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Work-related injuries within a large urban public school system in the Mid-Western United States

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Abstract.
BACKGROUND: More than 13 million employees are working in the public education sector which includes more than just teachers in the United States. This industry sector also employs custodians, maintenance, and administration. To date, there is very limited information about the type and frequency of injuries for these employees.
OBJECTIVE: To identify injury trends related to frequency and severity for different occupational injuries in a large urban school district.
METHODS: Between 2014 –2015, school district employees reported a total of 598 occupational injuries. Initial analysis of the data provided the frequency of injuries overall and for individual occupational categories. The Severity Index provides a score for job category and injury type based on severity and frequency.
RESULTS: Overall, the Slip, Trip and Fall category had the highest frequency, followed by Combative Situations, and Over-exertion. Teacher and Para-professional workers experienced the greatest number of injuries with violence being the most frequent cause. Based on the Severity Index, Over-exertion was identified as the primary exposure concern for Custodians, while Slip, Trip and Fall category had the greatest impact on Building Engineers.
CONCLUSIONS: With the diversity of negative outcomes, the administration will need targeted interventions for the various professions represented in the school systems. The injury severity profile indicates non-teachers should be a high priority for interventions with over-exertion and slips, trips and falls leading the risk.

Keywords: Teachers, custodians, lifting, assaults, slips, trips and falls

1. Introduction

Approximately 13 million employees work within the education industry in the United States, making it the largest portion of the National Occupational Research Agenda Services sector [1]. This industry sector includes primary and secondary schools, technical and other colleges, universities, professional schools, and educational support staff. While teachers may be the largest single group of workers employed by the average US public school system, they only make up about half of the total number of workers employed [2]. The other half of employed public school system workers is comprised of para-professionals and other school-related support staff with hundreds of job titles including food service workers, custodians, and office staff [3].

To date, there are limited data about the injuries and well-being of workers within the education industry. The Bureau of Labor Statistics [4] reported the overall injury rate for elementary and secondary schools sector was 3.0 per 100 employees while the cases

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involving days away from work, job restriction, or transfer was 1.2 per 100 employees [4]. Anderson and associates [5] found elementary and secondary schools were ranked among the top 15 industry groups for compensable claims but were among the lowest with respect to injury rates.

With respect to teachers, physical assaults occur on a routine basis with up to 8% of school teachers having experienced a physical assault (physical contact intended to injure or harm) while almost 40% having experienced a non-physical event (including threats, sexual harassment, verbal abuse, and bullying) in the past year [6–9]. The estimated annual cost of school violence against teachers alone is greater than $2 billion [10]. Many para-professional roles involve physical exertion, including heavy lifting and repetitive motion [11]. Flum et al. [12] found overall injury rates among university custodian staff was 39%. Furthermore, these individuals also deal with electrical equipment, operate machinery and can be exposed to aggressive behavior from children.

Decreased work capacity, long-term disability, unplanned termination, and early retirement are potential and largely uncompensated, consequences for workplace injuries [13, 14]. Alker et al. [15] and Campos et al. [16] noted that alterations in school employee health could result in either absenteeism (e.g., missed work days) or presenteeism (e.g., a health-related decrease in productivity on the jobsite), both which impact the worker performance and quality of the education provided. Monetary and personnel resources for injury prevention and occupational health are typically limited within school systems [5, 11]. Therefore, there is a direct need for timely data and relevant interventions to maximize the impact on school employee health and safety.

To date, the authors are unaware of any published studies focused on the trends of work-related injuries within urban public school system employees. The objective of this paper was to identify the frequency and severity of injuries for all types of employees within a large public school system within the Midwest region of the United States.

2. Methods

2.1. Data retrieval

The research team retrieved the injury data from an electronic database provided by the school district Health and Safety (H&S) Department. There are over 50 public schools across an urban area and about 4500 employees in this school district. The data included all injuries occurring within the school system during the year of 2014 and 2015 (January 2014 to December 2015). The two years of data were coded separately in Excel and then merged for analyses. All personally identifiable information (PII) was removed from each database, which included the injured person's name and injury location (e.g., school site) to ensure anonymity.

2.2. Reporting of injuries

School employees would initiate reports after the occurrence of injuries, which were then filed with the H&S department within the school system. Next, the H&S personnel abstracted and the coded the information, word-for-word, into an electronic format using Microsoft Excel. The work-related injury data was maintained by the H&S Department until transferred to the research team.

2.3. Job category

There were a total of 66 job titles in the 2014 database and 74 job titles in the 2015 database. After removing the PII, a research team member standardized all job titles by grouping them into job categories based on the type of work performed. The job categorization was completed to reduce the overall number of job titles for analysis. The ten standardized job categories included Administrator, Facilities, Food Services, Instructional/Intervention Specialist, Nurse, Para-Professional, Psychologist/Therapist, Security, Support Specialist, and Teacher. The team further collapsed the Facilities job title into secondary job titles to further exam trends, due to their wide range of titles and job duties involved.

2.4. Injury category

The H&S Department of the school district defined an "injury" as a reported accident, which may or may not have required first aid. Illnesses were not included in the employee injury reports. The research team organized the databases by accident date, accident location, injured person, standardized job title, a short accident description, and if the injury resulted in any number of lost time or restricted work days.

Each accident description was then reviewed by a research team member who standardized the injury into one of 12 different injury categories, based upon the Occupational Injury and Illness Classification System (OIICS) issued by the Department of Labor [17]. The remaining research team members then reviewed each accident description and subsequent grouping to determine concurrence. The 13 injury categories included: Assaults by Animals/Insects; Automobile Accident; Burns or Scalds; Caught In or Between; Contact with Electrical Current; Combative Situations (CS); Exposure to Chemicals; Laceration; Needle Stick; Over-exertion; Slip, Trip and Fall (STF); Struck Against an Object; and Struck by an Object. A complete description of the definition of each injury category is shown in the Appendix.

The research team further classified the injury category of STF into: Inclined Surface; Fall to Lower Level; Slippery Surface/Ice; Tripped Over Self; Tripped on Object; and Unknown. CS was also further classified into sub-categories: Bitten by Student; Pushed by Student; Struck by Student; Thrown Object; and Other.

2.5. Data analysis

Descriptive analyses of all the injury outcomes by injury category (event/exposure), job category (occupation) and month of the year were performed. Summary measures, frequency distributions, and cross-tabulations of exposure and job category were used to describe the data. Count and median were presented for recordable injuries with medical treatment received, with lost time, with job transfer or restriction and OSHA recordable cases.

Due to lack of the access to the annual workforce size by job category, the injury rate was not able to be calculated. Instead, a Severity Index (SI) was developed to simultaneously evaluate the frequency and severity of injury by multiplying the rank of the cases reported. The distinct ordinal numbers were assigned to each category by their severity. For example, the job category with the most injury cases received the lowest rank of 1. The idea of SI was adapted from Anderson and associates and was further developed for this analysis [5]. The SI includes total number of injuries (N), cases requiring medical treatment (n1), cases with loss time (n2), median loss time in days (M1), cases with work transfer (WT) or cases with restricted work (RW) (n3), Median WT or RW in days (M2) and rank (R) order for these variables. The SI is the product of the rank orders:

$$\mathrm{SI} = \mathrm{R}(\mathrm{N}) \times \mathrm{R}\left(\frac{\mathrm{n1}}{\mathrm{N}}\right) \times \mathrm{R}\left(\frac{\mathrm{n2}}{\mathrm{N}}\right) \times \mathrm{R}(\mathrm{M1}) \times \times \mathrm{R}\left(\frac{\mathrm{n3}}{\mathrm{N}}\right) \times \mathrm{R}(\mathrm{M2})$$

The interpretation of the Severity Index is that the lower the score, the greater the severity.

2.6. Statistical analysis

A nonparametric Wilcoxon Signed-Rank Test was performed to compare the overall changes in injury by event/exposure and job category, respectively, between the year of 2014 and 2015. The software R (version 3.4.1) was used for this analysis.

3. Results

During the reporting period [January 2014 to December 2015], school district employees reported a total of 598 occupational injuries, with a total of 307 injuries occurring in the year of 2015 as compared to a total of 291 injuries occurring in the year of 2014 (See Table 1). The most common total injury outcomes were: STF (246 cases); CS (167 cases); Over-Exertion (55 cases); Struck by an Object (51 cases); Struck Against an Object (34 cases); and Laceration (12 Cases). These six injury categories accounted for 95% percent of the injury cases. Slippery surfaces or ice contributed to 50% of the STF injuries (123 out of 246). A student striking an employee resulted in over 70% of the CS injuries (119 out of 167). No significant difference in the overall injury trend (p-value of 0.68) was found for different events or exposures between year of 2014 and 2015. Even though 25 more assaults occurred in 2015 than in 2014, CS still ranked as the second common injury in both years.

The Teacher and Para-professional job category accounted for approximately 54% of the reported injuries. Almost 17% of workers with injuries were from the facilities job category, which included Building Engineer, Custodian, etc. (See Table 2) with Custodians accounting for 50% of injuries (52 out of 101). Forty-five Food Service workers were injured in 2014 and 2015. In 2015, there were 16 recordable injuries for Food Service workers, almost a 45% decrease from 2014. In 2015, there were 84 recordable injuries for Para-professionals, a 42.4% increase

Table 1
Number of nonfatal occupational injuries in the Urban Public School District by injury outcome

Injury Category	2014	2015	Total	
	Number	Number	Number	Percent[#] (%)
	291	**307**	**598**	
Assault by Animal/Insect	**1**	**2**	**3**	**0.5**
Automobile Accident	**2**	**—**	**2**	**0.3**
Burn or Scald	**4**	**1**	**5**	**0.8**
Caught in or Between	**1**	**3**	**4**	**0.7**
Contact with Electrical Current	**—**	**2**	**2**	**0.3**
Combative Situations	**71**	**96**	**167**	**27.9**
Bitten by Student	*12*	*14*	*26*	*4.3*
Pushed by Student	*—*	*2*	*2*	*0.3*
Struck by Student	*51*	*68*	*119*	*19.9*
Thrown Object	*1*	*2*	*3*	*0.3*
Other	*7*	*10*	*17*	*2.8*
Exposure to Chemicals	**—**	**2**	**2**	**0.3**
Laceration	**6**	**6**	**12**	**2.0**
Needle Stick	**1**	**1**	**2**	**0.3**
Over-exertion	**29**	**26**	**55**	**9.2**
Slip, Trip and Fall (STF)	**123**	**123**	**246**	**41.1**
Inclined Surface	*—*	*2*	*2*	*0.3*
Fall to Lower Level	*18*	*20*	*38*	*6.4*
Slippery Surface/Ice	*68*	*55*	*123*	*20.6*
Tripped Over Self	*14*	*13*	*27*	*4.5*
Tripped on Object	*21*	*33*	*54*	*9.0*
Unknown	*2*	*—*	*2*	*0.3*
Struck Against an Object	**20**	**14**	**34**	**5.7**
Struck by an Object	**27**	**24**	**51**	**8.5**
Unknown	**6**	**8**	**14**	**2.3**

Note: Dashes indicate no data reported. Bold numbers indicate the major categories, which total to 100%, while non-bolded are sub-categories. [#]Percentage calculations are for the total counts from 2014 to 2015 and relative to the total number of injuries (N = 598).

Table 2
Number of occupational injuries in the Urban Public School District by job category

Job Category	2014	2015	Total	
	Number	Number	Number	Percent[#] (%)
Total	**291**	**307**	**598**	
Administrator	**15**	**13**	**28**	**4.7**
Facilities	**45**	**56**	**101**	**16.9**
Building Engineer	*11*	*12*	*23*	*3.8*
Carpenter	*1*	*6*	*7*	*1.2*
Custodian	*24*	*28*	*52*	*8.7*
HVAC Tech	*5*	*1*	*6*	*1.0*
Others	*3*	*4*	*13*	*2.2*
Food Services	**29**	**16**	**45**	**7.5**
Instruction/Intervention Specialist	**7**	**19**	**26**	**4.3**
Nurse	**4**	**1**	**5**	**0.8**
Para-Professional	**59**	**84**	**143**	**23.9**
Psychologist/Therapist	**11**	**3**	**14**	**2.3**
Security	**15**	**26**	**41**	**6.9**
Support Specialist	**8**	**6**	**14**	**2.3**
Teacher	**96**	**79**	**175**	**29.3**

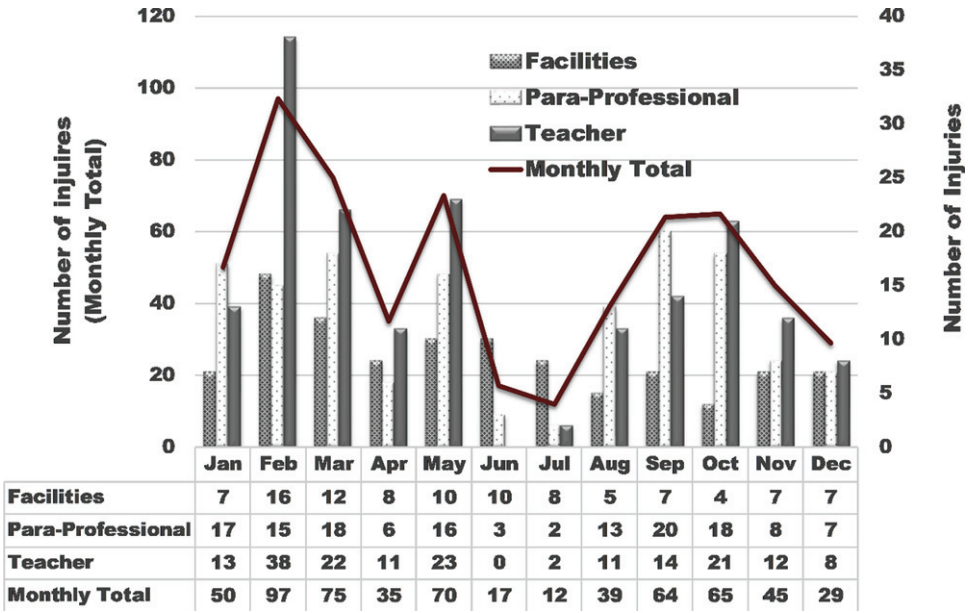
Note: Dashes indicate no data reported. Bold numbers indicate the major categories, which total to 100%, while non-bolded are sub-categories. [#]Percentage calculations are for the total counts from 2014 to 2015 and relative to the total number of injuries (N = 598).

from the 2014 total of 59. Teachers had an almost 18% decrease in injuries between 2014 (96) and 2015 (79). The Wilcoxon Signed-Rank test showed the changes in the total number of injuries for some job categories did not indicate any overall injury distribution change over time (p-value of 0.77).

Table 3
Leading causes of occupational injury in Urban Public School District by job category over entire 2-year period (2014 and 2015)

Job Category	Total injuries	Combative Situation number (%)	Over-exertion number (%)	Slip, Trip and Fall number (%)
Administrator	28	8 (28.6)	—	19 (67.9)
Facilities	101	1 (1.0)	32 (31.7)	33 (32.7)
Building Engineer	*23*	—	*3 (13.0)*	*13 (56.5)*
Custodian	*52*	*1 (1.9)*	*20 (38.5)*	*14 (26.9)*
Food Services	45	—	6 (13.3)	20 (44.4)
Instruction/Intervention Specialist	26	11 (42.3)	2 (7.7)	10 (38.5)
Nurse	5	—	—	4 (80.0)
Para-Professional	143	59 (41.3)	6 (4.2)	58 (40.6)
Psychologist/Therapist	14	5 (35.7)	—	3 (21.4)
Security	41	29 (70.7)	—	10 (24.4)
Support Specialist	14	1 (7.1)	—	6 (42.9)
Teacher	175	53 (30.3)	7 (4.0)	80 (45.7)

Note: Dashes indicate no data reported or data that do not meet publication criteria.

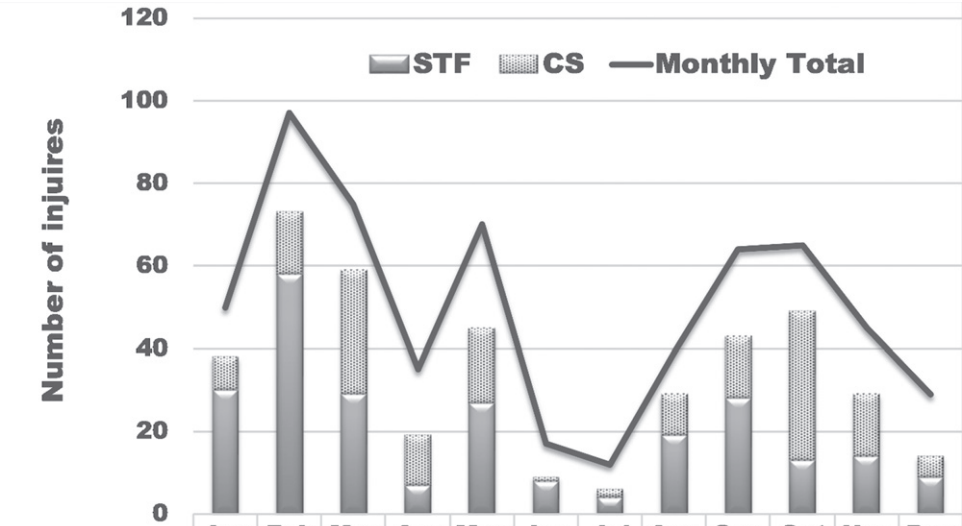


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Facilities	7	16	12	8	10	10	8	5	7	4	7	7
Para-Professional	17	15	18	6	16	3	2	13	20	18	8	7
Teacher	13	38	22	11	23	0	2	11	14	21	12	8
Monthly Total	50	97	75	35	70	17	12	39	64	65	45	29

Fig. 1. Number of occupational injuries in Urban Public School District by selected job category and month.

CS and STF were the leading injuries among Administrator, Instruction/Intervention Specialist, Nurse, Para-professional, Security and Teacher job categories. They accounted for 76% to 96% of the total injuries for those job categories (See Table 3). In Facilities and Food Service job categories, almost 58% to 64% of injuries involved Over-exertion and STF.

In general, the fewest injuries occurred in June (17 cases) and July (12 cases), respectively (Figs. 1 & 2). Employees reported most injuries in February (97 cases), followed by 75 cases in March, 70 cases in May, 65 cases in October and 64 cases in September. This trend applied to most injuries and most job categories. However, the total number of injuries among Facility workers stayed relatively constant throughout the year. Most of STF type injuries occurred in February (58 cases), followed by 30 cases in January, 29 cases in March, 28 cases in September, and 27 cases in May. Most of CS injuries happened during the school year, with the highest number of cases in October (36) and March (30).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CS	8	15	30	12	18	1	2	10	15	36	15	5
STF	30	58	29	7	27	8	4	19	28	13	14	9
Monthly Total	50	97	75	35	70	17	12	39	64	65	45	29

Fig. 2. Number of occupational injuries in Urban Public School District by injury type and month.

Table 4
Recordable cases of injuries in the Urban Public School District

Characteristic	2014	2015
Total cases	291	307
Cases with medical treatment received	99	138
Cases with lost time	24	25
Range (Median) of lost time (days)	1 – 180 (10.5)	1 – 121 (4)
Cases with job transfer or restriction	48	51
Range (Median) of job transfer or restriction (days)	2 – 160 (15.5)	1 – 211 (22)
OSHA recordable cases	88	109

In 2015, there were 138 recordable injuries involving medical treatment, a 39% increase from 2014 as well as 109 OSHA recordable cases, a 24% increase from 2014 (see Table 4). Forty-nine cases involved days away from work, or lost time, in 2014 and 2015. The median number of days away from work was 10.5 in 2014, which was 2.6 times as long in 2015. There were 99 cases involving job transfer or restriction reported during 2014 and 2015. The median number of days transferred or restricted from work was 15.5 (in 2014) and 22 (in 2015), respectively.

Over-exertion and STFs were ranked the lowest overall by SI, indicating the most severe occupational injuries. Facility workers, especially Building Engineers and Custodians, ranked the most severe occupational injury burden based on the lowest SI among the job categories (See Table 5).

4. Discussion

Overall, the elementary and secondary school sector has similar injury rates as other sectors such as construction, trade transportation and utilities and electrical equipment, appliance, and component manufacturing sectors, but has received limited investigations and interventions, likely due to the uniqueness of this sector [4]. One reason for the lack of attention may be due to the lack of regulation for public employees. While the Occupational Safety and Health Act of 1970 provided coverage for private employees, it did not address classified workers, such as public school employees [11]. As of today, 20 states do not have protections for public employees under OSHA-approved state programs [18]. This lack of oversight may be partially due to

Table 5
Severity index of occupational injuries by selected case characteristics

Characteristics	Severity Index
Injury Category	
Combative Situations	320
Over-exertion	**18**
Slip, Trip and Fall	**36**
Struck Against an Object	3750
Struck by an Object	3840
Job Category	
Administrator	90720
Facilities	**432**
Building Engineer	*270*
Custodian	*840*
Food Services	16200
Instruction/Intervention Specialist	75264
Para-Professional	4116
Security	3840
Teacher	11664

Note: Severity index was calculated separately for injury category and job category, e.g., they are not comparable. Bold numbers denote highest rankings (lowest score is considered most severe).

the lack of understanding of the impact of injuries and musculoskeletal disorders on workers in this industry.

Initial analysis of an urban school district data provided the frequency of injuries and the job categories with those injuries. The STF category had the highest frequency, followed by CS, and Over-exertion. While Teachers make up approximately half of all school system employees, they only accounted for 29% of the injuries in this study, with most of those injuries associated with combative situations. Para-professionals were found to experience a large portion of injuries as well. The Severity Index score for Para-professionals was ranked the third most severe among the various job categories, ahead of the Teachers job category. Furthermore, if the total number workers in the Para-professional job category is fewer than that of Teachers, occupational injuries among this group would raise even greater concern. Using the Severity Index (SI) methodology [5], Over-exertion among Custodians and STF among building engineers were identified as the injuries with the greatest concern (i.e., lowest Severity Index score).

Slip, Trip and Fall (STF) as an occupational hazard has been an ongoing focus of research for decades in the United States [19], and around the world [20]. Slip Trip and Fall events involve a combination of risk factors, including individual—gender and age, environmental—weather, surface condition, and obstacles in the way, and task—type of work being performed [13, 21–23]. In the current study, over 40 percent of injuries were STF.

Slip, Trip and Fall injuries on job sites or in the community can result in decreased work capacity [23]. Kemmlert and Lundholm [24] found women over 45 years at the greatest risk for STFs. Kemmlert & Lundholm [25] noted among the male occupations studied, only this injury category showed a significant relationship between accident and age. There is some evidence in this study that the STF injuries primarily involved slippery surfaces and/or ice, with a peak in February. Previous researchers have found an increase in STF injuries as temperatures declined [25–27], similar to this study.

Combative Situations were also found to be a major risk factor for injuries for teachers in this study. Combative Situations within school systems are a growing concern [7], but not a new one in urban settings [28]. Kingery and Coggeshall [29] observed barriers such as inadequate reporting systems, lack of funds for surveillance equipment, and sociopolitical pressure upon school employees to keep incident-reporting levels low. Several recent studies have found 4–8% of school Teachers working in the U.S. have experienced a physical assault [6, 7, 9], with almost 30-40% experiencing a non-physical workplace violence event in the past year [6, 8, 9]. In this study, Teacher and Para-professional categories workers experienced the greatest physical assault frequency with 71% of assault injuries involving students. Although the currently available literature has primarily focused on injuries to teachers, the present study noted para-professionals experienced slightly more assaults than teachers.

Although Over-exertion was not the most frequent type of injury found in this study, the SI analysis showed that it raised the most concern; especially for Facility workers who often suffer more severe injuries. Similar findings were reported by Anderson and associates [5]. They noted elementary and secondary schools were among the top fifteen industries with a higher burden of work-related musculoskeletal disorders in the service sector.

Despite the many workers that work in this large service industry, literature related to occupational health and safety within primary and secondary educational settings and among its various occupations remains relatively limited [11]. Many studies solely focus certain aspects of a specific job category within school systems, such as productivity of secondary school staff [15]; violence against Teachers [9, 16, 30, 31]; burns, cuts, and falls among Asian kitchen workers [32, 33]; or custodial injuries [34]. The literature specifically related to struck by or against an object,

and Over-exertion injuries are very limited [5, 35], as studied among school employees besides Teachers. Clearly, more research needs to be done among school employees to facilitate the promotion of occupational health and safety practices within school systems.

While this study provides the first look at injuries in urban public school systems, there are several potential limitations of the data that need to be considered when interpreting the results. First, this study relied upon self-reported employee injury records. As a result, it is possible injury results may have been higher due to unreported occupational events. Second, there was variation in the reporting quality of the injuries as they were completed by multiple individuals. This potentially limited some of the information about the injuries (e.g., no info on STFs conditions), diminishing some of the conclusions that could have been drawn. Finally, while the research team set out to calculate the injury rates, we were not able to obtain the actual total workforce size employed in the public school system as well as the specific breakdown within each job category. While all of these limitations may have limited how strong the study results could have been, the current results provided some insights into the common injuries of employees in a large urban public school system.

5. Conclusion

With so many school districts struggling financially to meet the needs of students, employees are often neglected, especially concerning health and safety. Overall, our results indicate that there is a need for initiatives for reducing the burden of injuries among workers in the sectors at high risk of injury. The current study provided evidence that the type of injuries varies dependent upon the type of employee (e.g., Teachers vs. Custodians vs. Administration). The results support the high prevalence of Combative Situations for Teachers and Over-exertion for facilities personnel (e.g., Maintenance and Custodians). The Severity Index indicated that Slip, Trip and Fall events and Over-exertions were the injuries of the most concern and Facility workers often suffer more severe injuries. The injury severity profile indicates non-teachers should be a high priority for interventions with Over-exertion and Slip, Trip and Fall leading the risk. Finally, the study points to the need and prevention direction for specialized training for the different employee categories as each has unique exposures, such as Combative Situations among Teachers and Para-professionals, Over-exertions among Facility workers and Slip, Trip and Fall among all workers but with a different focus.

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Conflict of interest

None to report.

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Appendix

Assault by Animal/Insect category includes injuries directly caused or the result of any animal or insect, which includes birds, bats, raccoons, spiders, bees, etc.

Automobile Accident category is when a motor vehicle collision occurs on CPS property and collides with a worker or another vehicle with a worker who becomes injured.

Burn or Scald category injury occurs when heat, friction, electricity or special burns by a hot liquid or steam occur to a worker.

Caught In or Between category includes injuries resulting from a person being squeezed, caught, crushed, pinched, or compressed between two or more objects, or between parts of an object.

Falls to a Lower Level category includes injuries caused by a fall to a level below where the person was sitting or standing. Examples would include falling from a desk, chair, or ladder.

Combative Situations category include injuries directly caused by a person(s) assaulting, biting, or performing some other violent act onto the worker. This may include deliberate injuries where there was direct intent to injure the worker or unintentional injuries where there was no intent to injure the person such as when a worker is restraining another person and become injured.

Lacerations were any injury that caused a deep cut or tear to the skin.

Needle Stick category injury is when a needle, or other sharp objects, penetrates the skin that may result in exposure to blood or other body fluids.

Over-exertion category injuries arise when one lifts, pulls, pushes or throws something, causing injury. This injury occurs when a muscle is pulled, or a joint is forced to move beyond its typical range of motion.

Slip, Trips and Fall category are injuries that occurred due to the result of too little friction or a lack of traction between the footwear and the floor surface or the foot striking or colliding with an object, which causes a loss in balance, and usually a fall.

Struck against An Object category injuries occur when an individual falls into something, or is physically forced into something such as a bookshelf, barricade, or other stationary objects.

Struck by An Object category injuries commonly occur when something falls off a shelf, or things are dropped by another worker onto a lower level.