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Sports Medicine Staffing Patterns and Incidence of Injury in Collegiate Men's Ice Hockey

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Context: The relative availability of clinicians as well as the types and training of health care providers have been associated with morbidity and mortality in non-athletic health care settings. Whether staffing variations are associated with injury incidence in collegiate athletes is unknown.

Objective: To evaluate whether the institutional ratio of athletes to athletic trainers (patient load) or the ratio of staff to nonstaff (graduate assistant and certified intern) athletic trainers or both is associated with the incidence of injuries sustained by male ice hockey athletes at the school.

Design: Descriptive epidemiology study.

Setting: National Collegiate Athletic Association (NCAA) men's ice hockey teams.

Patients or Other Participants: Collegiate men's ice hockey athletes.

Main Outcome Measure(s): The NCAA Injury Surveillance Program collected data from collegiate men's ice hockey athletes. Staffing patterns were obtained through telephone interviews. Injury counts, injury rates per 1000 athlete-exposures, and injury rate ratios with 95% confidence intervals were calculated and compared between the following groups: (1) schools with high (versus low) patient load and (2) schools with high (versus low) ratio of staff to nonstaff (graduate assistant and certified intern) athletic trainers.

Results: Both the patient load and relative number of staff athletic trainers were associated with variations in the incidences and types of diagnosed injuries in male ice hockey players. Specifically, fewer injuries were diagnosed by clinicians at institutions with high patient loads. The rates of injury overall and non–time-loss injuries were lower in the high patient-load group. Time-loss injury rates, severe injury rates, concussion rates, and overall rates of injury during competition were greater in the group with a higher proportion of staff athletic trainers, whereas non–time-loss injury rates were lower.

Conclusions: In this study of collegiate men's ice hockey players, athlete health outcomes were directly related to the number and types of clinicians available. Future researchers should evaluate whether this finding extends beyond men's ice hockey.

Key Words: concussion, collegiate athletics, epidemiology, health policy, skill mix

Key Points

- Sports medicine staffing, including both the patient load (number of patients a clinician cared for) and skill mix (types and training of clinicians), were associated with the injury outcomes of male collegiate ice hockey players.
- Fewer injuries overall and fewer non–time-loss injuries were diagnosed by clinicians at institutions with high patient loads. Fewer non–time-loss injuries and more concussions, time-loss injuries, and severe injuries were diagnosed by clinicians at institutions with a higher proportion of staff to nonstaff (graduate assistant and certified intern) athletic trainers.
- Whether the observed differences in injury rates reflect actual differences in the occurrence of injury or, instead, differences in injury diagnosis and documentation is unclear.

Staffing levels in sports medicine departments at National Collegiate Athletic Association (NCAA) member schools varied significantly,[1,2] with 2 particularly notable features. First, the average number of athletes an athletic trainer (AT) cared for varied across schools. Specifically, some ATs at NCAA member schools cared for more than 10 times the number of athletes as ATs at other member schools.[2] The effects of such disparities in patient load on clinician job satisfaction and athlete health outcomes are not well understood. However, institutions with fewer ATs per athlete were less likely to screen for mental health disorders,[3] raising the possibility that staffing limitations may impede ATs' ability to attend to all aspects of athlete health and wellbeing. Second, 2 staffing patterns emerged. Some schools primarily relied on staff ATs, supplemented by a small number of graduate assistants or certified interns, while other schools tended to have a larger number of graduate assistants or certified interns or both who were overseen by a smaller number of staff.[2] The effects of these differences in reliance on graduate assistant and certified intern ATs in providing patient care are unknown.

Across health care settings, the number and types of health care providers were associated with health care quality.[4] Clinician : patient ratios have been associated with a variety of patient health outcomes.[5–11] For example, the authors[10] of a 2002 study found that improved relative availability of registered nurses was associated with an improvement in a range of morbidity and mortality outcomes for patients across a diverse set of hospitals. In addition to the relative number of clinicians, the types and training of clinicians on a medical team (often referred to as the *skill mix*) have been associated with patient health outcomes.[12–15] For example, a greater registered nurse skill mix was associated with a reduction in a range of adverse outcomes in the inpatient hospital setting.[15] However, the evidence relating staffing and health outcomes in the sports medicine context to date remains limited.

Existing research has related staffing to the diagnosis and treatment of sports injuries in high school athletes. In an examination of high school football injury rates and health care services based on whether a full time or part time AT was employed at the school level, overall reported injury rates and the number of medical services were greater at schools that employed an AT full time rather than part time.[16] Importantly, rates of injuries that precluded an athlete from participating in subsequent game or practice time (ie, time-loss [TL] injuries) did not differ based on AT employment status. This suggests that an AT or other sports medicine clinician may be useful in identifying injuries that an athlete can easily conceal or play through. Although delayed identification may not have lasting consequences for some injuries, for others, such as concussions, continued play while symptomatic can prolong recovery[17] and lead to potentially catastrophic consequences if an additional impact is sustained before symptom resolution.[18] In another study,[19] researchers found higher rates of injuries, including TL injuries, in girls' soccer and basketball teams at schools that did not employ an AT versus schools that did. The authors suggested that this was, in part, the result of the ATs' efforts to prevent TL injuries by diagnosing and treating athletes with non–time-loss (NTL) injuries. Whether or how the relationship between clinician employment status and injury rates translates to the collegiate level is unclear.

In this investigation, we evaluated 2 hypotheses. First, we examined whether the institutional average ratio of athletes : AT was associated with the rates of documented injuries sustained by male ice hockey athletes at the school. Specifically, we hypothesized that the rates of severe and TL injuries would not depend on the ratio of athletes : AT, but the rates of reported overall injuries, NTL injuries, and concussions would be inversely correlated with the number of athletes for whom an AT provided medical care. Additionally, we assessed whether the ratio of staff : nonstaff (graduate assistant and certified intern) ATs affected the rate of injury diagnosis in male ice hockey players. We proposed that schools with more staff ATs would have higher rates of all injury types in their male ice hockey players.

METHODS

To answer these research questions, we conducted a mixed-methods study that consisted of a telephone-based interview, compilation of publicly available information on the number of athletes at universities, and an analysis of injury-surveillance data from collegiate men's ice hockey teams, as will be described in more detail. Men's ice hockey was purposively selected for this initial evaluation of staffing and athlete injuries, as it had the highest proportion of schools participating in the NCAA Injury Surveillance Program (NCAA-ISP) at the time this project was conducted.

Sampling Frame and Procedure

We gathered publicly available contact information for the head AT at NCAA schools that sponsored a men's ice hockey team (n = 142) during June and July of 2015. Up to 3 attempts at phone contact were made during the same period. The Institutional Review Board at Harvard University approved this project and determined that it did not constitute research on human subjects.

Telephone Interview Measures

Respondents were asked how many full-time equivalent (FTE) staff ATs, graduate assistant ATs, and certified intern ATs were on the sports medicine team at their university for the upcoming 2014–2015 school year. They were then asked about any changes in the number or FTE status of any of these positions since the previous school year; these changes were used to calculate staffing levels for the 2013–2014 school year.

Athlete Information

The number of athletes at the respondent's school for the 2013–2014 and 2014–2015 school years was obtained through publicly available Title IX disclosures on the United States Department of Education Equity in Athletics Data Analysis Web site (http://ope.ed.gov/athletics/).

Staffing Ratios

Using staffing information and athlete counts, 2 ratios were created: (1) the number of athletes per total FTE ATs (the sum of staff, graduate assistants, and certified interns) and (2) the number of FTE staff ATs per FTE nonstaff AT (graduate assistants and certified interns).

Injury Data

Staffing ratios were provided to the Datalys Center for Sports Injury Research and Prevention, Inc (Indianapolis, IN), which administers the NCAA-ISP. Ratios were matched within NCAA-ISP data if the respective school contributed men's ice hockey injury information to the repository. Detailed methods for NCAA-ISP data collection are available elsewhere.[20] Briefly, injury data are collected from a convenience sample of NCAA varsity sports teams through a real-time interface, with clinician injury diagnoses documented in electronic health records. All injuries must meet the NCAA-ISP definition of *injury*: occurring as a result of participation in an organized intercollegiate practice or competition and requiring attention from an AT or physician.[20] *Non–time-loss injuries* were those injuries that restricted participation for <24 hours. *Time-loss injuries* restricted participation for ≥24 hours. *Severe injuries*, a subset of TL injuries, either restricted participation for >3 weeks or resulted in a premature end to the athlete's season.[21] In addition to injury information, athlete-exposures (AEs) are documented. An *AE* is defined as 1 athlete's participation in 1 school-sanctioned practice or competition. The collection and compilation of injury information through the NCAA-ISP was approved by the Research Review Board of the NCAA. Only men's ice hockey injury data were analyzed in this preliminary study.

Statistical Analysis

Given the sample size and skewed distribution of staffing, the low patient-load and high patient-load groups were dichotomized based on the median values to provide the athlete : AT ratios. Similarly, the high-staff and low-staff groups were dichotomed based on the median values to provide the staff : nonstaff AT ratios. Thus, for a given number of personnel, the high-staff group had a higher proportion of staff ATs, whereas the low-staff group had fewer staff ATs relative to graduate assistants and certified interns.

Men's ice hockey injury rates were calculated as the number of injuries per 1000 AEs for all injuries, NTL injuries, TL injuries, severe injuries, and concussions. These injury rates were also considered overall and for practices and competitions. Injury rate ratios (IRRs) with 95% confidence intervals (CIs) were used to compare rates of injury between groups. Those IRRs with 95% CIs not containing 1.0 were considered statistically significant.

RESULTS

Sample

More than half of eligible schools (n = 77, 54.2%) participated in the telephone interview and provided information about their staffing patterns. Of these 77 schools, 17 provided men's ice hockey injury data to the NCAA-ISP for the 2013–2014 school year (Division I = 7, Division III = 10) and 18 did so during the 2014–2015 school year (Division I = 8, Division III = 10).

Staffing and Patient Load

The median number of athletes per total ATs (the sum of staff, graduate assistants, and certified interns) was 64. However, this varied widely from 20 to 160 athletes. The ratio of staff : nonstaff ATs ranged from 0.18 to 7, with a median value of 1.5. That is, some schools had 7 FTE staff ATs for each graduate assistant or certified intern, while others had 1 FTE staff AT for every approximately 5.5 FTE graduate assistants or certified interns.

Men's Ice Hockey Injuries and AEs

Across 97 456 AEs, a total of 1020 injuries were reported, of which 614 were NTL, 386 were TL, and 20 were missing data on participation-restriction time (Table 1). In addition, 88 injuries were severe. The overall men's ice hockey injury rate was 10.46/1000 AEs (95% CI = 9.82, 11.11).

Table 1. Injury Counts and Rates in Sample of Collegiate Men's Ice Hockey Programs, 2013–2014 and 2014–2015 Academic Years[a]

Injuries	Count	AEs	Injury Rate per 1000 AEs (95% Confidence Interval)
Total[b]			
Competitions	669	23 759	28.16 (26.02, 30.29)
Practices	351	73 698	4.76 (4.26, 5.26)
Overall	1020	97 456	10.46 (9.82, 11.11)
Non–time-loss[c]			
Competitions	403	23 759	16.96 (15.31, 18.62)
Practices	211	73 698	2.86 (2.48, 3.25)
Overall	614	97 456	6.30 (5.80, 6.80)
Time loss[d]			
Competitions	253	23 759	10.65 (9.34, 11.96)
Practices	133	73 698	1.80 (1.50, 2.11)
Overall	386	97 456	3.96 (3.57, 4.36)
Severe[e]			
Competitions	62	23 759	2.61 (1.96, 3.26)
Practices	26	73 698	0.35 (0.22, 0.49)
Overall	88	97 456	0.90 (0.71, 1.09)
Concussions			
Competitions	73	23 759	3.07 (2.37, 3.78)
Practices	19	73 698	0.26 (0.14, 0.37)
Overall	92	97 456	0.94 (0.75, 1.14)

Abbreviation: AE, athlete-exposure.

[a] Data originated from the National Collegiate Athletic Association Injury Surveillance Program, 2013–2014 and 2014–2015. Sums of each category's competition AEs and practice AEs do not equal overall AEs due to rounding error (due to the use of mean imputation based on all other valid AE data from the same year, division, and event type for missing data).

[b] Sum of non–time-loss and time-loss injuries does not equal total injuries due to 13 competition and 7 practice injuries with missing data for participation-restriction time.

[c] Non–time-loss injuries (ie, injuries that resulted in participation restriction <24 h).

[d] Time-loss injuries (ie, injuries that resulted in participation restriction of ≥24 h).

[e] Injuries that resulted in participation restriction of >3 wk.

Variation in Men's Ice Hockey Injury Rates by Patient Load of AT

Differences existed in men's ice hockey injury rates between the high patient-load and low patient-load groups (Table 2). For example, the injury rate in the high patient-load group was 40% lower than that in the low patient-load group overall (IRR = 0.60; 95% CI = 0.51, 0.70). This was driven primarily by variations in the NTL injury rates between groups (IRR = 0.37; 95% CI = 0.31, 0.44). The rates of TL injuries, severe injuries, and concussions did not differ between groups.

Variation in Men's Ice Hockey Injury Rates by Staff : Nonstaff ATs

Differences existed in men's ice hockey injury rates between the high-staff and low-staff AT groups (Table 3). For example, the high-staff group had a lower NTL injury

Table 2. Injury Counts and Rates in Collegiate Men's Ice Hockey Programs by Average Patient Load of All Athletic Trainers, 2013–2014 and 2014–2015 Academic Years[a]

Injuries	Low Patient Load[b]			High Patient Load[b]			
	Count	AEs	Injury Rate per 1000 AEs (95% CI)	Count	AEs	Injury Rate per 1000 AEs (95% CI)	High Versus Low Patient Load Injury Rate Ratio (95% CI)
Total[c]							
Competitions	421	11 942	35.25 (31.89, 38.62)	248	11 817	20.99 (18.38, 23.60)	0.60 (0.51, 0.70)[d]
Practices	220	36 817	5.98 (5.19, 6.77)	131	36 881	3.55 (2.94, 4.16)	0.59 (0.48, 0.74)[d]
Overall	641	48 759	13.15 (12.13, 14.16)	379	48 698	7.78 (7.00, 8.57)	0.59 (0.52, 0.67)[d]
Non–time-loss[e]							
Competitions	290	11 942	24.28 (21.49, 27.08)	113	11 817	9.56 (7.80, 11.33)	0.39 (0.32, 0.49)[d]
Practices	158	36 817	4.29 (3.62, 4.96)	53	36 881	1.44 (1.05, 1.82)	0.33 (0.25, 0.46)[d]
Overall	448	48 759	9.19 (8.34, 10.04)	166	48 698	3.41 (2.89, 3.93)	0.37 (0.31, 0.44)[d]
Time-loss[f]							
Competitions	123	11 942	10.3 (8.48, 12.12)	130	11 817	11.00 (9.11, 12.89)	1.07 (0.83, 1.37)
Practices	59	36 817	1.60 (1.19, 2.01)	74	36 881	2.01 (1.55, 2.46)	1.25 (0.89, 1.76)
Overall	182	48 759	3.73 (3.19, 4.27)	204	48 698	4.19 (3.61, 4.76)	1.12 (0.92, 1.37)
Severe[g]							
Competitions	24	11 942	2.01 (1.21, 2.81)	38	11 817	3.22 (2.19, 4.24)	1.60 (0.96, 2.67)
Practices	11	36 817	0.30 (0.12, 0.48)	15	36 881	0.41 (0.20, 0.61)	1.36 (0.63, 2.96)
Overall	35	48 759	0.72 (0.48, 0.96)	53	48 698	1.09 (0.80, 1.38)	1.52 (0.99, 2.32)
Concussions							
Competitions	45	11 942	3.77 (2.67, 4.87)	28	11 817	2.37 (1.49, 3.25)	0.63 (0.39, 1.01)
Practices	10	36 817	0.27 (0.10, 0.44)	9	36 881	0.24 (0.08, 0.40)	0.90 (0.37, 2.21)
Overall	55	48 759	1.13 (0.83, 1.43)	37	48 698	0.76 (0.51, 1.00)	0.67 (0.44, 1.02)

Abbreviations: AE, athlete-exposure; CI, confidence interval.

[a] Data originated from the National Collegiate Athletic Association Injury Surveillance Program, 2013–2014 and 2014–2015.
[b] Groups are based on a median split in the patient load. An odd number of team-years of injury data were analyzed, so the median value was included in the high patient-load group.
[c] Sum of each category's non–time-loss and time-loss injuries does not equal total injuries due to 13 competition and 7 practice injuries with missing data for participation-restriction time.
[d] Denotes statistical significance (ie, 95% CI does not contain 1.0).
[e] Non–time-loss injuries (ie, injuries that resulted in participation restriction of <24 h).
[f] Time-loss injuries (ie, injuries that resulted in participation restriction of ≥24 h).
[g] Injuries that resulted in participation restriction of >3 wk.

rate than the low-staff group (IRR = 0.68; 95% CI = 0.58, 0.80). However, compared with the low-staff group, the high-staff group had higher rates for TL injuries (IRR = 1.70; 95% CI = 1.37, 2.09), severe injuries (IRR = 1.93; 95% CI = 1.23, 3.02), and concussions (IRR = 1.77; 95% CI = 1.15, 2.73). Interestingly, no difference was found between groups in all-injury rates of men's ice hockey players (IRR = 0.96; 95% CI = 0.85, 1.09); however, this was because the injury rate differences between the high-staff and low-staff groups were in opposite directions for competitions (IRR = 1.27; 95% CI = 1.09, 1.48) and practices (IRR = 0.60; 95% CI = 0.49, 0.75).

DISCUSSION

We examined the relationship between institutional sports medicine staffing patterns and injuries on 1 men's ice hockey team at each school. We observed that aspects of how an institution staffed its sports medicine department were associated with rates of injury diagnosis. Our results suggested that both the relative number of clinicians to athletes (the clinician's patient load) as well as the relative number of staff to nonstaff ATs were meaningfully associated with the incidence and types of injuries that were diagnosed by the sports medicine team.

Lower rates of men's ice hockey injuries were reported at institutions with higher patient loads. In line with previous findings in the secondary school setting,[16] the number of athletes per clinician primarily affected NTL injury rates. The combination of the lower NTL injury rate in the high patient-load group and no difference in TL injury rates between patient-load groups may indicate that clinicians prioritized athletes with more obvious or critical injuries if time was limited. Here, it is important to note that NTL injuries can place equal or greater time demands on the clinician as do TL injuries.[22] Alternatively, it may reflect athletes observing busy clinicians and deciding that their possible NTL injury did not warrant evaluation, whether a clinician was present at games or practices or both, or the accessibility of the sports medicine clinic to the athlete. Additional research to clarify possible underlying mechanisms is warranted. Given that the early diagnosis of NTL injuries may prevent TL injuries from occurring later,[23] for optimal athlete health and wellbeing, it is critical to prevent TL injuries by diagnosing and appropriately rehabilitating NTL injuries.

We also found the relative number of staff ATs to graduate assistant and certified intern ATs was associated with injury diagnosis patterns. Rates of time-loss injuries, severe injuries, and concussions were higher in the group with a higher proportion of staff ATs. It is possible that

Table 3. Injury Counts and Rates in Collegiate Men's Ice Hockey Programs by Ratio of Staff to Nonstaff Athletic Trainers, 2013–2014 and 2014–2015 Academic Years[a]

Injuries	Low Staff[b] Count	AEs	Injury Rate per 1000 AEs (95% CI)	High Staff[b] Count	AEs	Injury Rate per 1000 AEs (95% CI)	High Versus Low Staff Injury Rate Ratio (95% CI)
All injuries[c]							
Competitions	284	11 502	24.69 (21.82, 27.56)	385	12 256	31.41 (28.27, 34.55)	1.27 (1.09, 1.48)[d]
Practices	209	34 698	6.02 (5.21, 6.84)	142	38 999	3.64 (3.04, 4.24)	0.60 (0.49, 0.75)
Overall	493	46 201	10.67 (9.73, 11.61)	527	51 256	10.28 (9.40, 11.16)	0.96 (0.85, 1.09)
Non-time-loss[e]							
Competitions	195	11 502	16.95 (14.57, 19.33)	208	12 256	16.97 (14.66, 19.28)	1.00 (0.82, 1.22)
Practices	155	34 698	4.47 (3.76, 5.17)	56	38 999	1.44 (1.06, 1.81)	0.32 (0.24, 0.44)[d]
Overall	350	46 201	7.58 (6.78, 8.37)	264	51 256	5.15 (4.53, 5.77)	0.68 (0.58, 0.80)[d]
Time-loss[f]							
Competitions	84	11 502	7.30 (5.74, 8.86)	169	12 256	13.79 (11.71, 15.87)	1.89 (1.45, 2.45)[d]
Practices	50	34 698	1.44 (1.04, 1.84)	83	38 999	2.13 (1.67, 2.59)	1.48 (1.04, 2.10)[d]
Overall	134	46 201	2.90 (2.41, 3.39)	252	51 256	4.92 (4.31, 5.52)	1.70 (1.37, 2.09)[d]
Severe[g]							
Competitions	21	11 502	1.83 (1.04, 2.61)	41	12 256	3.35 (2.32, 4.37)	1.83 (1.08, 3.10)[d]
Practices	7	34 698	0.20 (0.05, 0.35)	19	38 999	0.49 (0.27, 0.71)	2.41 (1.02, 5.74)[d]
Overall	28	46 201	0.61 (0.38, 0.83)	60	51 256	1.17 (0.87, 1.47)	1.93 (1.23, 3.02)[d]
Concussions							
Competition	23	11 502	2.00 (1.18, 2.82)	50	12 256	4.08 (2.95, 5.21)	2.04 (1.25, 3.34)[d]
Practices	8	34 698	0.23 (0.07, 0.39)	11	38 999	0.28 (0.12, 0.45)	1.22 (0.49, 3.04)
Overall	31	46 201	0.67 (0.43, 0.91)	61	51 256	1.19 (0.89, 1.49)	1.77 (1.15, 2.73)[d]

Abbreviations: AE, athlete-exposure; CI, confidence interval.

[a] Data originated from the National Collegiate Athletic Association Injury Surveillance Program, 2013–2014 and 2014–2015. Sums of each category's competition AEs and practice AEs do not equal overall AEs due to rounding error (due to the use of mean imputation based on all other valid AE data from the same year, division, and event type for missing data).

[b] Groups are based on a median split in the patient load. An odd number of team-years of injury data were analyzed, so the median value was included in the high staff group.

[c] Sum of non–time-loss and time-loss injuries does not equal total injuries due to 13 competition and 7 practice injuries with missing data for participation-restriction time.

[d] Denotes statistical significance (ie, 95% CI does not contain 1.0).

[e] Non–time-loss injuries (ie, injuries that resulted in participation restriction of <24 h).

[f] Time-loss injuries (ie, injuries that resulted in participation restriction of ≥24 h).

[g] Injuries that resulted in participation restriction of >3 wk.

staff ATs, who on average have more experience than graduate assistants or certified interns, may pursue more conservative injury-management patterns and more frequently remove athletes from play to recover, thereby increasing rates of TL injuries. Previous researchers[24] suggested that less experienced ATs more frequently perceived pressure to prematurely return athletes to play after concussion. Athletes may also be less likely to report injuries to graduate assistants or certified interns because of their perceived lack of experience. This may extend to other injuries, again helping to explain why a sports medicine department with a higher proportion of staff ATs (and thus, on average, more experience) may have higher rates of TL and severe injuries. Investigators[25] have associated insufficient staffing with incomplete implementation of concussion-management protocols. Staff ATs, rather than graduate assistant or certified intern ATs, are also often in charge of concussion education. Thus, schools with more staff may have more robust education and management protocols and possibly improved athlete concussion-symptom reporting and increased rates of concussion diagnosis as a result. Again, additional evaluation to clarify possible underlying mechanisms for these associations is warranted.

The rates of all injuries incurred during practice, NTL injuries overall, and NTL injuries in practice were all lower in the high-staff group than in the low-staff group. It may be that staff ATs were not present at practices as frequently as graduate assistant or certified intern ATs. Thus, at schools where staff ATs made up a larger proportion of the sports medicine team, injuries, and especially NTL injuries, sustained during practices may have sometimes gone undiagnosed. Additionally, at schools where staff ATs were a larger proportion of the sports medicine team, athletes may have felt reluctant to approach a staff member with a minor NTL injury. This could decrease the overall rate of NTL injury diagnosis compared with that at schools with more graduate assistant or certified intern ATs. Conversely, the difference in NTL injuries between the high-staff and low-staff groups could represent differences in injury documentation rather than injury diagnosis.

It is interesting to note that the overall injury rates for competitions and practices went in opposite directions: the practice rate was higher in the low-staff group, while the competition rate was higher in the high-staff group. This resulted in a null finding for the overall IRR between groups. It could have been that, among sports medicine staffs with greater proportions of staff ATs, these staff ATs were more experienced and thus felt more comfortable asserting themselves to remove an athlete from play during competition. On the other hand, staff members may not be present at practices as frequently as graduate assistant or certified intern ATs. Therefore, schools with a higher proportion of graduate assistants and certified interns may more frequently have an AT present at practice who is able to diagnose injuries that occur during this time. Additional evaluation of the mechanisms leading to these differences is warranted.

Staffing levels may also affect injury incidence and health care provision less directly. The number of patients a clinician cares for has been described as a cognitive stressor[26] and source of job dissatisfaction[8,27] in other areas of medicine. In these studies, clinicians' performance or their perception of their performance was related to the number of patients in their care. Insufficient staffing has been associated with clinician burnout and job dissatisfaction, specifically among ATs in the collegiate sports medicine setting.[28–34] Some authors[28] suggested that patient load can lead to a disparity between the expected workload and realized workload, which in turn was related to clinician burnout and job dissatisfaction. Others[34] indicated that staffing concerns were related to work-life conflict which, in turn, was associated with clinician burnout. Although speculative, it is possible that beyond the strict time constraints related to seeing more patients, these psychological factors play a role in a clinician's ability to perform at his or her best as a health care provider. Future research is needed to evaluate the possible mechanisms linking staffing patterns and injury rates and whether clinician job satisfaction, stress, or burnout are influential factors.

LIMITATIONS

Although we found an association between institutional sports medicine staffing patterns and injury rates, this cannot be interpreted as a causal relationship. Many factors, such as the division of competition, may influence injury rates beyond the staffing measures examined in this initial evaluation; future study to account for these additional variables is warranted. Furthermore, our findings may not generalize to non-participating schools, sports, or levels of competition. Future investigations with larger samples, including more sports over longer periods of times, are required. We addressed staffing patterns at the school level with respect to the injuries on 1 team. Our data did not allow us to understand how an institution allocates its clinicians across teams or to our specific team of interest: men's ice hockey. Future researchers could also improve upon the present evaluation by obtaining true patient-load values for each clinician rather than school-wide averages. Finally, the present analyses rely on the assumptions that (1) injury-documentation practices are relatively uniform across groups and across injury types and (2) documentation is reflective of diagnosis. It could be, however, that reporting practices vary according to staffing levels and qualifications.

CONCLUSIONS

These results provide initial evidence that the number and types of clinicians on a collegiate sports medicine staff are associated with the rates of reported injuries. These findings are congruent with evidence from the secondary school athletic setting,[16] as well as previous work[3] relating patient load and mental health screening practices, and suggest that athlete health care is affected by the relative number and types of clinicians available. The field of sports medicine is moving toward more integrated approaches to sports injury prevention that acknowledge the importance of intrapersonal and environmental factors.[35] Given the wide variation in sports medicine staffing in the collegiate setting, additional research is needed to evaluate the relationship between sports medicine staffing patterns and athlete health outcomes more broadly, as well as to understand the mechanisms by which the associations we found arose. Recognizing that sports medicine staffing patterns may be an influential factor in injury diagnosis and prevention is essential in working to ensure that all athletes have access to appropriate and equitable health care.

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