

Injury Prevention in Medical Education: A Systematic Literature Review



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OBJECTIVE: Traumatic injury is the first cause of death for Canadians aged 1 to 44 years old. To reduce the global burden of injury, the need for healthcare professionals with injury prevention proficiency is growing. The aim of this study was to review the literature to identify and analyze current injury prevention curriculums amongst medical undergraduate and residency programs.

DESIGN: A systematic literature review (no date restriction was used) was conducted using Embase, Medline, ERIC, and CINAHL. Three reviewers independently selected studies, extracted data, checked accuracy, assessed risk of bias, and assessed quality. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis guideline was followed. The study was registered with PROSPERO, #CRD42016048805.

PARTICIPANTS: Articles were included if they were peer-reviewed, published in the English language, and reported data on injury prevention and control curriculum.

RESULTS: Eight hundred and twenty-four articles were identified with the initial search strategy. Internal consistency reliability, generalizability, evidence for content, criterion-related and construct validity was performed. The systematic review synthesized the characteristics (population, intervention type, outcome measures) described in the literature. This review is the first step in identifying gaps in injury prevention teaching and curriculums for medical students and residents.

CONCLUSION: The number of studies reporting the incidence and/or effectiveness of injury prevention and control curriculum is limited across the literature. Therefore, there is a knowledge gap in providing injury prevention education. Given that physicians play a vital role in the prevention or control of injuries, further development of medical undergraduate and residency programs to include core concepts of injury prevention would be

unquestionably paramount. (J Surg Ed 76:700–710. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Injury Prevention, Medical Education, Medical Student, Residency, Curriculum

COMPETENCIES: Patient Care, Medical Knowledge, Interpersonal and Communication Skills

BACKGROUND

Injury has a major societal impact. In Canada, injury is the number one cause of death amongst those aged 1 to 44 years, the fifth leading cause of death amongst those of all ages and is responsible for a burden of \$ 26.8 billion in 2010.¹ Worldwide, injuries account for 1.7 times the death toll from all cases of HIV, tuberculosis, and malaria.² Over 5 million people die from injuries every year, and more than tens of millions are burdened by the long-term effects of injuries.² It holds that most injuries are predictable and preventable, and therefore such statistics represent a serious public health concern.

To tackle the multifaceted elements of injury prevention promotion, Cohen and Swift created a framework entitled *The Spectrum of Prevention*³ which includes an element of “educating providers” that highlights the influential position that physicians hold in injury prevention (amongst other providers).³ Physicians are often the first point of contact of the injured patient in the medical system preceding and following injury, there is no doubt that there is an inherent responsibility of physicians to take on a major role in injury prevention. In addition, the Medical Council of Canada licensing exam (required by all practicing medical doctors in Canada) objectives include ensuring requisite of knowledge of public health systems in Canada including functions related to injury prevention.⁴ Moreover, preventative medicine remains a central theme amongst most primary care providers.

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Despite these role calls and mandates, it is unclear whether medical schools and medical residency programs truly prepare their trainees to be knowledgeable and competent in communicating injury prevention information to their patients. The aim of this study is to systematically review the literature and detail the range of injury prevention and control education curricula among medical undergraduate and residency programs.

METHODS

Search Strategy

The search protocol, including research question, inclusion, and exclusion was developed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines.⁵ The protocol was registered with PROSPERO, No. CRD42016048805. The electronic search was performed using Embase, Medline, ERIC, and CINAHL (no date restriction was used) with the combination of subject headings and free text key words including “accident prevention,” “wounds and injuries,” “occupational-related injuries,” “medical education,” “program,” “course,” “curriculum,” “intervention,” “education,” “PGME,” “UGME,” “residency,” “resident,” “medical student” and “clerkship.” The references of all retrieved articles were manually searched for cross-references.

Exclusion and Inclusion Criteria

We included published, peer-reviewed manuscripts pertaining to injury prevention and control curricula, from its publication date until this review. The search was restricted to populations that contained medical students or medical residents. Only articles written in the English language were selected. Full articles were obtained for all accepted studies and for any studies with incomplete abstracts. The manuscripts were then reviewed in full for eligibility. The study selection was performed by 2 independent reviewers and all disagreements were resolved with the assistance of a third independent reviewer and consensus was obtained.

Data Collection and Extraction

The following data were extracted: (1) observational articles: study population, study objective, percentage of participants without any injury prevention education, percentage of participants endorsing the importance of injury prevention education, and key study findings; (2) interventional articles: study population, intervention, percentage of participants demonstrating knowledge acquisition, percentage of participants demonstrating knowledge retention, and future direction. Extracted data were reviewed by the 3 independent authors.

Quality Evaluation and Risk of Bias Assessment

The authors assessed risk of bias for all eligible studies using the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies⁶ and the Newcastle-Ottawa Scale for Interventional Studies.⁷

RESULTS

Search Results

A Preferred Reporting Items for Systematic Reviews and Meta-Analysis⁵ flow diagram outlining the systematic review process and number of articles retained at each stage of data acquisition is provided below (Fig. 1). The initial literature search generated 1024 articles. The removal of duplicates yielded 818 articles, from which 797 were excluded based on abstract screening. In total, 27 full texts articles were assessed for eligibility for which 8 articles were excluded secondary to not meeting the protocol’s inclusion criteria. In total, 19 studies were available for systematic analysis. No additional articles were determined from other sources including review of references of the included articles.

Study Characteristics and Analyses

The manuscripts included in the systematic review were divided into 3 groups based on study-type:¹ 9 observational studies,² 5 interventional studies and³ 6 position statement. One manuscript was included in both the observational studies and interventional studies group. The study characteristics and data are outlined respectively in the following tables (Tables 1, 2 and 3).

The 9 manuscripts that were included in observational studies surveyed medical students, residents as well as medical schools to determine the presence and extent of injury prevention education (IPE) during medical training. As outlined in Table 1, the majority of participants admitted to no IPE provided during their training. Not all studies documented the percentage of participants that endorsed the importance of IPE. However, of the studies who did, most participants recognized and endorsed the importance of IPE.

Five interventional-type manuscripts were included in this review. The published extracted data demonstrates that modular IPE workshops,^{17,19} IPE course,^{11,20} and longitudinal programs stretched over medical school years¹⁸ all result in successful satisfaction and knowledge acquisition of IPE concepts for medical students.¹⁷ In addition, web-based modules are successful for knowledge retention in general,^{19,20} when compared to a control group.¹¹

All 6 manuscripts included in Table 3 endorse the importance of IPE. An excerpt from each article’s

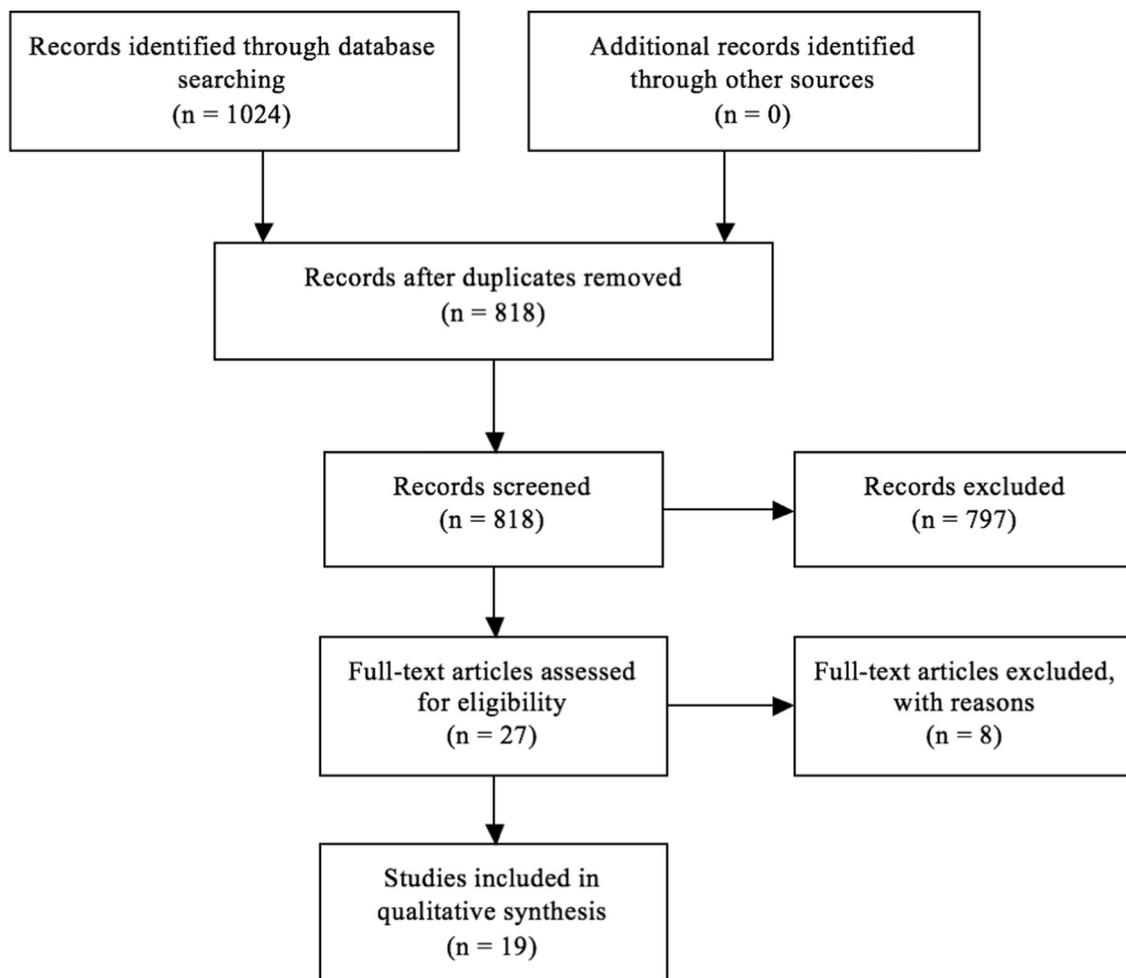


FIGURE. PRISMA flow diagram describing the systematic process of inclusion and exclusion of articles.

position statement was selected as an evidence of their endorsement.

Quality Evaluation

The risk of bias was categorized for each study. The results of bias from the NIH scale are presented in [Table 1](#), and the results from the Ottawa-Newcastle score are presented in [Table 2](#).

DISCUSSION

It is well known that injuries have a substantial burden on our society. They have an effect on every person whether this be in a direct or an indirect way, and result in physical, mental and economical consequences. What is less known, however, is that most of these injuries and their repercussions are entirely predictable and preventable. To this extent, the Committee on Trauma of the American College of Surgeons with its partnerships,

are currently working toward creating a National Action Plan to “achieve zero preventable injury deaths.”²⁷

The development of comprehensive injury prevention strategies and, educational programs for medical students and residents, are paramount to reduce injuries and their burden. In addition to various public health initiatives including the Centre for Disease Control and Prevention, Parachute Canada, and the Canadian Collaborating Centres for Injury Prevention, the importance of prevention within medical education has long been recognized. The Association of American Medical Colleges first sanctioned this point in its report entitled “*Training Future Physicians about Injury*.”²⁸ The panel constructed various learning objectives, outlined 3 categories that are specific to injury prevention education including¹ understanding the epidemiology of injury,² the ability to deliver appropriate clinical care for injuries, and³ understanding injuries in the context of health systems, and outlined learning experiences in support of medical trainee education in injury

TABLE 1. Articles Reporting Injury Prevention Education in Observational Studies

Author (Year)	Study Population	Study Objective	% Participants Without IPE	% Participants IPE Importance	Key Findings	Other	Bias NIH Scale*
Anglin (1997) ⁸	109 MS, 14 interns, 10 Emergency medicine R and other	To determine opinion and exposure to IPE obtained during medical school	70 (MS)	99	Majority of respondents endorse no IP education, believe inadequate time is devoted to IP education and support IPE within medical school curricula.	91% expected to receive IPE during residency training	Fair
Anglin (1996) ⁹	461 Emergency medicine R and graduates	To determine opinion and exposure to IPE during residency	56 (MS)	97	Majority of respondents endorse importance of IPE in EM, inadequate IPE, no IP lectures and do not consistently read journal articles on IP.	28% of the respondents consistently read IP articles 70% endorse greater focus of IPE in their training	Fair
Butler (1996) ¹⁰	635 MS from 6 medical schools	To determine IP-related knowledge, attitudes and IPE exposure during medical school	9 (MSC)	—	Majority of students did not answer factual questions about injury prevention, and control correctly.	Rating of medical problems significantly more important and more preventable than injury problems	Fair
Gittelman (2010) ¹¹	76 Pediatrics R	Longitudinal study to determine efficacy of a 2-week injury prevention course in group of residents as compared to a resident case control group	41.4 (IG, MS) 42.1 (CG, MS) 44.7 (CG, R) 36.4 (CG, R)	—	Increased knowledge in IP knowledge in participating group versus the control group at first year of residency indicating knowledge acquisition, and final residency year indicating greater retention of knowledge	See Table 2	Fair
Leone (2000) ¹²	62 Surgery R	To determine resident knowledge of IP concepts	85.5 (MS, R)	69	Residents are poorly educated regarding basic IP concepts. Majority of residents endorsed formal instruction as necessary during their residency training.	Mean 34% correct answers with no correlation seen with medical school attended, previous IPE, residency training level, or trauma service experience.	Poor
Villaveces (2005) ¹³	88 Medical schools	To determine and characterize IPE in medical school curriculums	60 (MSC)	—	Majority of medical schools worldwide do not cover basic IP concepts.	IPE concepts less frequently taught in Middle Eastern and African universities compared with other regions	Poor

(continued on next page)

TABLE 1. (Continued)

Author (Year)	Study Population	Study Objective	% Participants Without IPE	% Participants IPE Importance	Key Findings	Other	Bias NIH Scale*
Wright (1997) ¹⁴	135 Pediatrics R	To determine residents' IPE during residency, and counselling practices on IP for their patients	—	—	All residents reported some IPE topics during their residency in a variety of settings, mostly notable ambulatory clinics. Article did not discuss IP concept-related education	All residents identified one topic routinely counselled which was most likely to be a topic for which they received instruction, had pre-printed materials and familiar with educational aids. Most identified barriers were lack of time during visit and lack of information about the topic.	Fair
Wright (1998) ¹⁵	87 Medical schools	To determine availability and characterize IPE during medical school	52.9 (MSC)	—	Majority do not cover IPE in their curricula and do not offer non-clinical electives on IP subjects.	Medical schools with trauma centres are 4 times more likely to include IPE in their curriculum. The majority (77%) of medical schools surveyed reported requirement of IPE, however were no more likely to include IPE in their curriculum as compared to medical schools that did not endorse this requirement.	Fair
Zavoski (1996) ¹⁶	140 Program directors	To determine IPE provided to residents as compared to disease prevention	—	—	IP is less frequently taught than disease prevention in residency programs.	Residency programs addressed only 59% of IP-related topics. Article did not discuss IP concept-related education.	Good

MS, medical student; R, resident; MSC, medical school; IG, intervention group; CG, control group.

*NIH Quality Assessment Tool used to judge each study to show evidence of: (1) minimal bias (good), (2) some bias (fair), or (3) significant risk of bias (poor).

TABLE 2. Articles Reporting Injury Prevention Education Curricular Interventions

Author (Year)	Study Type	Study Population	Intervention	% Knowledge Acquisition	% Knowledge Retention	Other	Newcastle-Ottawa Bias Scale*
Aiken (2006) ¹⁷	C	125 MS	Modular IP interactive workshop	Program evaluation overall 4.5-4.8 on a scale of 0-5	NA	Overall participant satisfaction	NA
Gittelman (2010) ¹¹	CCS	76 R	Two-week injury prevention course	Intervention group test scores significantly higher than control group after first year of residency	Intervention group test scores significantly higher than control group at the completion of residency, and as compared to baseline.	See Table 1	2
Graham (2010) ¹⁸	C	124 MS	Longitudinal IP curriculum	Mean score 90.3% on performance evaluation (year 1) 92% of students passed end of clerkship OSCE home safety station 97% of students passed end of clerkship OSCE child safety seat use	NA	Overall participant satisfaction	NA
Sangvai (2012) ¹⁹	RCT	57 R	Interactive versus noninteractive web-based module	Control group post test scores (mean = 90.36 +/- 7.32) significantly higher than intervention group (mean = 60.0 +/- 11.06)	Post-test scores lower than immediate post-test scores Post-test scores higher than pretest scores No statistical difference between groups	Residents had positive attitude towards IPE Direct observation of resident interaction with patient and families resulted in no change in clinical practice	7
Webb (2011) ²⁰	CCS	26 MS	Trauma and injury course	6% increase in knowledge gain (not statistically significant)	NA	Overall participant satisfaction	1

C, cohort; CCS, case control study; RCT, randomized control trial; MS, medical students; R, residents.

*Newcastle-Ottawa Scale (NOS) used to assess quality of nonrandomized studies while considering: (1) the selection of the study groups (maximum 4 points); the comparability of the groups (maximum 1 point); and the ascertainment of either the exposure or outcome of interest (maximum of 3 points). A maximum of 9 points may be awarded.

TABLE 3. Articles Reporting Injury Prevention Education Related Position Statements

Author (Year)	Institution	Author Position Statement
Anonymous (2008) ²¹	NA	"Emergency physicians should integrate injury prevention and control into their practices as they interact in the following settings: (1) Emergency medical services (. . .), (2) Emergency department (. . .), (3) Medical schools/Hospitals (. . .), (4) Community."
Garrettson (2012) ²²	Injury Prevention Research Center, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA; Department of Epidemiology, University of Colorado-Anschutz Medical Campus, Aurora, Colorado, USA; School of Public Health, University of Washington, Seattle, Washington, USA; Occupational and Environmental Health, University of Iowa, Iowa City, Iowa, USA	"Schools of public health, medicine, nursing, and other health disciplines should incorporate injury content into the curriculum for all students."
Hargarten (1986) ²³	St Luke's Hospital, Milwaukee, Wisconsin	"Our specialty (injury prevention and control) has achieved board recognition and is now becoming more accepted in medical school curriculums. Students must not only possess clinical skills to properly treat patients but also must have the knowledge and skills to prevent or lessen the severity of those injuries."
Martinez (1998) ²⁴	Administrator, National Highway Traffic Safety Administration, U.S. Department of Transportation, Washington, D.C.	"Ultimately, all of us in medicine must not only learn to look at what comes through the hospital doors but also learn to go outside those doors to find out how to more effectively deal with and prevent injuries in our communities."
Phelan (2007) ²⁵	Department of Emergency Medicine, Medical College of Wisconsin, Milwaukee, Wisconsin, USA; Department of Academic Affairs, Medical College of Wisconsin, Milwaukee, Wisconsin, USA; Department of General Surgery, Indiana University, Indianapolis, Indiana, USA; Injury Research Center, Medical College of Wisconsin, Milwaukee, Wisconsin, USA	"Curriculum change is one of many strategies and initiatives that must be implemented if we are to deal with the burden of injury. Showing how injury can be incorporated into multiple disciplines and specialties is the power behind this curriculum approach."
Yoshii (2010) ²⁶	University of California, Irvine School of Medicine, Irvine, CA Yale University School of Medicine, Department of Emergency Medicine, New Haven, CT	"Future and current physicians have a vital role in prevention of injury. They must be involved in developing strategies, practices, and behaviors that promote safety and health in patients as well as the community. We need to incorporate these principles into the medical school curriculum, so that all medical students have a basic understanding of injury prevention and control, which parallels their knowledge of other major health conditions."

prevention. In addition, the Medical Council of Canada licensing exam (required by all practicing medical doctors in Canada) objectives include requisite of knowledge of public health systems in Canada including functions related to injury prevention.⁴

In our systematic review, we identified: (a) 9 observational studies that surveyed medical students, medical residents, and medical school directors to determine opinion and exposure to injury prevention education (Table 1); (b) 5 studies reporting injury prevention education curricular interventions (Table 2); and, (c) 6 articles featuring position statements endorsing the importance of injury prevention and control education amongst medical students and residents (Table 3).

Observational Studies: Despite attention being drawn for the necessity of educational programs for medical trainees, the limited number of published curricula may indirectly show that there is limited integration of injury prevention education amongst medical and resident curriculums. This systematic review identified 9 observational studies that surveyed medical students, medical residents, and medical school directors to determine opinion and exposure to injury prevention education (Table 1). Anglin et al. surveyed 461 emergency medicine residents and graduates of which 97% of respondents endorsed pertinence of injury prevention within their field of practice, and 70% endorsed the need for greater focus within residency.⁸ Only 44% of respondents endorsed access to lectures on injury prevention, and 28% engaged in self-study by reading journal articles. The same authors went on to survey 154 emergency medicine resident candidates (medical students, interns, and residents in other specialties) to determine their exposure to injury prevention education in medical school.⁹ Seventy percent of respondents denied lectures on injury prevention during medical school, while 90% of those had received formal training on individual prevention topics including most commonly: suicide, child abuse, poisoning, rape, and alcohol-related injuries. Butler et al. surveyed 635 fourth-year medical students for prior exposure to IPE, as well as tested participants on injury prevention knowledge using, and attitude toward injury as a health problem.¹⁰ The average score of the administered 15-multiple choice and ranking questionnaire was low at 47% (range 9-94%). Attitudes were assessed using 5-point Likert-scaled items, which revealed that participants rated medical problems as more important (mean difference of 0.72, CI 0.67-0.78), more preventable (mean difference 0.18 CI 0.14-0.22) than injury problems and more comfort in addressing medical risk factors as opposed to injury topics with patients (mean difference 0.59, CI 0.54-0.64). Wright and Litaker surveyed 124 American medical schools of which 47.1% of respondents include IPE within their

curriculum and 29.9% offered nonclinical electives in IPE.¹⁵ Villaveces et al. surveyed 82 medical schools across 31 countries (3 Africa, 12 America, 16 Asia/Oceania, 36 Europe, 5 Middle East) on their status of injury prevention education and found that 60% of schools did not cover basic concepts.¹³ The authors noted frequency of teaching specific injury topics in some pertinent geographical areas, i.e. road traffic injuries in Asia. The survey by Gittelman et al. of 76 pediatric residents revealed an average of 87.3% with minimal exposure to IPE.¹¹ Wright et al. also surveyed chief pediatric residents which all endorsed education in injury prevention most often in ambulatory clinics, and residents were mostly likely to counsel patients on those same topics.¹⁴ Zavoski et al. surveyed pediatric residency program directors for 17 injury prevention topics and found that 10 topics were covered by 80% of the programs excluding smoke detector use, safety fences around swimming pools, sports-enhancing substances, helmet use, firearm safe storage, and athlete counseling of stretching and safe play.¹⁶ In a study by Leone and Hammond, 62 general surgery residents scored an average of 35% on a knowledge test of injury prevention concepts, of which 9 reported prior education.¹² In Summary, the majority of medical students, emergency medicine, pediatric general surgery residents, and medical school director participants admitted to minimal IPE provided during their training and endorsed its' importance. The studies that administered tests showed that the average of respondents scored below the 50% mark. Despite the heterogenicity in the participants and results reported in the above studies, it is clear that medical student and resident knowledge in injury prevention is lacking, and advancement in injury prevention education curriculum is required.

Interventional Studies: Regarding articles that outline curriculum intervention initiatives (Table 2), all 5 studies reported various forms of injury prevention education curricula. Among these: a cohort study that included a 2 to 3-hour modular workshop¹⁷, a case-control study with a 2-week course,¹¹ a cohort study regarding a multidisciplinary course in injury prevention as a fourth year selective,²⁰ a randomized control trial that compared interactive versus noninteractive web-based modules¹⁹ and a cohort study with a longitudinal program over all medical school years.¹⁸ All 5 studies demonstrated knowledge acquisition in injury prevention and control concepts amongst their participants. Participants who partook of the 2-week course were compared against a control group, and it was found that their knowledge acquisition and retention was unsurprisingly higher.¹¹ Furthermore, students involved in the multidisciplinary course that exposed them to oral presentations, small-group discussions, etc., demonstrated positive outcomes such as: acknowledgement of preventable nature of

most injuries, its recognition as a disease, and their role to play.²⁰ In regards to effective and efficient ways to add injury prevention material to the already dense medical curriculum; Graham et al. mention that using a longitudinal approach may be the most appropriate option.¹⁸ Of note, the randomized trial concluded that, even though the web-based modules improved knowledge acquisition, they were insufficient to change clinical practice; therefore, supporting the need for better educational strategies.¹⁹ A limitation of note to is that all studies reported participant knowledge by asking participants to complete different study tests that cannot be directly compared to each other.

Position statements: Institutions and individuals that delivered these position statements (Table 3) are from: ¹The American College of Emergency Physicians, ²Injury prevention research offices, ³Department of Public Health, ⁴Department of Epidemiology, ⁵Emergency Medicine Physicians and ⁶General Surgeons. All 6 statements stress that injury prevention concepts should be incorporated into medical school curricula. Furthermore, Yoshii and Martinez, highlight the importance of not only providing injury prevention training to all physicians but to also extend prevention efforts to the community.^{25,26} Moreover, Hargarten mentions that, on top of knowing how to treat injuries, it is also important to know how to prevent them.²³

Physicians are often a patient's first point of contact with the medical system preceding and following injury. Injury prevention-related topics in medical education have mostly been reported by those in the department of emergency medicine and pediatrics. Recently, surgeons have been added to the repertoire of specialties that endorse importance of injury prevention education in their curriculum.²⁹ Surgeons have the unique opportunity of caring for a large number of trauma patients. Alongside the multidisciplinary team, surgeons work to improve the trauma patient's determinants of health that may directly be related to circumstances surrounding their initial trauma. There is a golden opportunity to take leadership and counsel our patients on injuries and future injury prevention. Leone et al. unfortunately found that general surgery residents are poorly educated on injury prevention.¹² A comprehensive educational program targeted to surgical residents would have significant impact in the management of trauma patients.

Furthermore, injuries are relevant to all medical specialties, and should not be limited to the former areas. Whether this be a family physician counseling a new parent on seatbelt safety, a general surgeon performing a laparotomy in the operating room for a gunshot wound, emergency medicine inserting a chest tube on a motor vehicle collision patient in the realms of a trauma bay, a

medical specialist who is consulted on fall risk reduction, or a physiatrist managing a patient's rehabilitation following traumatic spinal cord injury, numerous medical specialties' practices are comprised of patients pre- or postinjury in one form or another. In terms of creating an educational program to capture most specialties, it seems that a comprehensive education on injury prevention principles targeted toward medical students would be an appropriate starting point, with limited and reformed scope of injury prevention education programs created with residents of surgical and medical specialties in mind.

Despite that this research shows that existing online and classroom-based modules are effective for injury prevention education, there is currently no published data regarding consistent implementation of such curricula within medical student and resident training programs. Increasing the knowledge and awareness of injury prevention and control principles amongst medical trainees by integrating an injury prevention education program within the existing curriculum will ultimately improve primary prevention activities within future physicians, with the ultimate goal of improving the international burden of injuries.

The limitations of this review include the heterogeneity of the included manuscripts with regards to patient population studied, methods, and reported results. The lack in methods and reporting consistency account for difficulty with any higher level quantitative analysis of the included studies. In addition, no fellowship programs were included in the review, notably the Trauma and Acute Care Fellowship as well as postgraduate programs which are designed to certainly include education in injury prevention and control. Furthermore, only published manuscripts were included in this review, which may not be reflective of existing medical school and residency programs that may not be published in the literature. Further studies should include a survey of medical schools and residency programs in order to capture the extent and depth of existing curricula, and identify more specific gaps.

Given that physicians carry the responsibility in teaching and informing injured patients on the prevention and control of injuries, and that most of these injuries are predictable and preventable, including dedicated core concepts of injury prevention into the curriculum of undergraduate and residency medical education programs, would be crucial and possibly reduce the burden of injury on the society.

AUTHOR CONTRIBUTION

E.S. contributed to literature search, study design, data collection, data interpretation, and article writing. S.F.

contributed to study design, data interpretation, and critical revision of the article. J.L. contributed to study design, data interpretation, and critical revision of the article.

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SUPPLEMENTARY DATA

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.jsurg.2018.10.009>.