Examining Athletic Trainers' Impact on Student Athlete Emergency Room and Urgent Care Visits Using Electronic Health Records and Visual Analytics

Abraham Kim[1], Scott Bonnette, PhD[2], Chen Xin, MDes[1], Victoria L. Graham, DAT, ATC[3], Kelsey Logan, MD, MPH[1,2], Danny T.Y. Wu, PhD, MSI[1],

[1]University of Cincinnati College of Medicine, Cincinnati, OH; [2]Division of Sports Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, OH; [3]American Public University System, Charles Town, WV

Introduction

Athlete trainers (AT) are healthcare professionals whose responsibilities include helping student athletes via injury prevention care, injury evaluation, and coordinating care and follow-ups with athletes [1]. ATs prevent many preventable emergency visits, decreasing medical payments for both patients and hospitals. Studies have shown that ATs can have positive impacts on the quality of care of student athletes as well as increasing the number of self-reported sports-related injuries[2]. However, not all high schools have ATs due to several factors such as the development of the sport programs at the high school, budget, socioeconomic status[3], geographic location, and other factors. Therefore, there is a critical need to examine ATs' contribution and effectiveness using objective measures to determine whether it is advantageous to having an AT, especially for high school athletics. In this mixed methods study, we examine the relevance of ATs' work and contributions to decreasing emergency room visits made by student athletes via electronic health records (EHRs) and semi-structured interviews. In this abstract, we reported the development of a R-shiny application utilizing visual analytics to help facilitate the quantitative analysis.

Methods

The study adopted a mixed method design in a concurrent manner. EHRs (N=1,780) regarding Emergency Room (ER) and Urgent Care (UC) visits of student athletes were obtained from a large pediatric academic medical center. The dataset contained approximately 19 different high schools/sports clubs (some schools/club changed AT coverage or unable to acquire data for a certain years) from a midwestern city over three fiscal years (2018-2020). The use of such records was approved by the institutional review board. Given information about these schools and visits including the socioeconomic status (derived from percentage of students receiving free school lunches), presence of athletic trainer, the total roster of the school athletics program, the number and date of each ED visit from student athletes, and the type of each visit, statistical analyses were performed on the dataset via two-tailed and unequal variance t-tests with a significance level of .05. A data pipeline (Figure 1) with a R-shiny application (Figure 2) was developed to assist the exploratory analysis and report the statistically significant differences. Specifically, the dataset was transformed to data cubes using Structured Query Language (SQL) so that the R-shiny application can use the user-supplied filtering values to slice and dice the data. R-shiny user-interface is uniquely different from other interfaces in terms of customization, interactive visualizations, and hypotheses testing. ED visits of different schools were categorized by both SES and AT presence. Several hypotheses were tested when examining the quantitative data, using the type of AT presence as the primary comparing categorical variable. Social economic status (SES) was also used as a variable of comparison. To normalize the differences between schools with different total rosters, the number of visits was divided by the respective total roster, i.e., the school the student athlete attended. In addition, semi-structured qualitative interviews were conducted for several athletic trainers of the schools provided in the quantitative dataset. The audio of each interview was transcribed verbatim and thematically analyzed. In addition to questions prepared by the researchers, all interviewees were asked to discuss whether they were aware of ED visits made by the student athletes and whether they referred the athletes to the ER. The quantitative and qualitative data were triangulated.

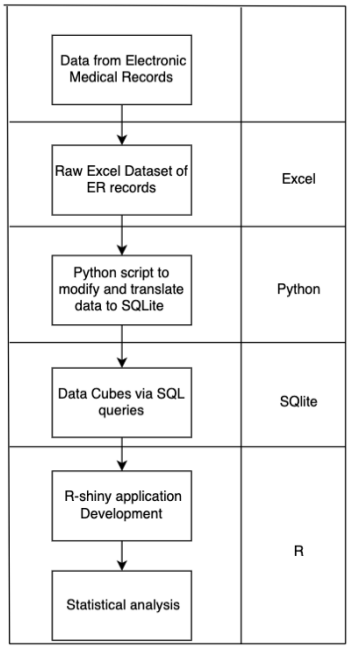

Figure 1. Data pipeline

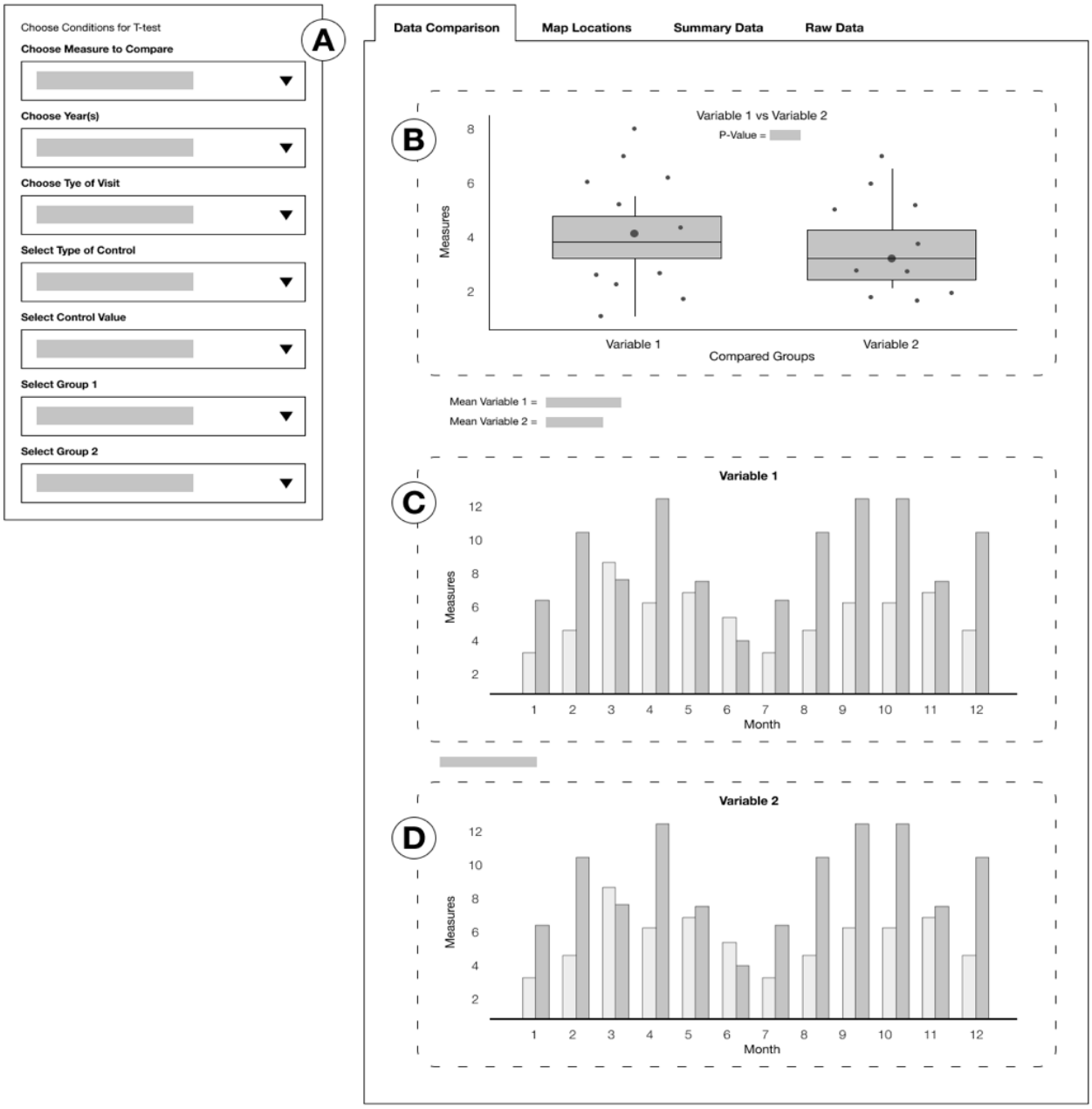

Figure 2. Mock-up of the R-shiny Interface: A) Filters, B) Data Distribution by Group, C, D) Measure Scores by Month and School

Results

Table 1 shows the hypothesis tests and their significance. In sum, there were two statistically significant tests. No comparisons between full-time and part-time AT schools were significant in the first school year. In the second school year, schools who had a fulltime ATs (mean=0.104) had significantly lower emergency room visits per athlete than schools with part-time coverage (mean=0.149) for musculoskeletal issues or illnesses potentially related to sports ($p=0.045$). In the third year, schools who had a fulltime AT (mean=0.066) had significantly lower emergency room visits per athlete than schools with part-time coverage (mean=0.147) for all other illness types ($p<0.01$). The preliminary analysis of the nine semi-structured interviews found four themes regarding care delivery

of ATs: the need for full-time athletic trainers/more staffing, lack of resources, lack of education specific to the safety of the sport, and AT's relationship with student.

Table 1. Statistics Summary (*p-value<0.05; S=Sports-Related Injuries, M=Mental Health-Related, O=Others)

Year	Type of ED Visit	Mean ED Visits under Full-Time AT Presence Mean	# of athletes under care of Full-Time ATs	Mean ED Visits under Part-Time AT Presence	# of athletes under care of Part-Time ATs	p-value
2018	S	0.178	1745	0.189	645	0.805
	M	0.042		0.023		0.137
	O	0.201		0.235		0.531
2019	S	0.105	1567	0.150	579	0.046*
	M	0.017		0.023		0.213
	O	0.166		0.146		0.337
2020	S	0.099	864	0.115	1009	0.620
	M	0.032		0.017		0.394
	O	0.066		0.148		0.006*

Discussion and Conclusion

The R-shiny application utilizes visual analytics to generate immediate quantitative results from the EHRs, allowing for relatively quick comparisons, allowing for the development/testing of further hypotheses. By filtering the data using parameters as determined by the user (Figure 2), one can generate immediate results. However, the results did not reveal conclusive answers regarding the influence of AT presence on the number of ED visits. There were few significant results as shown in Table 1. A more adequate comparison between the impact on ED visits with presence of full-time ATs and no ATs was not possible given the limited data provided by the dataset on ED visits from schools with no ATs. Meanwhile, we are refining the R-shiny application to explore the data and provide empirical evidence to the qualitative themes.

This study is limited because it only selected and analyzed high schools in a midwestern city; the study did not interview student athletes and could only take upon the perspective of ATs leading to potential bias, nor did this study have a record regarding how many visits were successfully prevented by AT referrals. While ED visits are one way of objectively measuring the impact of ATs on student athletes, it not necessarily the most accurate or reliable. Utilizing the data pipeline in Figure 1, additions or modifications to the dataset can rapidly be analyzed. In addition, the data pipeline can be applied to other areas given its generalizable design (data cube, visualization, and statistical tests) Future work involves connecting ED visits with the cost data to quantify the potential positive impact of full-time AT presence and create a sustainable model for schools to maintain full-time ATs.

Acknowledgement

We thank Mr. Siyi Zhu for creating the mock-up of the R-shiny Interface.

References

1. Slone HS, Buckner JF, Hewson K, Barr MJ, Crawford T, Woolf SK. Economic impact of outreach athletic trainers on a health system: implications for program growth and sustainability. Phys Sportsmed. 2018 Nov;46(4):460–5.

2. Wallace J, Covassin T, Nogle S, Gould D, Kovan J. Knowledge of Concussion and Reporting Behaviors in High School Athletes With or Without Access to an Athletic Trainer. J Athl Train. 2017 Mar;52(3):228–35.

3. Kroshus E, Rivara FP, Whitlock KB, Herring SA, Chrisman SPD. Disparities in Athletic Trainer Staffing in Secondary School Sport: Implications for Concussion Identification. Clin J Sport Med. 2017 Nov;27(6):542–7.