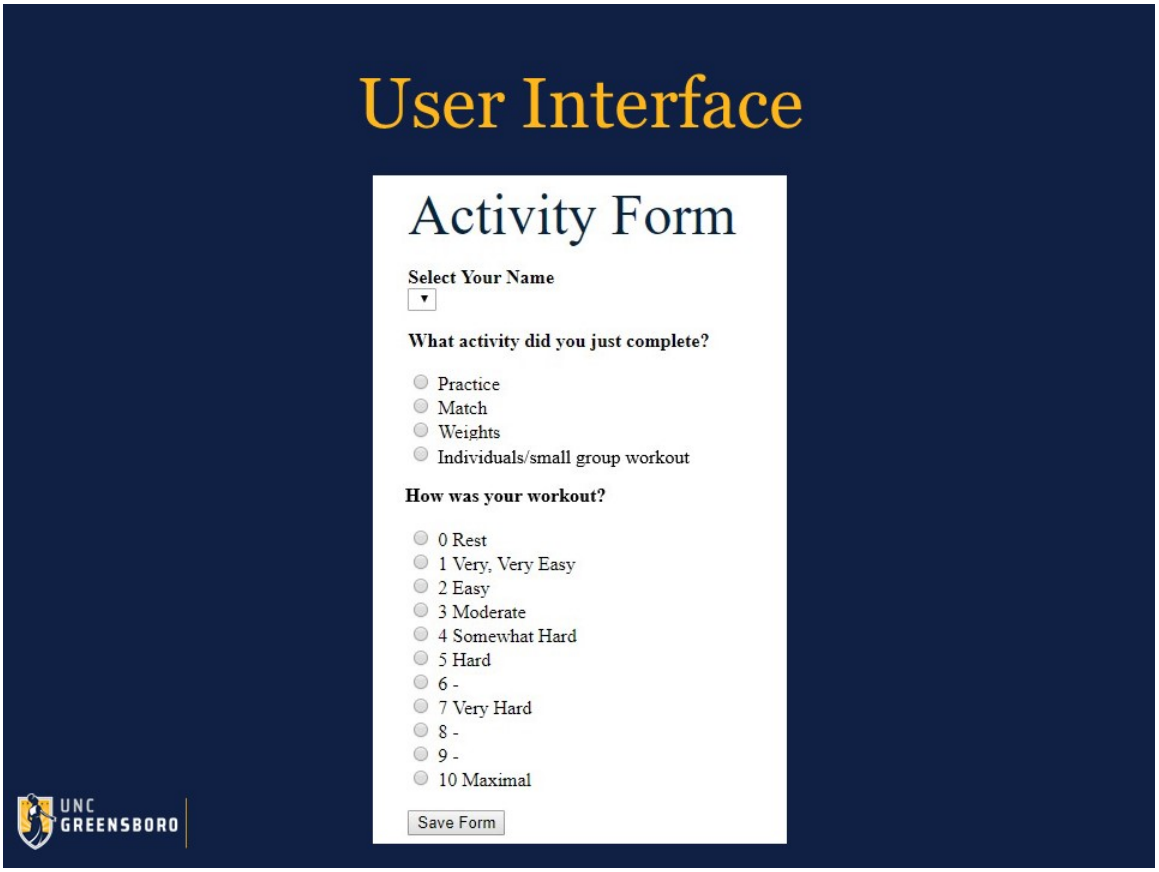
User Interface
Activity Form
Select Your Name
What activity did you just complete?
Practice
Match
Weights
Individuals/small group workout
How was your workout?
0 Rest
1 Very, Very Easy
2 Easy
3 Moderate
4 Somewhat Hard
5 Hard
6 -
7 Very Hard
8 -
9 -
10 Maximal
Save Form
UNC
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Findings & Discussion

Can rating of perceived exertion (RPE) be used to measure training load?

- Kilometers and sRPE were found to be closely related
- In a perfect world, you have both subjective and objective measures to base training load decisions
  - If you cannot afford objective, RPE may be an acceptable alternative

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Findings & Discussion

Can RPE indicate higher risk of injury?

- When weekly sRPE workload exceeded 2618 AU, players were at 2.5 times the risk of injury the following week compared to those below 2618 AU.
- What do the numbers mean?

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
78 min p 5 RPE 390 AU	86 min p 6 RPE 516 AU	73 min p 6 RPE 438 AU	46 min p 3 RPE 138 AU	79 min m 8 RPE 992 AU	OFF	49 min p 3 RPE 147 AU

  - This week is 2621 AU, above the threshold noted above
- What should we do? Shut this person down?

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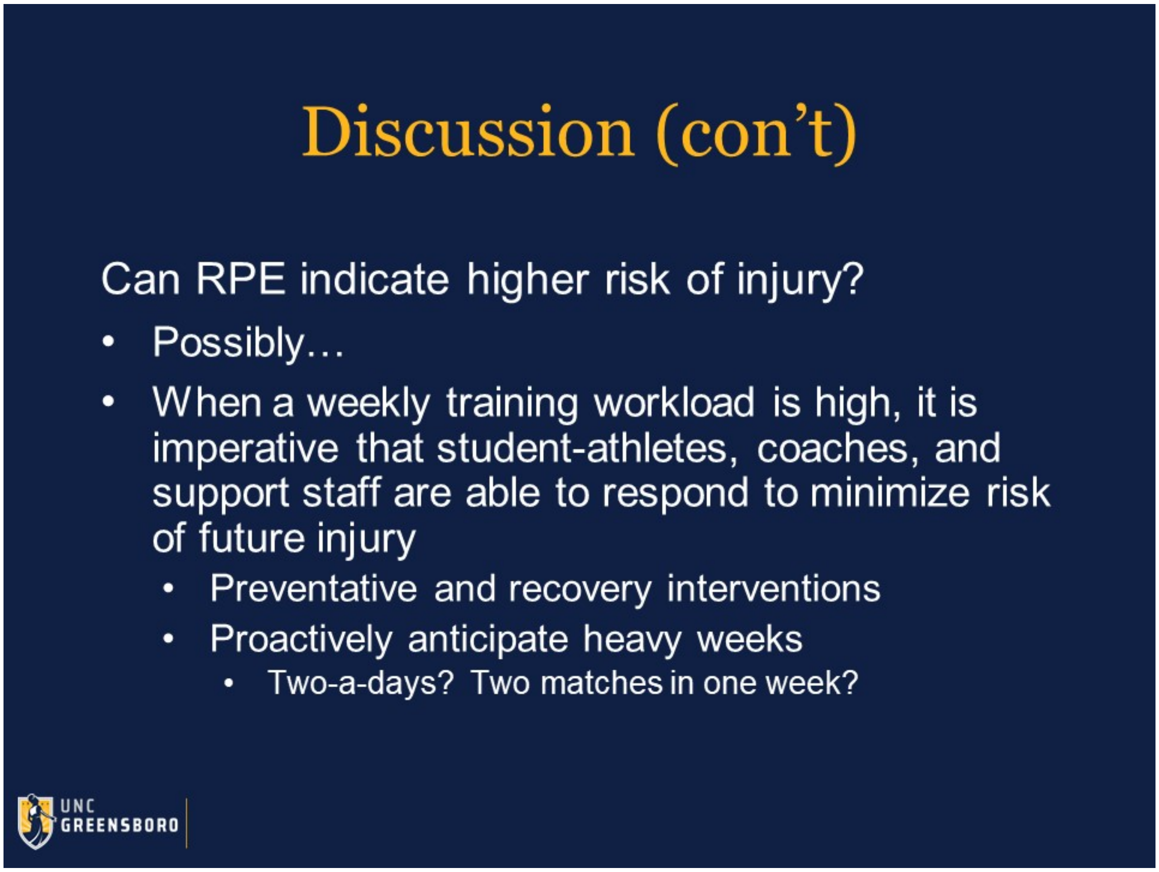
Discussion (con’t)
Can RPE indicate higher risk of injury?
• Possibly…
• When a weekly training workload is high, it is imperative that student-athletes, coaches, and support staff are able to respond to minimize risk of future injury
• Preventative and recovery interventions
• Proactively anticipate heavy weeks
• Two-a-days? Two matches in one week?
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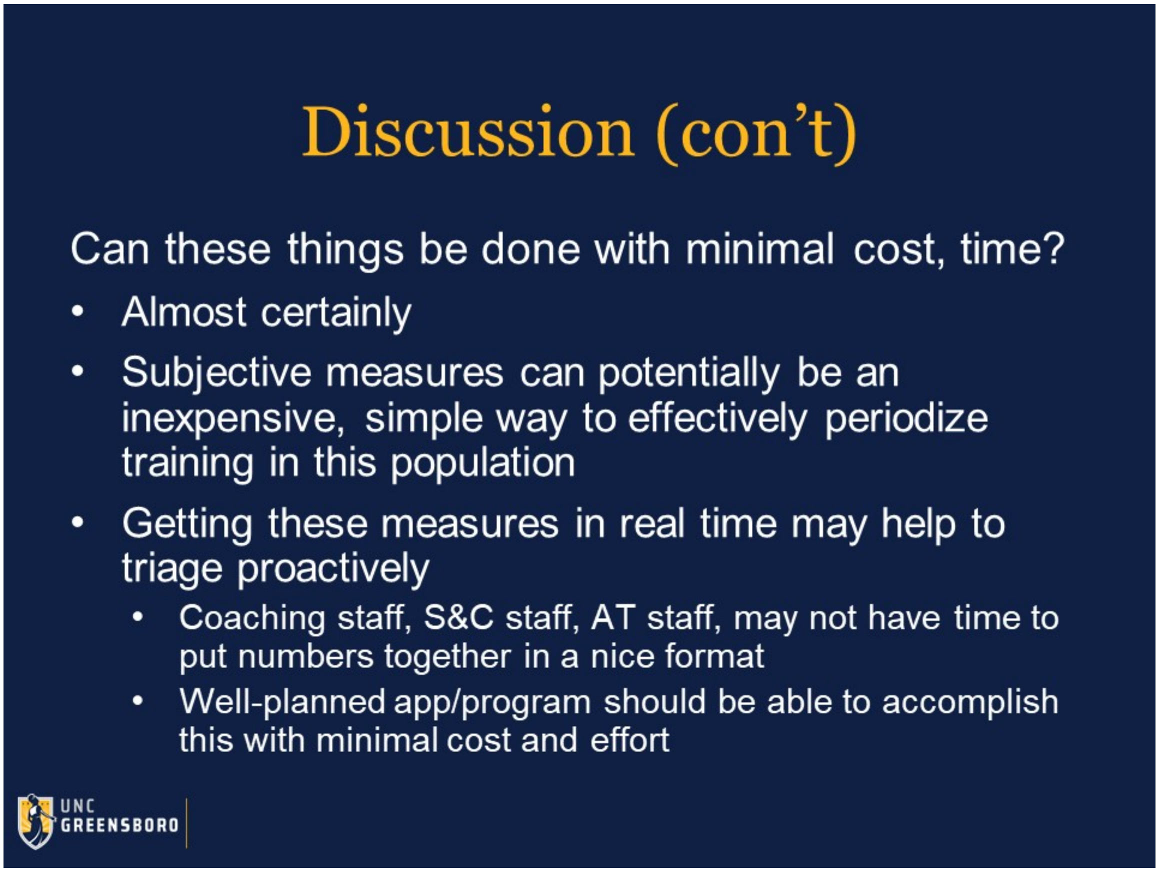
Discussion (con’t)
Can these things be done with minimal cost, time?
• Almost certainly
• Subjective measures can potentially be an inexpensive, simple way to effectively periodize training in this population
• Getting these measures in real time may help to triage proactively
• Coaching staff, S&C staff, AT staff, may not have time to put numbers together in a nice format
• Well-planned app/program should be able to accomplish this with minimal cost and effort
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Future Considerations
Collect data from females, other sports
• Will these different demographics/sports have different results?
Provide load quantification/management capabilities for all reaches of athletics
• Do not need expensive programs or equipment to accomplish objectives
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Thank you for your time!
Questions??
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APPENDIX C

DISSEMINATION INFOGRAPHIC