AN EVALUATION OF THE MEMORANDUM TO REQUIRE CONCUSSION EDUCATION IN ONTARIO SCHOOLS

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Abstract

Introduction: Concussion is a type of traumatic brain injury that is common among children and youth. Concussions can cause multiple short-term problems but can also lead to a number of serious long-term consequences. Recent evidence suggests that concussions are becoming more common, especially in school-aged children. On March 19, 2014, the Ministry of Education of Ontario has issued a Policy/Program Memorandum (PPM) that prompts school boards to create and sustain a concussion policy. The effectiveness of the PPM has not yet been studied. **Purpose:** The primary objective of this study is to evaluate the effectiveness of the PPM by analyzing the different concussion prevention programs introduced in response to the PPM by the school boards. **Methods:** This will be a three-part study. The first part of the study will be a qualitative analysis of the concussion programs using questionnaire distributed to school boards. The second study will be a pre-post analysis of the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) data to establish whether or not the policies had an effect on concussion incidence in an emergency department setting. The third study will survey high school physical education teachers, coaches and/or trainers about concussion policies and the PPM. **Results:** All 72 Ontario public school boards had a concussion protocol on their board's website by June 2016. The analysis of 8 years of CHIRPP data on concussions generally, and school based concussions specifically, revealed that the number of diagnosed concussions increased significantly subsequent to the introduction of PPM 158 while the number of suspected concussions decreased. For the final study, twelve teachers responded to the survey. All were aware of their board's concussion policy; 83% reported that they had received training and/or relevant education, 75% had a trained individual present at every game/practice, 83% noticed a difference in parental involvement, 100% reported changes in the way return-to-play (RTP) and return-to-learn (RTL) protocols are implemented at the schools and 92% agreed that there was a need for a government-mandated concussion law.

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Glossary/Abbreviations List

AAFP	American Academy of Family Physicians
AAN	American Academy of Neurology
AANS	American Association of Neurological Surgeons
AAOS	American Academy of Orthopaedic Surgeons
ABC	Airway, Breathing, Circulation
ACE	Acute Concussion Evaluation
ACSM	American College of Sports Medicine
ADP	Adenosine Diphosphate
AE	Athlete Exposure
ARL	Army Research Laboratory
ASTM	American Society for Testing and Materials
AT	Athletic Therapist/Athletic Trainer
ATP	Adenosine Triphosphate
BESS	Balance Error Scoring System
CAT/CT Scan	Computerized Axial Tomography/Computerized Tomography Scan
CATCH	Canadian Assessment of Tomography for Childhood Head Injury
CATT	Concussion Awareness Training Tool
CCC	Canadian Concussion Collaborative
CIHI	Canadian Institute for Health Information
CDC	Centers for Disease Control and Prevention
CHIRPP	Canadian Hospitals Injury Reporting and Prevention Program
CNI	Chronic Neurocognitive Impairments
CNP	Computerized Neuropsychological Testing
CPSC	Consumer Product Safety Commission
CSI	Concussion Symptom Inventory
CTE	Chronic Traumatic Encephalopathy
DND	Department of National Defense
DTI	Diffusion Tensor Imaging
ED/ER	Emergency Department/Emergency Room
EEG	Electroencephalogram
FIFA	International Federation of Association Football
GCS	Glasgow Coma Scale
HBI	Health and Behavior Inventory
HPE	Health and Physical Education
IIHF	International Ice Hockey Federation
IMPACT	Immediate Post-Concussion Assessment and Cognitive Testing
KT	Knowledge Translation

LEA	Local Education Agency
LOC	Loss of Consciousness
MACE	Military Acute Concussion Evaluation
MHI	Mild Head Injury
MLB	Major League Baseball
MRI/fMRI	Magnetic Resonance Imaging/Functional Magnetic Resonance Imaging
MSE	Mechatronic Systems Engineering
NBA	National Basketball Association
NCAA	National College Athletic Association
NEISS	National Electronic Injury Surveillance System
NFL	National Football League
NHL	National Hockey League
NISPP	National Injury Surveillance and Prevention Program
OPHEA	Ontario Physical and Health Education Association
OSBIE	Ontario School Board' Insurance Exchange
PCS	Post-Concussion Syndrome
PCSS	Post-Concussion Symptom Scale
PHU	Public Health Unit
PPM	Policy/Program Memorandum
RPCSQ	Rivermead Post-Concussion Symptoms Questionnaire
PTA	Post-Traumatic Amnesia
$\underline{RT_{clin}}$	Clinical Reaction Time Test
RTL	Return to Learn
RTP	Return to Play
SAC	Standardized Assessment of Concussion
SCAT	Sport Concussion Assessment Tool
SIS	Second-Impact Syndrome
SFU	Simon Fraser University
SOT	Sensory Organization Test
TBI/mTBI	Traumatic Brain Injury/mild Traumatic Brain Injury
TDSB	Toronto District School Board
UBC	University of British Columbia

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Foreword

Concussion is a common type of traumatic brain injury (TBI) that is often the result of a blow, bump or another physical force applied to the head or the body that can change the way the brain functions. While most of these changes are temporary, a concussion can have multiple long-lasting adverse effects on the overall health of the injured individual. The force of the hit causes the brain to shake or “rattle” within the skull, thus causing a concussion. More specifically, most concussions can result from 3 possible scenarios: the effect of the brain striking the inner skull (known as the coup), the deceleration of the head that causes the brain to hit the opposite side of the skull (the countercoup) or the head rapidly rotating from one side to another causing shearing and straining of brain tissues (known as a rotational concussion).

It is difficult to identify the origin and the first use of the term "concussion" but historians believe that it was first recognized by the Persian physician Rhazes in the 10th century A.D [1]. The meaning of the word is believed to come from the Latin *"concuss"* or "*concutere"* - to shake violently [2]. The definition has constantly changed throughout the centuries, with confusion in terminology remaining a staple even in modern-day literature. Despite heavy, prolonged and multi-disciplinary research on the topic, the neuropathology and pathophysiology of concussion remain a mystery, leading to a plethora of obscure hypotheses, beliefs and 'facts' [1]. In all cases, the delicate neural pathways of the brain are damaged, resulting in neurological and functional disturbances. But these disturbances are also present in other brain injuries, so how can the injury or condition known as concussion be singled out and diagnosed?

The word concussion has been applied to many different types of brain injuries and continues to be ill defined by modern researchers. It has been used to explain the post-concussion

symptoms, the actual injury itself, the prolonged after-effects of the condition, the pathophysiological mechanisms, and other injury-to-the-head-related abnormalities [3-4]. Other terms may be used interchangeably with concussion, including mild traumatic brain injury (MTBI), mild head injury (MHI), minor head trauma, or just plain head injury. However, recent research suggests that labeling concussion as something else may convey the wrong message to parents, and affect treatment procedures and outcomes [5-6]. The American Medical Society for Sports Medicine has recently concluded that "while all concussions are MTBIs, not all MTBIs are concussions", arguing that all of the above-mentioned concussion synonyms should *NOT* be used interchangeably when describing or diagnosing concussion [7]. Because most people don't suffer any long-term, post-concussion problems, the condition is often referred to as a "mild" injury, with no clear gradation or explanation as to what the term actually implies or what it encompasses [8]. Despite all of the research and interest in concussion, it remains a puzzling injury compounded by a lot of challenges around its evaluation, management, recovery and particularly, prevention.

Chapter 1. Introduction. Literature Review

There is very little research available on the assessment and evaluation of concussion polices, protocols or Policy/Program Memorandums (PPM), particularly in youth. Primarily this is because most of these policies are very recent, that is, they are unlikely to have immediate effects and need time and persistence to be fully implemented, understood, evaluated and accepted. While there are some studies that have looked at the evaluation of various concussion surveillance tools and programs, they have not used the same measuring criteria and are very different in terms of their methodological approach [9-11]. The main difference between a PPM and any other federal policy is that the PPM is not a law but is essentially an outline or a guide of expectations to be followed to achieve the desired outcome. In addition to this, many studies when evaluating policies only focus on the change in reported concussion rates and do not consider other aspects of the policy (education, return to play (RTP)/ return to learn (RTL) practices, injury instance protocol, etc.). This literature review will focus on a broad overview of concussion prevention-related research with the goal of identifying gaps or problematic areas in this field with the main focus being youth, school-related concussion prevention strategies. Any concussion policy is a complex and multi-level process that involves a lot of individuals and systems. It is not enough to create a virtual or hardcopy of a policy and post it around the schools. To be actually usable and effective, it needs to be heard of, implemented, and of course, evaluated at a later date to see if it has had any effect on concussion incidence, recovery, or other aspects of the issue [12-13].

1.1 Looking at school compliance

As of February 2017 there is no concussion legislation in Canada at either the provincial or federal level. As will be further discussed in **Chapter 1.7**, every legislation, policy and bill that has been proposed has either been met with criticism/rebuttal or did not proceed past the first stages of the legislative process. This is surprising, especially if one considers the many U.S. state laws that have been introduced over the past decade and a heightened media focus on elite athlete injuries. The only known attempt at evaluating concussion policy in Canada is the recent study by Hachem et al. (2016) which looked at concussion policy implementation at the Toronto District School Board's (TDSB) schools following the introduction of the PPM # 158 [9]. Using an electronic survey approach, the authors contacted 109 high school principals in the TDSB to find out whether they have implemented student concussion education programs and concussion management protocols. About a third of the principals responded, and the general findings were that almost all schools provided concussion education to students (92%), mostly via physical education classes, about 92% and 77% of the schools had return to play and return to learn protocols respectively [9]. However, less than 50% of all schools provided any sort of concussion education to parents, pointing out this fact as an area in need of improvement.

In a large U.S. study Baugh and Kroshus et al. (2014) examined compliance with NCAA concussion policy by surveying coaches, clinicians and compliance officers at NCAA member schools [10]. This was done after the NCAA instituted mandatory concussion regulations in 2010. The researchers concluded that most schools (82%) had a concussion management plan in place. Most of the schools considered their protocol to be effective, but only about 70% had an annual education component in their policy. In addition, most of the respondents admitted a need

for further improvement, citing education of coaches, education of athletes and more staffing in the sports medicine department as the most relevant areas in need of development [10]. The effectiveness of these protocols is yet to be evaluated and it is not clear to what degree implantation has been accomplished.

One problem that often comes up when discussing the effects of legislation in the US is that they only apply to public schools. There are many private schools, athlete associations and sports organizations that are not required to comply with the law. This is especially important when analyzing U.S.-based studies, considering that most of these private organizations have their own programs and protocols. One group of researchers led by Morrissey et al., looked at school compliance rate after the establishment of the 2010 Rhode Island law to curb concussions in youth sports, schools and sports organizations. They discovered that many private schools outside the league (Rhode Island Interscholastic League), and community organizations do not follow the recommended regulations and in some cases ignore new RTP regulations [11].

1.2 Evaluating concussion prevalence pre-post-/legislation or law

A recent retrospective study by Trojian et al. (2015), looked at sport-related concussions (SRCs) treated in emergency departments (ED) before and after the Connecticut Public Act (CT PA) 10-62 to determine if the law had an effect on the frequency of SRCs-related ED visits [14]. The authors discovered a very interesting fact; while the number of ED visits per month for all pediatric patients that were treated and released did not significantly vary by year, the number of concussions for high school students was significantly different (more than doubled) between all of the years prior to the state policy compared to the post-policy years [14]. This study was

considered to be an important precursor as to what this thesis might expect to find in its own, similar study of pre-post concussion ED trends in Ontario**.**

Another study was conducted in Washington State by Bompadre et al. (2014) to determine the effect of the Lystedt law, the first nation-wide concussion law in the US, on injury and concussion documentation in Seattle public high schools [15]. They discovered that the rate of documented concussions in the 2 years after the introduction of the Lystedt Law (discussed in **Chapter 1.6.1**) was more than 2 times the rate in the 2 years before the law. In addition, they noticed that the rate for female concussions was almost double that of the males, but were unable to explain this finding, pointing out that due to the mandatory reporting nature of the Law, the often-cited "females report more concussions" explanation is not applicable in this case [15].

Dompier and colleagues (2015) have looked at changes in the rates of concussion diagnosis at three National Collegiate Athletic Association (NCAA) Division I football programs before and after the NCAA's rules were implemented [16]. While not a state-level law, NCAA certified schools must adhere to the protocols and this makes these laws arguably more effective than state-wide or nation-wide legislation. The authors found a significant change in rates of diagnosis following the rule change, indicating that the policy may be achieving one of its intended goals, but cautioned that it might also be due to other factors such a nation-wide increase in concussion awareness [16-17].

Another research team lead by LaRoche (2016) looked at the extent to which the 2012 Wisconsin state concussion law affected reporting in 2013 [18]. Analyzing information on almost 800 Wisconsin and Milwaukee-area high school and college athletes, the authors found a significant, 55.1% increase in concussion reporting. They also interviewed the athletes and found that having the law there made them more likely to report a concussion, possibly suggesting that

not only do the laws help raise awareness but they also contribute to other important factors. In addition the researchers found that many athletes that did not report concussions were aware of general concussion management policies (i.e. rules about RTP protocol) even if they did not know or chose to ignore the state law [18].

In 2013, Kilcoyne et al. analyzed 3 collegiate Division I military academy football teams to determine if the number of concussions changed after the NCAA published new guidelines for the diagnosis and treatment of concussions in student athletes (2010). They looked at combined concussion incidence rates (measured as athletic exposures) before and after introduction of the new guidelines. Similar to above studies, the authors discovered a two-fold increase in the combined incidence rate of concussions for the 2010-2011 season, suggesting that the policies were possibly instrumental in improving concussion diagnosis [19].

Finally, one large study that analyzed the effects of state legislation on health care utilization for children with concussion discovered an interesting trend that started even before the introduction of the state laws. The authors noticed an ongoing upward trend in increased health care utilization rates demonstrated before enactment of the first state law in 2009 [20]. The rate of treated concussions rose from 4.98 per 1000 children (annualized rate) in early 2006 to 7.15 per 1000 children in the 2008-2009 school year, and almost doubled in 2011-2012, at 13.27 per 1000 children [20]. This translated to a 92% increase in concussion-related costs that was also present, albeit to a lesser degree in states without legislation. The authors conclude that not only did concussion legislation raise overall injury awareness, but it also contributed to an increase in medical attention devoted to concussive injuries in children.

1.3 Relationships between Health and Physical Education teachers/coaches and concussion policy

The problem with *all* the state laws is that none of them were designed or implemented with the goal of concussion prevention. In an analysis of state-wide youth TBI laws, Harvey Hosea (2013) found that no state's youth sports TBI law focuses on primary prevention, and instead only mention steps to identify and respond to these injuries and avoid multiple TBIs [21]. The science and research is not always there and fast, "unprecedented in the medical field," implementation of these laws only compounds the problems [20]. Less than half of these laws require the coaches to receive concussion education and training [22]. One group of researchers discovered that only 21 states match the gold standard set by Washington state's Lystedt law, and nearly all lack any consequences for schools or teams that don't comply with the law [23].

The best way to understand whether or not the concussion laws are having an effect is to analyze and interview health and physical education teachers and school coaches- the individuals that are actually implementing the policy at the so-called ground level. One of the first attempts at analyzing the work of coaches was a study by Covassin, Elbin and Sarmiento (2012). This study looked at the perceptions of youth sport coaches who had received the Centers for Disease Control and Prevention's (CDC's) "Heads Up: Concussion in Youth Sports" booklet on preventing, recognizing, and responding to concussions [24]. Coaches that had the CDC's materials for at least 6 months were approached with a survey that had questions pertaining to demographics, awareness of sports-related concussion, and the usefulness of the provided information booklet. The results of the study were that about 75% of all respondents reported being better able to identify athletes who may have a concussion, with 50% reported having

learned something new about concussion after reviewing the materials, 63% now viewed concussions in a more serious manner, while 72% of coaches reported that they are now educating others on concussion [24]. While the study was self-reported and inherits the associated bias, it nevertheless demonstrated that not only can something be done to improve concussion awareness but that coaches can play a critical role in establishing and enforcing new research, guidelines and regulations [25].

Research by Chrisman et al. (2014), evaluated the variation in concussion education and knowledge in the context of the Washington State Law. Even though 3 years had passed (at the time of the study) since the introduction of this law, little is known about its implementation and/or effectiveness. The authors used a survey approach to analyze the extent of concussion education for coaches, athletes, and parents as well as coaches' concussion knowledge and experience [26]. Almost all coaches answered concussion knowledge questions correctly, and most of them have received some sort of concussion training (whether videos, training, slide presentations, tests, etc.). The situation was much worse in the athlete and parent responses. Only a third of all athletes received concussion education, and so did only 16.2% of the parents. The authors did not find any differences in education for coaches, parents and athletes, and location (rural vs. urban) also did not play a role. For an unexplained reason, but possibly due to differences in sport culture, football players received more extensive concussion education than soccer players [26]. This study demonstrated that while the majority of coaches have substantial concussion education and have good general concussion knowledge, the other "parties" involved are fairing much worse and require additional education.

A similar finding was reported in an analysis of concussion law compliance in rural Idaho (U.S.). Faure, Moffit & Schiess (2015) looked at the challenges faced by a rural western state

when trying to implement concussion policies. First the authors confirmed the fact that educational awareness has led to an increase in diagnosed concussions. Second, while there was formal education of teachers and coaches, the same could not be said of parents and student-athletes who did not receive any education despite it being mandated by law. The authors point out that the absence of medical personnel, and lack of financial resources, especially in small communities hindered compliance efforts and led to an overall, less effective policy [27].

Another study in the State of Washington by Shenouda et al. (2012), assessed concussion knowledge (such as RTP guidelines) of youth soccer athletes, parents, coaches and officials. They discovered that in general, concussion knowledge was high; about 90-95% of all respondents knew that concussions were serious, that loss of consciousness was very rare, could identify neurological manifestations of concussion and were aware that medical clearance was needed before an injured athlete could return to the game [28]. About 85% of all respondents were aware of the state law (Lystedt Law). In short, the awareness is there, and the authors propose that further research is needed in the areas of equipment and practice guidelines.

Rivara et al. (2014), conducted a study with high school football and girls' soccer athletes playing in fall 2012 and their coaches and parents in 20 urban or rural high schools in Washington State [29]. The researchers wanted to know 3 things: the incidence of sports-related concussions, the proportion of athletes that continue to play even with concussion symptoms, and the effect of the type/ modality of coach education on the likelihood of athletes reporting symptoms to the coach or playing with symptoms. They measured concussion incidence in terms of concussions per 1000 athlete-exposures (AEs). The study discovered some alarming trends. First, concussion incidence was almost 11% in both soccer and football, a much higher number than reported in other studies that have been discussed in this report. Further 69% of injured

athletes reported playing with symptoms, and 40% reported that their coach was not even aware of their concussion. [29] These alarming numbers led the authors to conclude that any future changes in athlete attitudes on reporting concussions will likely not be accomplished through legislation alone, highlighting the need for additional measures. Other research has shown that the availability of evidence-informed policies does not guarantee that they will be easily accepted and implemented. Improved dissemination and adoption of guidelines needs to start with the end-user and requires a multi-disciplinary approach [30].

1.4 Challenges and Issues in Concussion Implementation: the Need for Further Research

The previous chapter paints an exciting, successful and optimistic picture in the development of concussion policy in the U.S. Despite the apparent progress made in state concussion legislation, there are still major hurdles to overcome. The exact stipulations of these laws vary among states, the individuals allowed to evaluate and clear an athlete for return to play differ greatly, and there is a big discrepancy in the education requirements for coaches and other athletic staff. Legislation has historically proven effective in injury prevention, and those working with youth athletes hope that concussion legislation will be similarly successful [31]. True incidence rates of concussion are unknown. A combination of high-profile athlete's concussions (Sidney Crosby 2010, James Harden 2012, Brianna Scurry 2010, Kevin Kolb 2013, Thibaut Courtois 2014, etc.), concussion-related lawsuits and increased implementation of concussion regulations and guidelines has contributed to an enhanced public concussion alertness and improved knowledge and understanding of this condition. Simply put, more concussions are being diagnosed and "noticed". But there is still a significant gap between

knowing about the injuries and actually preventing them. Successful implementation is a critical factor in any injury prevention program[32].

There are multiple factors to consider when looking at factors that can help facilitate or improve implementation. Existing partnerships, procedures, and resources; centralized implementation authority; prior related efforts; and involvement in the policymaking process by those now charged with implementation can all help guide ongoing efforts to reduce the harm of sports-related traumatic brain injury [33]. The standardization of efficient concussion education programs needs to be made a priority if one hopes to accurately and effectively inform all members of the athletic, academic, and medical communities about the importance and urgency of concussion [34]. Everyone needs to be "on the same page" in order to ensure accuracy of diagnosis, knowledge of recent medical developments/ research as well as prompt and efficient medical response. Incentives and punitive measures also need to be considered as important factors in compliance with legislation and can help change the way people view this issue [31].

Steps also have to be taken to improve knowledge translation (KT) practices. Efficient dissemination strategies need to be put in place to ensure that all parties (coaches, teachers, athletes, parents) have up-to-date information and access to the latest concussion management advances and tools. The current technological advances, on-the-go internet access and ease of information sharing can greatly enhance and expedite the KT process and should in theory, ensure swift, evidence-informed action. There are a lot of electronic apps and other commercially available concussion tools and applications. These help in disseminating concussion info and raise public awareness but, there are no empirical studies or reviews that have evaluated these tools and their realistic usefulness and validity.

Just by knowing something is bad or that it could have dire consequences for one's health or general well being is no guarantee that it will alter their attitudes towards it [35-36]. There are multiple examples to support this. Wearing a helmet (for bicycles, motorcycles or skiing), for instance is a well known "protective factor", that has been proven to prevent many types of head-related injuries, but people still choose not to wear one. Research needs to look at what it would take to translate concussion education interventions into long-term changes in behavior among athletes, coaches and parents. Some studies suggest that the most successful education efforts have taken steps to ensure materials are user-friendly, interactive, utilize more than one modality to present information and are embedded in mandated training programs or support legislation [37]. Education has to be provided using empirically sound and fact-driven methodologies, theory or conceptual ideas alone are not enough. Diverse, psychosocial frameworks have shown promise in convincing the target population to 'buy in' into the idea and subsequently alter their behavior [37]. These strategies and tools can be used to enhance future concussion policies and legislation. Stakeholders and all others involved should understand, appreciate and accept these policies and this will not help in implementation but it will hopefully one day reduce the rate of youth concussion, increase sports participation, and just make sports safer in general.

1.5 What can be done to reduce concussions?

The only known "cure" for concussion is prevention. It is the first and most important step when addressing the current youth injury crisis. A lot of research over the years has focused on various forms of protective equipment, specifically mouthguards and helmets. Unfortunately, no clinical evidence exists that either of those devices can prevent concussion [13]. Mouthguards

have been shown to prevent dental and orofacial injury, while helmets are of course essential in preventing other forms of head injury (e.g., skull fracture) in various sports (e.g. skiing, biking), but laboratory and field tests show no effect on concussions [13, 38-40]. It has also been suggested that the way to reduce concussion is to focus more on rules, education and training. For instance, some suggest that there should be better training and coaching, better and safer rules, better equipment (where applicable), head impact exposure monitoring, neck strengthening exercises and delaying start of contact and collision sports (i.e. start contact practices at an older age) [41]. Others believe it has to do with respect and good sportsmanship, via a combination of good parenting and coaching to minimize unnecessary aggression and behavior on the field [42-43]. Education is also thought to play a critical role in injury prevention, especially in respect to knowledge translation (KT) of new guidelines, rules, scientific findings and training strategies for coaches and other athletic personnel, but also for players, their parents and everyone else involved [13, 44].

Whatever the solution, one thing remains certain, reducing the incidence of youth concussions in schools and lowering the rate of unreported concussions needs to be made a public health priority [45]. Multiple partners need to be involved at all levels of government and the athletic community. Yes, the government and various sports governing bodies need and *must* to be involved in creating and maintaining safety guidelines, regulations and if need be, legislation to protect the young, developing, brain in children. Consequently, concussion medical professionals such as sport medicine physicians, athletic therapists, nurses and others need to stay up-to-date on recent brain injury scientific developments, new policies/guidelines and other information that can help them in concussion recognition, treatment and management [46]. But it's up to the parents, coaches, trainers and teachers to ensure that children enjoy sports while at

the same time staying healthy and injury-free. It goes back to the previously-mentioned concept of education, but it is also more than that. Children need to be taught about concussions, about the long-term dangers that can affect their whole lives; they need to be guided and trained in a way to not only avoid injury (as much as possible), but to have the knowledge and resources to recognize injury symptoms, to know when to stop playing and understand and appreciate the time needed to recover and get back into school and sports [47]. Parents can help them by educating and supporting them and sticking to an effective recovery protocol in situations where, unfortunately, the child did get an injury. Coaches and teachers not only serve as the first line of injury responders, but they also guide and train youth to respect the game, respect each other and avoid unnecessary injury.

In this regard, schools are an ideal setting for any sort of prevention initiative because of their emphasis on education [48]. Lack of province-wide concussion monitoring programs combined with an insufficient (or in some cases non-existent) number of concussion-trained school personnel are just some of the challenges facing implementation of concussion prevention programs. In Canada, the lack of any significant government-backed action (i.e. legislation) only worsens this situation. While research has yet to show whether or not concussion education works, it can raise awareness, redirect resources, promote detection and hopefully improve concussion incidence and prevention. As of January 30, 2014, all 50 US states have passed some sort of a law to better protect young athletes from sport-related brain injuries and concussions [49]. The bills primarily focus on safe RTP guidelines, generally via a combination of education, monitoring and medical treatment. For example, the Mississippi Youth Concussion Law (Mississippi was the last state to adopt a concussion law) consists of three components; concussion education for kids and parents, immediate removal of players with suspect

concussion and mandatory clearance of the athlete by an appropriate health care provider (physician, nurse practitioner, etc.) [50]. Supported and advocated by such organizations as the National Football League (NFL), these laws aim to raise concussion awareness and improve their treatment and detection. Many, including the American Academy of Orthopaedic surgeons (AAOS) are strong proponents of concussion legislation, believing that it can help bring concussion injuries to national attention [51].

The situation in Canada is much more complicated. No Canadian provinces have similar legislation. The following sections will briefly look at various strategies to reduce the number of concussions at the school level or reduce subsequent injuries, without involving government-level legislation. The limitations of each approach will also be discussed.

1.5.1 Preseason baseline testing

The idea of preseason baseline testing comes from the notion of reference comparison. Simply put, if one were to have information on how the athlete performed on a specific set or battery of tests before the injury, they can then be compared to the after-injury results with the goal of identifying cognitive deficits and/or other injury complications. This preseason evaluation often includes concussion-related questions including a past history of concussion (number, frequency, severity and recovery), the presence of mood, learning, attention or migraine disorders and may also include baseline symptom scores, baseline balance testing, a baseline sideline evaluation tool (SCAT3) and/or baseline computerized neuropsychological (CNP) testing [7, 52]. This type of extensive testing has been shown to be more useful in high-risk athletes, especially in those with a history of concussions or other head-related conditions or disabilities (i.e. migraine headaches, learning disorders) [53].

The approach makes logical sense, and is supported by many health care professionals, but, unfortunately, the reliability of these tests is frequently unknown and controversial. To date, no study has shown that use of these tests provides any concrete evidence of better short-term or long-term outcomes for athletes with concussions [7]. The role of baseline testing outside of high-risk sports has never been adequately studied and while the CDC actively promotes it as part of their "Action Plan for Coaches", they should not be used as a substitute for rational, clinical judgment [54-55]. There are also many other disadvantages to using baseline testing and they all stem from the problem of allocating resources, training, interpretation and unproven benefits.

First, preseason tests take a while to do (anywhere from 20-40 minutes) and require an honest and serious mindset to get valid results. Some research shows that athletes can 'fake' or purposefully underperform on a test, a concept referred to as *"Sandbagging"* [56]. Younger athletes might just simply answer randomly just to get things over with, or just not care enough to take the test seriously [56-57]. Distractions, attention difficulties and reading difficulties might also contribute to a worse-than-expected result. Many of these tests are also not free, costing either the individual or the system anywhere from $60-100 [57]. Some scientists are worried about the commercialization of baseline testing, suggesting that many clinics and programs use the tests to make money without putting in the time and effort to interpret them properly or to even adequately train the test-administering personnel [58]. Most of the baseline tests, especially the neuropsychological ones, also need to be administered by a trained health care professional, one that can expertly interpret test results, especially if the tests are going to be the basis for any RTP decisions [54-55, 58]. Finally, there is evidence that many athletic trainers that use the popular baseline computerized neurocognitive test IMPACT (Immediate Post-Concussion

Assessment and Cognitive Testing) don't bother examining the baseline tests for validity and don't rely on the tests when deciding whether to send the player back into the game [54, 59]. This suggests the either the trainers don't trust the tests enough, or they are more inclined to use their judgment, experience and situation to make their decisions. Quoting Christopher Randolph, a professor at Loyola University Medical Center and former team neuropsychologist for the Chicago Bears; *"There basically are no data that would suggest that once someone has recovered from objective symptoms that you can detect anything with these tests. They provide nothing more than a false sense of security."* [54, 60].

Recently, Parachute Canada released updated recommendations into baseline testing for Canadian youth and adult athletes that state that baseline testing is not required for post-injury care of youth athletes with suspected or diagnosed concussion and is not recommended and that sports organizations should instead focus on appropriate medical assessment, management, and return to sport [61-62].

1.5.2 Rule Changes

Because concussions in sport have lately become such a hot topic of research and discussion, it has contributed to many rules changes and coaching strategies with the overall aim of preventing brain injury [63-65]. For example, the NFL after multiple lawsuits and heavy pressure from the media, medical professionals and player associations have introduced a few major rule changes in an attempt to reduce the high number of pro American Football concussions. Without getting into the game specifics, the first rule banned hits to the head of players in "defenseless positions," such as a quarterback delivering a pass or a receiver making a catch [66]. There were also rule changes introduced against head-down tackling or "spearing", a

common practice which frequently resulted in injury to both players [67]. Additionally the NFL moved kickoffs up five yards to the 35-yard line last season, an attempt to increase the number of touchbacks and de-emphasize kick returns which is considered one of the most violent and chaotic plays in football [66, 68]. US Soccer has changed its heading rules in an attempt to protect younger kids from concussion by not allowing kids under the age of 10 to head the ball either at practice or at the matches [69]. The new rules were designed answer a lawsuit brought last year against U.S. soccer and others by a group of parents in California who argued the groups weren't doing enough to protect kids from head injuries [69].

In Canada, research on ice hockey showed that stricter bodychecking rules led to injury rates that were between three- and 12-times lower [70]. Many, including Hockey Canada, have implemented to this change, banning body checking in Pee Wee leagues made up of 11- and 12-year-olds, postponing its introduction to the Bantam league, made up of 13- and 14-year olds [70]. Others accept the idea, but worry about uniformity and standardization of rules across cities, counties and provinces. Recent rule changes in the National Hockey League (NHL), which outlawed bodychecks aimed at the head and checking from a player's blind side, has not led to lower concussion rates among pro hockey players since it came into force in the 2010-11 season [71]. Research analysis showed that the type of hits that were outlawed by the rules weren't actually responsible for the majority of concussions. The authors suggest that if there were more severe consequences for players whose actions lead to injuries like concussions, for example forcing the perpetrator to spend as much time off the ice as the recovering athlete, then it could lead to major changes in how the game is played and what happens on the ice [71]. Doctors like Dr. Ross Upshur of the Dalla Lana School of Public Health at the University of Toronto and Dr. Paul Echlin of Elliott Sports Medicine Clinic in Burlington, Ont., suggest that a shift in the way

youth play a game needs to take place in order to prevent future injury [72]. They suggest a few precautionary rule changes such as eliminating intentional head contact, increasing the size of playing surfaces, decreasing the number of participants playing on the field, eliminating certain aspects of some games (e.g. heading in soccer) and enforcing significant suspensions akin to the eye-for-eye mentality as mentioned before [72].

While it is an outwardly simple concept, changing the rules or regulations in any major sport is a difficult and time-consuming venture [73]. It is often challenging to convince the major professional sports organizations (i.e. NHL, NFL, MLS) to alter their rules to meet specific guidelines. All of these organizations do their own research and have their own doctors whose opinions are often at odds with external, unaffiliated research. More often than not, organizations such as the NFL are more likely to spend resources on unproven safety equipment or innovative technologies than tailor their own policies to meet updated, validated guideline [74]. It is also relatively costly to attempt to change the rules at a system-wide level (i.e. school board). It would require personnel training, awareness seminars for athletes and parents, reprinting of training manuals and/or guidelines, introduction of new equipment and possibly many other expenses. In terms of professional sports, it is very difficult to shift expectations on the part of coaches, officials, and athletes as well as of parents and especially the fans [73]. It goes without saying that there is a lot of money involved in professional sports and fans bring in the income. Turning the fans away from the game because of major rule changes, or perceived 'softness' is unacceptable and contributes to the difficulty of beneficial rule changes. There is also some evidence that delaying or reducing contact in practice puts athletes at risk in the future because they have not adequately mastered or practiced appropriate contact skills at an early age when the ability to acquire skills is at its greatest [73, 75]. Finally, it is important to keep in mind that it

often takes a long time to alter people's perceptions about the risk of certain activities [76]. Nevertheless, rule changes can alter the culture of any sport and specify or define acceptable behavior for everyone involved [71].

1.5.3 Safety Equipment Changes

No evidence exists on the use of helmets or mouthguards and subsequent reduction in concussion risk [77-78]. Modern helmets are excellent at protecting the head from various impact-related trauma and fractures but are unable to account or compensate for rotational acceleration leading to inconclusive and conflicting research and evidence. Attempts have been made in hockey to study that face shields, visors and cages have on concussion incidence. Both USA Hockey and Hockey Canada require youth under 18 to wear a full face mask (Cage) [73]. A hypothesis has been put forth that facial protection may also reduce the incidence and severity of head injury in ice hockey by decreasing head acceleration after an impact, but there is no evidence that this type of protection reduced concussions in ice hockey [79]. Other studies, looking at professional, college and amateur ice hockey players show no significant difference in the occurrence of concussion between those players wearing visors, full-face protection, or in the case of NHL, not wearing any facial protection at all [80-81]. There is some evidence however that full-face protection is better than visors when looking at post-injury recovery. One older study looking at university hockey players found that athletes who sustained a concussion while wearing a visor missed significantly more practices and games per concussion than those sustaining concussions while wearing full-face protection [82].

The NFL meanwhile, continues to modernize, enhance and test various helmets even though most research, as mentioned before, collectively acknowledges the idea that helmets offer

minimal to no protection against concussion. Lots of resources are being devoted to testing hundreds of helmets, with the end goal of finding a solve-all-problems design [74]. The University of Washington, together with a startup called Vicis recently developed a new helmet that adapts to any head size and has a "deformable structure" with multiple layers of different material that absorbs an impact, almost like an airbag [83]. The NFL is hoping that these investments can raise its public image and demonstrate the organization's desire to address concussions. Without going into the history and engineering aspects of safety equipment, it is important to mention that recent technological advances, medical research and heightened interest have paved the way to hopefully, one day develop sports-specific helmets and/or other safety equipment to decrease concussions in sports. Knowing that helmets do not protect from concussions, many scientists have instead shifted the focus of their research impact sensors and other electronic monitoring devices. Another example of new concussion-measuring technology is a strip of tape that gets attached to the helmet on the outside; changing color as the player sustains impacts, somewhat similar to a litmus test for concussions [84-85]. These devices can not only be used as an effective tool to measure and record the strength of a hit or an impact, but they can serve as early predictors of concussion injury [85]. There are however, multiple limitations that are inherent with this type of injury prevention approach [86].

First, there is the issue of marketing unproven, untested equipment. For example, as discussed at a 2011 hearing on concussions and the marketing of sports equipment before the U.S. Senate Committee on Commerce, Science, and Transportation, many sports equipment products make false claims on their packaging and in advertisements [87]. Sure, it boosts sales but it contributes to a false sense of security and should not be permitted. Secondly, helmet research and development is expensive. If the helmet is too expensive to mass produce, it will

only be used by elite athletes and not reach youth and other members of the general population. Can the costs be subsidized and reduced in some way? Maybe, but then the companies that are making these helmets will want something in return (i.e. grants, subsidies, advertisement deals, etc.). The same can be said about impact sensors. They are costly to develop, test and use. While the idea of a built-in electronic concussion recognition system is excellent in theory, in practice it does not contribute to a reduction in concussions, nor does it help prevent them or somehow reduce their impact on the injured individual. There is also a moral-economic trade-off in all of this. For example, from a parent's perspective, does one spend significantly more money on an expensive, custom-engineered helmet with a built-in sensor that can monitor collision strengths or risk the *slightly* more likely chance of concussion with a much cheaper, mass produced design? This is serious dilemma that could affect sports inclusion, participation and various associated health outcomes, especially in an economically impoverished situation.

1.5.4 Other changes (multi-disciplinary medical evaluations, technological inventions, playing surfaces, presence of athletic therapists)

This section will provide an overview of research focusing on alternative strategies to reduce the impact of concussion. Most of these have demonstrated promising results, but are either too new, time consuming, or expensive to be effective in a school-based setting [60, 88-89]. Nevertheless there are some advantages and a lot of key aspects can be taken away from these options, especially when working with concussion policies.

1.5.4.1 Medical Evaluations

This first category combines a few additional approaches that have been proposed over the past few years in the hopes of reducing concussion prevalence and making sports safer for

both children and adults. Some clinicians have proposed multi-disciplinary medical evaluations as an alternative to baseline testing. For example, Dr. Michael Ellis, a neurosurgeon and Medical Director of the Pan Am Concussion Program in Winnipeg, Manitoba suggests that concussions can be managed by family medicine physicians and pediatricians without any baseline testing [74]. Other doctors agree, suggesting that timely professional medical assessments can help in making RTP decisions [74, 90]. Medical professionals can also give helpful advice on child seats, seatbelts and childproofing one's home. There are however, some glaring limitations to this approach, the chief one of them being the lack of available medical personnel and the time-related resources that it would take to manage concussions, to track recovery progress and for subsequent follow-up checks. It could work in a private system or in professional teams whereby the school/team can hire additional medical staff to observe and treat its players throughout the season. This becomes very difficult if not impossible to implement in a public school and care system, where the medical resources are stretched thin as it is; with many families lacking family doctors and waiting for months to get diagnostic imaging done or an appointment to see a specialist [91-92].

1.5.4.2 Different Playing Surfaces

The Consumer Product Safety Commission (CPSC) and ASTM (American Society for Testing and Materials) International have developed guidelines for playground surfacing that can help reduce playground-related injuries [73]. This also affects concussion, as some research in cheer-leading demonstrated that the shock-absorbing capacity of the surface on which cheerleaders practice and perform can play a role in head injury frequency and severity [93]. Other findings in this area are somewhat varied across studies and the types of injury. For example one study looking at NCAA soccer players showed that the incidence of head and neck

injuries, including concussions, was significantly ($p < .01$) higher on artificial turf than on grass [94]. Studies looking at college football injuries were inconclusive with one study reporting no variation in incidence of head trauma by field type, while another found that football players experienced more concussions on natural grass than on artificial turf [95-96]. That being said, a private company called Viconic has recently proposed the use of a blast-resistant mat called Astroturf (that it has been successfully selling to the US Army) as an underlay material that would go underneath the fake turf used on some NFL fields. This turf, softens the impact of falls, and can be used to hypothetically reduce the number of tackle-based concussions that happen when a player gets taken down and hits their head on the ground [74]. Generally it is thought that older, synthetic, hard plastic artificial turfs resulted in faster game speeds and allowed for stronger collision impacts, while newer, synthetic surfaces are designed to mimic the properties of natural grass while reducing friction and impact forces [73]. Using an underlayer has never been tested but has shown promise in Viconic demonstrations. Playing surfaces in other sports are rarely studied or considered as a possible factor in concussion, and are therefore will not be discussed in the context of this paper. One major limitation in any turf-related research or improvements is that a lot of soccer fields and football fields in North America, do not use artificial/synthetic turf. Sometimes it's a matter of viability, resources, and the age of the arena. sometimes it's just team preference or there are other factors in play. Either way, while turf-related injury research shows some promise, it's applicability is very selective both in terms of location and sport played [97-99].

1.5.4.3 Electronic Concussion Awareness Applications

The past decade has seen a technological "boom" in the development of handheld electronic devices such as smartphones, tablets and laptops. Where before, news and required

information could only be acquired from a library, stationary television, or desktop computers, modern technological advances allow users to access online libraries, databases, news sites, and various aid programs with only a few clicks and a couple of seconds of browsing. Everything from dieting advice, discount concert tickets and consumer product reviews, to investment tips, electronic banking and healthy-living suggestions can be either found on a smartphone-accessible mobile internet or downloaded as an interactive application or app. Capitalizing on this development, many teams, associations and even the government have created apps to provide concussion info, keep track of injuries and provide other resources for its users.

For example, in 2012, Hockey Canada spent more than $100,000 to develop a new smartphone application to help educate parents, coaches and trainers on how to diagnose and treat concussions [100]. Almost $200,000 was spent by British Columbia's Children's hospital to launch a new online tool to help teachers track and manage concussion recovery among their students [101]. Funded by BC's Education Ministry and the University of British Columbia (UBC), the Concussion Awareness Training Tool (CATT) is a free, “one-stop” source of information on concussions [101-102]. Finally, this past year (2016), the Federal Minister of Health in Canada launched a mobile app (*Concussion Ed*) designed to give Canadians free access to critical concussion resources [103]. *Concussion Ed* provides users with interactive resources and tools around how to prevent, recognize and manage concussions, including information on when to see a doctor and RTP - RTL guidelines. Led by Parachute Canada, this app was developed under the guidance of its Expert Advisory Committee and with members from the Canadian Concussion Collaborative to select relevant, evidence-based material [103].

Professional sports organizations such as the NFL have also incorporated new technological advances to make the game safer. For instance, starting in 2013, all all NFL teams’

in-game concussion evaluations were to be conducted by medical personnel using the league's concussion-assessment tool loaded onto iPads [66]. The new collective bargaining agreement between the league and the player's union, put aside significant funding for medical injury research including concussion [66]. The NFL used this money to launch the Head Health Initiative, a four-year, $65-million effort to detect and treat traumatic brain injury (both the ZERO1, a specialized helmet project and Viconic's Astroturf underlay came out of this initiative) [104]. While the technological developments and the money invested in medical research by the NFL and other sport organizations are applaudable, the effectiveness and usefulness of the various online concussion monitoring tools and apps have not yet been successfully evaluated. Furthermore, the financial resources themselves are a limitation of this approach, because the results are not always apparent and isn't clear whether or not the advancements, apps and awareness media campaigns are having any meaningful and cost-worthy effect.

1.5.4.4 Athletic Therapists in Public Schools

One other intervention that has been shown to be effective in preventing, diagnosing and managing concussions is the presence of athletic therapists at practices and games. There is some evidence that there are significantly more concussions in high school games with ATs than those without ATs [105-106]. Not only do ATs have concussion training, their interest in sports, sports medicine and field experience makes them as much, if not more important, than other healthcare professionals. One study has also showed that ATs are much more aware of current concussion management guidelines than many primary care physicians [107]. Another significant advantage of having ATs is the fact that they know the players so well because they see them on a daily basis. They know their usual behavior/attitude patterns and are more likely to pick up on more

subtle, hard-to-spot signs that an athlete might have suffered a concussion [7]. This frequent proximity to the players also gives the ATs a unique opportunity to do the daily follow-up examinations that help identify the progress made on the step-wise RTP protocol, as well as build trust that is crucial for injury reporting and concussion education [45]. In 2013, The American Academy of Pediatrics stated that "the AT can help reinforce communication of any school or sports restrictions to safeguard against the student-athlete beginning a return-to-play protocol but still having academic adjustments." [108].

Unfortunately, this approach suffers from the same lack-of-personnel and funding problems discussed in the first section of this chapter. While a 2009 study shows that almost two thirds of U.S. secondary schools with an ongoing athletic program have access to ATs, the situation in Canada is much worse [109]. While there are some private school systems and sport teams that have year-round ATs during games and practices, there are *NO* athletic therapists in public schools in Canada. In contrast, one survey conducted by C.S. Mott Children's Hospital and the University of Michigan have found that 67% of all participating parents support a requirement to have certified a athletic therapist or another health professional onsite for practices and games [110]. Why there is such a difference between the two countries' public school systems is unclear but it most likely has to deal with policy/legislation and funding. Nevertheless, the evidence is there that ATs are effective and resources should and must be devoted to ensure that public schools in Canada have access to these health professionals [109, 111-112].

1.5.4.5 Experimental Technologies

The last 2 concussion-prevention initiatives that will be mentioned in this chapter are the ARL substance and the BrainShield decals. Both of these technologies are experimental, but have shown some promise and are interesting enough to be worth a quick overview [113-115]. First up, are rate-actuated tethers to couple the head to the body that were introduced by the Army Research Laboratory (ARL) in 2014, after receiving a research grant from the Head Health Initiative [74, 114-115]. These tethers (made from their special substance) are attached from the lower bar of a helmet to a player's chest to prevent the head from snapping back quickly after a hard hit, but at the same time allowing for slow and normal movement [74]. Somewhat similar conceptually to a seat-belt, the strap hardens and keeps the head up in the event of a sudden jerk. Initially designed to help protect ankles and knees from injury, but ended up finding a different use for it [116]. One glaring limitation to this technology is that the strap (or even multiple straps) needs to be connected to something, possibly a whole bodysuit that might hinder the athlete's movement and put him into even more dangerous situations. In addition, public access to this substance/strap and associated costs have not been disclosed and could potentially make it unfeasible in a mass-produced sports-equipment environment.

The second concussion-prevention technology is called BrainShield; a helmet decal developed by Simon Fraser University's (SFU) School of Mechatronic Systems Engineering (MSE) and a company called Shield-X Technology Inc., who advertize it as a viable way to greatly reduce concussion [117-118]. BrainShield is a unique sticker that is made of micro-engineered layers that are installed on the outer-shell of helmets and significantly enhances their protection [117]. They are very thin (<1mm), easy to apply, and are fairly inexpensive, priced at $50 for a pair [118]. Daniel Abram, the creator of BrainShield calls it "a seatbelt for

your brain" and says that the decal can reduce both sharp twisting and compression of the head during most of angled impacts [117, 119]. The first prototype was tested by the SFU's football team and contributed (along with new tackling techniques taught by the team's coach) to an almost 3-fold decrease in concussions (from 14 to 3) [118]. The stickers were then given to a couple of secondary schools in the Vancouver area. The results were even more impressive with Handsworth Secondary, a North Vancouver high school team reporting zero concussions in the current football season [120].

More research is needed to test BrainShield but the company is on the right track and is currently testing the stickers for use in bicycle helmets. As with any approach, there are a couple of limitations to BrainShield. First of all, the testing sample size is too small. It is not clear whether or not the actual sticker or the changing rules/strategies have contributed to a decline in concussions. Second, as mentioned by Jay Prepchuk, head coach for the Handsworth team, the use of the decals don't absolve the players from the responsibility of playing the game safely and they still need to follow the rules to ensure their safety [119]. Convincing various teams and organizations might also be difficult considering the initial skepticism directed towards the project and the way the final product looks (sticker). But the current advances in research and science shows that there is potential to hopefully one day mass market a simple sticker-like device to help prevent head injuries and combat the concussion epidemic [117-119].

1.6 Concussion Polices in the U.S.

While the previous section has focused on many different approaches on how to prevent concussion, the primary intervention needs to be developed and implemented at the highest levels. Without specific directives, guidelines, and support at the national level, the prevention

tools discussed in chapter 2 cannot reach the masses and will only remain as viable options at a local, community level. For example, introducing major sport law changes or getting athletic therapists to be present at public school sporting events cannot be accomplished without the involvement of the federal government, major sports regulatory bodies or organizations (i.e. NHL, NFL, FIFA, etc.) and various other stakeholders (Medical Associations, equipment manufacturers, professional athlete's unions, etc.). This next chapter will look at regional (state/provincial) and federal concussion policies (US & Canada), international concussion legislation, and conclude with an overview of the history of concussion-related policies and guidelines in Canada.

Recent legal activity directed at the NFL, high-profile athlete injuries and a combination of mass media focus, increased research and ease of internet access have pushed sports concussion awareness to the national level. This heightened awareness has contributed to an unprecedented public outcry for concussion regulation and legislation. Many research papers in both U.S. and Canada are also showing a marked increase in concussion incidence, especially in youth [121-122]. Are concussions really on the rise? Or maybe better concussion guidelines and monitoring programs (e.g. injury surveillance systems), as well as a successful introduction of state laws (in the U.S.) have contributed to an increase in concussion diagnoses, awareness and reduced the rates of underdiagnosis/underreporting [123-124, 32].

1.6.1 Zackery Lystedt Law

As mentioned at the beginning of Chapter 1, starting with the "Zackery Lystedt Law" passed in 2009 in the State of Washington, all 50 U.S. states have now passed some sort of a 'return to play' law [125]. The schools (and other sports organizations) are now required by law

to remove, monitor, and clear for play every single injured young athlete. Zackery was a 13 year-old football player who sustained a devastating brain injury while playing football in 2006 [126]. This brain injury left him in a terrible state from which he is still slowly recovering. It is now believed that Zackery suffered 2 concussions in one game, leading to Second Impact Syndrome and him barely surviving after spending 7 days on life support, and 3 months in the hospital overall [127]. The work of his family, along with many community partners have led to the creation of player protection laws in all the states. The majority of these states enacted legislation targeting youth sports-related concussions. In addition, some states also introduced legislation to address TBI in veterans, and to provide insurance coverage for survivors of traumatic brain injury [128]. Detailed information on each state's concussion laws can be found on the National Conference of State Legislations website and will not be discussed in this report [128].

The initial 2009 Washington law has 3 components to its legislation and similar tenets form the foundation of all the other state's laws. The 3 sections are as follows:

1. Education for coaches, parents and athletes about concussion risks, symptoms & recovery with a mandatory requirement that parents sign a form acknowledging receipt of the information [73].
2. Removal from play of athletes with suspected concussion.
3. Mandatory evaluation of an injured athlete by a medical professional and written clearance before RTP.

1.6.2 Other State's Laws

Other state laws vary somewhat in the component specifics and this may influence the effect that they actually have on concussion prevention, diagnosis, and recovery, such as the extent of education and training required, the expertise of the health care providers who are

permitted to clear athletes for return to play, and the individuals/parties that are covered by the law [73]. These laws help create some sort of a uniform way to improve concussion care and RTP/RTL by standardizing the roles and responsibilities of athletes, parents/ guardians, coaches and healthcare providers [7, 129]. In 2011 the state of Texas launched Natasha's Law, named after Natasha Helmick, a prominent concussion legislation advocate. It used the concepts of the Zackery Law but expanded them further by introducing a requirement of school districts to create a concussion management panel that would be compromised of a multi-disciplinary medical team [126]. Parents/Guardians also need to annually sign off that they have received and read safety documentation and any new (if any) guidelines and practices. Another component that the law introduces is mandatory biennial training for coaches, licensed health care professionals and even physicians. Many other sports associations, universities and even some youth sports leagues have also instituted their own concussion policies.

1.6.3 Federal Legislation

Surprisingly though, there hasn't been any federal-level, nationwide legislation in the U.S. until July 2014, when United States Representative Lois Capps from California introduced H.R. 5324. H.R. 5324, titled Supporting Athletes, Families and Educators to Protect the Lives of Athletic Youth Act (SAFE PLAY) [126, 130]. The purpose of the act is to mandate local education agencies (LEAs) to implement formal concussion plans in public schools, including spreading information on concussion issues (signs, symptoms, consequences, etc.), steps to notify parents in case of a concussion, requirement to have a medical authorization before RTP, and various academic accommodations (when needed) to promote efficient RTL. The SAFE PLAY act is still in the process of the legislative cycle. From the looks of things, it has been bounced around quite a lot over the past few years finally being referred to the Subcommittee on

Early Childhood, Elementary, and Secondary Education on April 29, 2015 [131]. It is the hope of this author that this legislation finally gets passed and contributes to the creation of a uniform concussion prevention and management protocol which will have minimal state-to-state variability and can objectively inform policy makers in their attempts in dealing with youth concussions. Perhaps the interest and involvement of those at the highest levels of power can help promote safety and better respond to concussions in youth. For example, in May 2014 president Barack Obama hosted the Healthy Kids and Safe Sports Concussion Summit, the purpose of which was to promote research on sports-related concussions in youth sports and raise concussion awareness [126]. These progressive strides can hopefully one day lead to a reduction in youth concussion and help better diagnose, manage and treat this dangerous injury.

1.7 Concussion Policies in Canada

Compared to the U.S., there is a lack of concussion policies in Canada. While the Ontario Physical and Health Education Association (OPHEA) has issued guidelines for concussion management in various sports, they are not mandatory and the school boards are able to alter them to suit their own needs [132]. They also represent the *minimum* standard and should in theory, serve as the foundation for effective concussion management protocols. These standards are often incorporated into most of the bills and policies that have been introduced to the House of Commons over the past 7 years. The following bills or attempts at legislation are presented in a chronological order for ease of understanding and historical representation. One important point to note is that only three provinces (British Columbia, Nova Scotia, and Ontario) have proposed some sort of a concussion policy or an amendment to an existing policy.

1.7.1 British Columbia Bill M 206

The first concussion safety law was proposed in 2011 in the province of British Columbia. Known as Bill M 206 or the Concussions in Youth Sport Safety Act, it attempted to pass a 3-criteria concussion policy very similar to the Lystedt law [133]. It was introduced by Dr. Moira Stilwell, BC's Minister of Social Development and would also highlight which sports were considered "high risk". Despite passing the first reading, the bill has not yet become law and might have been knocked down or "forgotten" and is yet to see any revisions and/or additional readings. In a November 2015 statement, Health Minister Terry Lake said that BC will not be pursuing concussion-related legislation and will instead focus on education-based approaches [134].

1.7.2 Nova Scotia Bill 63

In 2011 in Nova Scotia, Chuck Porter, the Chair of the Human Resources Committee introduced the Concussion Awareness Act as a Private Member's Bill 63. This Act applies to all school-age participants on organized team sports and to all participants in minor sports and was introduced to develop and make available education on the impact of a concussion and respecting procedures designed to protect players after sustaining a head injury [135]. Even though the bill went through a first reading in May 2011, it did not proceed any further. A quick overview of the bill's progress and a web search for the Bill 63 - relevant articles, media feeds or any other news revealed no new information and no mention of the bill in any media outlets. The official province of Nova Scotia's legislation website also has no new info on the bill after its May 2011 reading [136].

1.7.3 Ontario Bill C-319

There has been a bit more concussion-related activity in Ontario, starting with October 4, 2011, when MP Glenn Thibeault (New Democratic Party) reintroduced the National Strategy for Serious Injury Reduction in Amateur Sport Act (Bill C-319). The bill's primary goal was to reduce the incidence of serious injury in amateur sport. This was to be done through a 5-step process including the establishment of a national medical surveillance program to properly track incidence rates and the associated economic costs of injuries in amateur sport, the establishment of guidelines regarding the prevention, identification, treatment and management of cerebral concussions in amateur athletes, amendment to the *Criminal Code* that would make it an offence for a coach or any other person in a position of authority to knowingly permit a participant to return to play without meeting the criteria specified under the guidelines, creation of guidelines for the training of coaches and other persons involved in amateur sport and the establishment of a standardized education program that is designed to enhance participant safety at all levels of sport [137]. While there was initially a lot of interest in the bill, and even though it passed through two parliamentary sessions, it still did not become law. The Bill's slow progress was addressed in a Q&A online conversation with Mr. Thibeault, who was optimistic, but at the same time skeptical of the bill's future due to the order of precedence for private member`s business in the House of Commons and the nature of other important bills [138].

1.7.4 Ontario Bill 39

Another bill was introduced in Ontario in 2012 by Laurel Broten, Ontario's then-Minister of Education, as an amendment to the *Ontario Education Act* with respect to Concussions. Similar to C-319, this bill adds a new section to the Education Act that authorizes the Minister of

education to make policies and guidelines respecting head injuries and concussions such as a requirement for the boards to establish policies and guidelines respecting head injuries and concussions, giving the Minister the authority to make regulations about the same matters and also covers various liabilities and civil proceedings [139]. This bill called Bill 39 passed its first reading on March 6, 2012 and proceeded to the Committee stage, but died on the order paper when then-Premier Dalton McGuinty prorogued the Legislature in October 2012 and thus, in the end, the bill was not passed.

1.7.5 Ontario Bill C-566

Two years later in January 2014, Kirsty Duncan (The Current Minister of Science of Canada), then-MP for Etobicoke North introduced bill C-566, the so called Pan-Canadian Strategy on Concussion Act. Introduced as a private member's bill, it proposed to enhance public awareness and education and improve current practices respecting the prevention, diagnosis and management of concussion, establishes a Pan-Canadian Concussion Awareness Week and requires the Minister of Health to develop a Pan-Canadian Strategy on Concussion, and also enacts the establishment of a Concussion Board to advise the Minister [140]. The bill has been introduced and passed its first reading at the House of Commons but three years later, its future is unclear.

1.7.6 Policy/Program Memorandum #158

The Policy/Program Memorandum #158 (PPM) was introduced on March 19, 2014 by the Ministry of Education of Ontario. Titled "School Board Policies on Concussion" this policy expects all school boards in the province to develop and maintain a policy on concussion and provides directions on policy development and implementation [141]. This is the first known

successful attempt at a federal-level concussion policy in the country and its importance cannot be understated. Because of the novelty of the program, at least in a Canadian setting, and the ambiguity of the PPM in terms of specific policy-creation guidelines, it is not clear whether any of the school board policies will be effective and implementable. The evaluation of this PPM is the central objective of this paper and thus it will be discussed in greater detail throughout the 3 papers.

The Policy/Program Memorandum #158 (PPM) is the only successful government attempt at concussion legislation. It was created in part as a response to the current concussion crisis but also possibly due to the slow progress (or failure) of Bill 39 (**Chapter 1.7.4).** In the memorandum, the government mandates that each public school board in Ontario needs to create and implement a concussion policy by January 30, 2015. The PPM entails several components, including strategies to develop concussion awareness; concussion identification, prevention and management strategies; and training for school and board personnel. The ministry recognizes that concussions can have significant social, physical, cognitive and emotional effects on students, and concussion polices are an important step in promoting safety and maintaining effective study environments [141]. The main objective of this legislation is to create healthier schools. Individuals at all levels of the education system (Ministry of Education, school boards, school staff, administrators, parents, students, volunteers, etc.) have specific roles to play in creating and maintaining a safe school environment.

At the very minimum, each school board's policy must contain the following five components. Development of concussion awareness: sharing concussion-relevant information (prevention, identification, seriousness, etc.) with all involved parties. Prevention: strategies for minimizing risk at sporting events. Identification: initial concussion response strategies,

assessment guidelines, and steps following a concussion. Management procedures for diagnosed concussions: these include RTP and RTL (return to learn) protocols. Training: there should be strategies for concussion training, concussion research awareness or some sort of continuing-education sessions for relevant school employees to keep up-to-date with current concussion research findings and development. The PPM serves as a informative guide on concussion policy, but it places the responsibility on each individual school board to design and implement their own version of a concussion program. It is important to note that the school boards should create a system to ensure policy compliance at the *individual school level*. To this end, the Ontario government has created a web portal to help the boards create an effective concussion management program. Due to the novelty of the concussion policy, at least in a school-based system in Canada, the boards were advised to work closely with various community partners (including universities, research centers), to successfully develop and implement their concussion policy.

In response to the PPM, the Ontario Physical and Health Education Association (OPHEA), in partnership with other organizations, has released a concussion protocol as part of the updated Ontario Physical Education and Safety guidelines [132]. It incorporates all five of the major PPM components but reorganizes them into three main components. This protocol includes information on various aspects of concussion management but also establishes detailed, activity-specific safety guidelines. More information on the specifics of the revised protocol, is available on the OPHEA website [132]. It is important to note however, that while there are internationally recognized graduated stepwise approaches to return to physical activity or RTP, no such guidelines exist for returning to learn. Instead, these approaches should be individualized, to meet the particular needs of an injured student [142].

1.7.6.1 Limitations of the PPM

There are a couple of major limitations to PPM 158 and to other PPMs in general. First and foremost, PPMs are NOT laws [143]. An individual cannot be legally prosecuted for not following the policy. The Ministry of Education of Ontario uses PPMs to set guidelines for School Boards, and outline procedures and practices, but they do not have same the legal force of Statutes and Regulations. Another limitation that flows from this is ambiguous wording. Similar to the problems discussed with many U.S. laws in **Section 1.6**, unclear wording, direction and minimal advice offered in PPM 158 can lead to inconsistency and unevenness across the multiple dozens of different policies across all Ontario school boards. To put it bluntly, a school board that has never had a concussion policy in place might find it difficult to quickly develop "strategies for providing regular and ongoing training on concussion awareness, prevention, identification, and management to relevant school board employees and school volunteers" [141]. They can use the ministry help portal online but it will still take time, and will most likely involve a trial-and-error process of protocol adaptation. Also, one other thing to keep in mind is that the PPM only applies to publicly-funded schools in Ontario, which is a limitation in itself but an expected one, considering the independent, non-publicly-funded nature of private schools.

Another potential restrictive factor to any concussion policy, is that concussion diagnosis can only be made by a qualified medical practitioner (i.e. a Medical Doctor or a specialized nurse), limiting the school board's role in the process. In addition to this, while the school boards are required to report on their activities upon request from the Ministry, there are no clear expectations or policy-grading tools included in the memorandum. How does each board know whether their policy is "good" or not? Even more important, how do they know it's even working? Suffice it to say, it is not clear when and how the individual school concussion policies

will be evaluated. In addition, because of the novelty of the program, at least in a Canadian setting, and the ambiguity of the PPM in terms of specific policy-creation guidelines, it is not clear whether any of the school board policies will be effective and implementable.

In the official PPM documentation there is a short mention on school board reporting. Specifically "In accordance with paragraph 27.1 of subsection 8(1) of the Education Act, school boards will be required to report to the Ministry of Education upon implementation and, upon request thereafter, on their activities to achieve the expectations outlined in this memorandum" [141]. The problem with this type of phrasing is that the so-called "expectations" in the PPM are more like checkmark guidelines. Just having any sort of unspecified concussion awareness program in place is enough to qualify or "pass". The same can be said of training coaches/teachers. And so on. Either the ministry should have been more specific with their suggestions *OR* the school boards are expected to create the best possible policy (but what is considered best?) with the resources they currently have and with subsequent ministry advice (if required).

Either way, what the PPM can do is serve as a temporary alternative to national legislation. It is that it only applies to publicly-funded schools in the province of Ontario, but the rest of Canada should look at what's done in Ontario and follow with their own concussion prevention programs; whether they may be rule changes, education, coach training or a legislation approach. There is no such thing as being "concussion-proof" especially in contact sports. Injuries are bound to happen, sometimes there are accidents, foul play, or not enough attention from medical personnel or sports staff that leads to a missed diagnosis [144-146]. It is intricately tied and often associated with sports and will unfortunately continue to occur as more and more individuals participate in them. Promoting concussion awareness, improving diagnosis

and concussion management, making the game safer and teaching youth about respect, safety and following guidelines is a collective endeavor, one that requires input and participation from all stakeholders involved in the injury prevention process. Previous concussion legislation attempts have been rejected in the House of Commons or were "lost" somewhere in between official Readings. None have included the components necessary to prevent or reduce concussions such as electronic tracking of injuries (or other concussion monitoring systems) or some sort of a system to evaluate the ability of such protocols to reduce the incidence of concussion [147]. Whereas similar policies in the U.S. have shown some promise, only time and research will tell whether or not they are effective in preventing or reducing the number of youth concussions.

1.7.7 Ontario Bill 149, Rowan's Law Advisory Committee Act

On November 25, 2015, Ottawa-area MPP Lisa MacLeod introduced Bill 149, called *Rowan's Law Advisory Committee Act, 2015* ("Rowan's Law") in the Ontario legislation [148]. The bill establishes a committee to review the jury recommendations that were made after an inquiry into the death of Rowan Stringer, a 17-year old rugby player from Ottawa who died after sustaining a concussion during a game on May 12, 2013, and to also review legislation, policies and best practices from other jurisdictions respecting head injuries [148]. The chief objective of said committee would be to provide recommendations as to how to raise awareness, prevent or reduce and treat head injuries in sports. The coroner's jury verdict has 49 recommendations aimed at school boards but also at other organizations OPHEA, the Royal College of Physicians and Surgeons of Canada and the Ministry of Health [149]. Unlike the previous mentioned bills, Rowan's Law has received all-party support and was essentially pushed through the legislation

process in an extremely short time. The bill received Royal Assent on June 9, 2016, less than 7 months(!) after it was first introduced in the House of Commons [150].

However, despite becoming law, it is important to keep in mind that "Rowan's Law" is only a *mandate to create a committee* into the death of Rowan Stringer. It is now a law and will serve as a template for actual policies. In a release, the Minister of Sports and Persons with Disabilities Carla Qualtrough said that "Rowan's Law… is a step in the right direction," and that "It builds on work that has been underway with our provincial and territorial colleagues for some time" [150]. A lot of money has been recently spent by the government on many projects involving concussion prevention, treatment, and diagnosis. For example, the federal government invested $1.4 million to harmonize guidelines across the country [151]. Some researchers are skeptical of this approach and point out that the knowledge about concussion prevention and recovery is already there, but all the research, and all the money and resources spent have not translated into effective action [152].

Two lessons can be learned by looking at "Rowan's Law" and the subsequent media interest and government focus. One, Rowan Stringer's death could have been prevented with formal concussion policies in place and strict adherence to concussion management and recovery guidelines [148-149,152]. Highlighting this problem is a recent (2014) poll by the Canadian Concussion Collaborative (CCC), an umbrella organization that includes the Canadian Medical Association and the Canadian Paediatric Society, of sport organizations who represent concussion-prone sports, that found that only 41 per cent of 44 organizations surveyed had concussion management protocols in place [153]. Learning from other countries like the U.S. could help in establishing these protocols, ensuring that concussions do not get missed, misdiagnosed or ignored. The second lesson from all of the policy attempts mentioned above is

that it all takes time, but at the same time it is important to remember that policy legislation is only one of several strategies that could reduce concussions. Many organizations, sports clubs, teams and schools can and should have their own policies, that could shape their respective injury outlooks without waiting for a government-mandated one. Legislation is not a panacea solution and there are many limitations associated with it which will be discussed in the next chapter of this report.

1.8 Difficulties and Limitations of Policies/Legislation

The existing concussion safety laws in the U.S. and the proposed policies in Canada are an important first step in protecting young athletes from concussion but there are a few major limitations that would make it unwise to rely solely on federal legislation. The first problem is with uniform acceptance, standardization and implementation. Simply put, concussion safety laws should be the same across every province and state. This would not only ensure that athletes get the same standard of care wherever they go, but it would also increase the ease of statistical comparisons, as well as policy modifications and improvements. For example, in the case of "Rowan's Law" would only apply to the province of Ontario. Other provinces *might* develop potentially similar laws or they might not. Similarly, many U.S. states differ not only on the wording of their respective concussion policies but also on some very key specifics. For example one study that looked at RTL across different states found that only 8 states (16% of total) had a RTL law or RTL-related guidance in the state concussion policy [154]. What's worse, none of the laws actually provided any guidance on athletes suffering extensive post-concussive symptoms and only 1 recommended an evidence-based standard for RTL guidelines [154].

Another study found major differences in terms of mandated concussion education (for coaches, trainers and ATs), and RTP protocols with regard to the timeline, content, and health care professional that can provide written clearance [155].

Another problem that faces concussion legislation or, in fact, any nation-wide injury policy is the lack of specialist medical personnel in many towns, rural areas or remote locations. In addition, larger cities might have long waiting lists for these health care professionals. There is no mandate in most current concussion safety laws that requires field medical personnel to have any specialized concussion treatment training (outside of the First-Aid components) [73]. Training front-line medical personnel, especially in the rural areas could be expensive and time-consuming but it would improve and standardize care [156-158]. However, it would improve and make the game safer in locations where there were previously no such safety measures. Some state's laws, such as Connecticut's law (Senate Bill 456) are strict and require mandatory training for coaches and continuing education follow-up courses every few years, while others such as Illinois (House Bill 200) only mentions that educational material needs to be made available to school districts in order to educate coaches as well as parents and student athletes [73]. In theory then, some towns in Illinois can "implement" their version of the mandated concussion policy by handing out necessary info pamphlets on concussions.

The final major limitation to concussion legislation is that it is very difficult to implement. Policy implementation takes time especially so, in the absence of clear and precise guidelines. For example, there are coroner's recommendations as to what to do in "Rowan's Law", but there are no steps or instructions to getting there. Dr. Pierre Fremont, chair of the Canadian Concussion Collaborative, thinks that results of the policies directed at children's safety are conflicting and confusing [159]. Sure it's useful to promote concussion safety and

increase awareness but Dr. Fremont thinks that many of the current U.S. policies are difficult to implement and police [159]. No one is regulating sports teams and schools to ensure that there is enough "awareness" and even if there is, how would you go about measuring it [159]? It is simple to draw-up an awareness pamphlet or give a short talk on concussion prevention but how would that transfer to an actual field setting? While the state laws mandate that a medical note needs to be shown before returning to action, who is inspecting and tracking these notes, and is there even a system in place to keep track of recurring injuries? Some researchers promote the so-called knowledge-to-action policy framework whereby knowledge transfer should be user-specific, context-specific, impact-oriented and an interdisciplinary process [160-161]. It could help get information across in an expedited, easier-to-understand and helpful way, contributing to more effective policy implementation.

A few additional minor limitations will be briefly mentioned in this paragraph. First, concussion education is a strong component of most concussion laws but research has not shown no evidence of the effect of these interventions on behavior [73]. This is especially important in improving concussion attitudes and beliefs, and subsequently improving concussing reporting habits. Given the recent nature of all these concussion laws, protocols and guidelines, it is not clear what constitutes good "concussion prevention training" and what the expectations are for all sports training personnel (coaches, Health and Physical Education teachers, athletic trainers, etc). Canadian jurisprudence states that coaches "must take all of the necessary steps to avoid placing a young athlete at risk of sustaining or aggravating an injury" but and that their responsibilities may vary "according to the risks of the activity, accepted business practices and applicable professional guidelines or standards" [162]. In this sense the coach has the most important position in the concussion policy stakeholder "pyramid" as they are the ones that can

directly influence how the game is played (rules, safety equipment used, injury prevention strategies), how the athletes feel about the game (e.g. respect each other, respect the coach, report injuries) and how new guidelines, polices or rules are introduced and implemented.

The next chapter will present the 3-paper evaluation of the PPM. The researchers hope to gain a better understanding of concussion policy effectiveness in youth athletes by analyzing the Ministry of Education's PPM # 158 in terms of its uniqueness, impact and school board adherence. Information gained from these studies will hopefully be used to develop other injury-related policies and advance sport and injury-prevention development. It will also serve to educate students and their parents on the serious nature of head injuries and hopefully help reduce future incidences of concussion

1.9 Study Purpose

The main purpose of this study is to review and evaluate the effectiveness of PPM # 158.. The three studies and their objectives/purposes are as follows:

Study 1. Evaluation of Ontario school board concussion policies in response to the Policy/Program Memorandum # 158

Study 1 objective: Ascertain if school boards have followed the PPM guidelines and developed a concussion policy by either January 30, 2015 or current study period (February 2017).

Study 2. Trends in concussions at Ontario schools prior to and subsequent to the introduction of a concussion policy - an analysis of the Canadian Hospitals Injury Reporting and Prevention Program from 2009-2016.

Study 2 objective: Examine trends in school-based concussions by conducting a pre-post analysis using data taken from Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP).

Study 3. Physical education teachers' perceptions of concussion policies in relation to Ontario's Policy/Program Memorandum #158.

Study 3 objective: Explore *perceived* effectiveness of the concussion policies from the perspective of Health and Physical Education teachers/coaches

Chapter 2. Paper 1: Evaluation of Ontario school board concussion policies in response to the Policy/Program Memorandum # 158

Abstract

Introduction: Concussion is a common but preventable injury among children and youth. Recent evidence suggests that health service utilization for concussions is becoming more common, especially in school-aged children. On March 19, 2014, the Ministry of Education of Ontario issued a Policy/Program Memorandum (PPM) #158 that prompts the school boards to create and sustain a concussion policy. **Purpose:** The primary objective of this study was to determine the effectiveness of PPM #158. This was addressed through two specific aims: 1) to determine whether school boards complied with PPM #158 and had a policy in place by the January 2015 deadline, and 2) to determine whether these policies met the criteria outlined in the PPM #158 documentation. **Methods:** An online search was conducted to determine whether each board had a policy in place by the ministry deadline. Ontario school board concussion protocols were analyzed using a questionnaire that was sent to school boards that agreed to participate in the study. **Results:** By June 2016, all 72 publicly funded Ontario school boards had an electronically accessible concussion policy. 25 school boards, or 34.7% of boards demonstrated interest in this study. Out of these, 18 boards sent back a completed questionnaire. Almost all participating school boards (16/18) had a return-to-play (RTP) and a return-to-learn (RTL) component in place, 14/18 boards had concussion prevention and assessment strategies as well as required staff training as part of their protocol, 10/18 school boards had a trained individual at every sports game and/or practice, 16/18 boards reported educating their coaches/trainers/staff, and 10/18 provided education to their students. **Conclusion**: Some school

boards report having implemented various elements of concussion protocols, and the PPM #158 appears to have been successful in terms of school board policy creation and implementation.

Introduction

On March 19, 2014, the Ministry of Education of Ontario issued a Policy/Program Memorandum (PPM) # 158 that requires all school boards in the province of Ontario (Canada) to "develop and maintain a concussion policy" (1). The ministry expects that these policies would have four outlined components including; strategies to develop awareness of the seriousness of concussions; strategies for the prevention and identification of concussions; management procedures for diagnosed concussions; and training for board and school staff (1). At the time of this paper, no government-mandated legislation exists in any Canadian province or territory, making Ontario's PPM #158 a first step in a growing effort to minimize the risk of concussions and improve concussion management procedures. Comparatively, from 2009 – 2013, all 50 states in the U.S. adopted some sort of a concussion law or legislation. While it is not clear whether any of the U.S. policy efforts are having an effect, it has raised awareness of the issue and should hypothetically help reduce the number of concussions nation-wide or at the very least improve concussion detection, follow-up and management.

Working together with the Ministry of Education, the Ministry of Health and Long Term Care and the Ministry of Tourism, Culture and Sport, the Ontario Physical and Health Education Association (OPHEA) developed a concussion protocol that would serve as a template for school boards to effectively implement PPM #158. OPHEA also created a series of online training modules, consultation support, a concussion information portal, as well as various other tools that are available online on the organization's website (2). OPHEA's safety protocol is considered

the minimum standard for school boards and they are crucial for concussion prevention strategies and ensuring a safe environment in schools across Ontario.

In a large study looking at annual and seasonal concussion trends, Zemek et al., suggests that a number of recent cases of concussion in high-profile professional athletes have raised both the scientific and the public concern, and could be the reason for the increased health service utilization for youth concussions (3). The Ministry of Education of Ontario, with the launch of PPM #158, expected that all 72 Ontario school boards would implement their own version of the protocol outlined in the Ontario physical education safety guidelines no later than January 30, 2015 (4). The protocol was required to have several sections including information on concussion prevention, concussion symptomatology, response procedures for a suspected concussion and management procedures for post concussion; including return-to-play (RTP) and return-to-learn (RTL) components (1).

Ontario recently (February, 2018) passed Rowan's Law, an education policy on concussion management in schools. It is named in honor of Rowan Stringer, a 17-year old high school rugby player who died after being knocked unconscious during a game. An inquest into her death revealed that she suffered multiple concussions over the previous week (5). A panel of concussion experts provided a list of recommendations to the government with the hopes of raising concussion awareness, regulating concussion management and ultimately saving lives; ensuring that circumstances that took the life of Rowan Stringer do not repeat themselves (5). However, it is only a list of general suggestions, and not a formal, government-enforced legislation (6). All PPMs outline the Ministry's expectations regarding the implementation of ministry policies and programs and act in accordance with the Education Act, requiring the school boards to report policy implementation and, upon request thereafter, their activities to

achieve the expectations outline in the memorandum (1). Subsets of the Education Act can give the Minister of Education power to establish a given policy or to force school boards to comply with it. Multiple other concussion policy attempts at both the provincial and federal levels have failed to pass, prompting the Ontario government to take this PPM-approach in the hopes of reducing youth concussion incidence, improving the injury outlook and promoting sports safety.

The PPM that was introduced was a set of guidelines, not directly regulated or enforced, thus it was up to each school board across Ontario to create and implement their own concussion policy. *Implementation* is key, as just having an administrative policy in place doesn't ensure that school staff are aware of it and that they follow the updated protocols and regulations (7). This study aims to determine the effectiveness of the PPM by answering two specific aims: 1) to determine whether Ontario school boards created a concussion policy by the ministry deadline and; 2) to determine the extent to which these policies met the criteria outlined in the Policy/Program Memorandum # 158 (PPM). Findings of this study will help to identify barriers and enablers to the implementation of the policy.

Methods

The first step of this study involved a web search of all 72 Ontario school boards to identify whether or not they had established a concussion protocol. This took place in May and June of 2016, about 16 months after the ministry deadline. Specifically, a web search was conducted to see whether the school boards had an online (on their board's website) version of their protocol.

After conducting this search, all school boards were contacted via email and/or phone and were asked to participate in the study. Only 25 boards or 35% of all Ontario boards agreed to

participate after three rounds of communication, while another 10 declined to be involved outright. Additional ethics approval was completed for some of these school boards as requested by the boards' contacts. After completing ethics approval, the researchers identified a person at each school board who was responsible or involved in the creation/implementation of their concussion policy (e.g. policy analyst, ethics department staff, research supervisor, external relations liaison, etc). Board representatives' contact info was provided by the school board. School boards who gave their consent then allowed school board representatives (referred to hereafter as 'boards') to participate then filled out a questionnaire related to the implementation of their board's concussion policy, that was forwarded to them either via email or in some cases, regular mail (**Appendix A**). The 72 school boards contacted did not include 7 school authorities for children with special needs and 3 additional small 1-school boards in northern Ontario that were not listed on the Ontario Secondary School Teachers' Federation (OSSTF) website, and were thus excluded from this report (8). All of these schools had a very small student population and in the case of special needs schools, they had very minimal athletic programs and had their own protocols in place for various disability- and injury- related purposes and instances.

The questionnaire used in this study was developed by the research team, with input from Parachute Canada (a national, charitable organization) and the Ministry of Education of Ontario. Many of the questions were derived from ministry PPM documentation, OPHEA guidelines, and from conversations with experts at Parachute and the Ministry of Education. Specifically, questions dealing with policy components such as presence of trained individuals at high-risk sporting events, what to do if there is a suspected concussion, RTP and RTL specifics, incident information and access to this data, and questions on reducing concussions in schools, were all extracted from the Ministry-suggested injury protocols.

The questionnaire included 7 multiple-choice option and 5 yes/no questions; with an option to comment or provide alternative responses. Two additional questions were included that were to be answered only if a school board did not have a policy in place at the time of the study; however, no boards responded to these two questions given that all boards had a policy in place. Information gathered for this questionnaire was compared to the policy, to assure alignment in topics and wording. Please note that Question 12 asked for permission to interview high school physical education teachers and coaches about their knowledge, opinion and beliefs about concussions, policies and general attitudes towards government-mandated interventions. This question is linked to part 3 of this PPM evaluation study, and is described elsewhere (**Paper 3**). The questionnaire was shown to and approved by Parachute Canada and the Ministry of Education.

Results

All 72 Ontario public school boards had an uploaded concussion protocol on their board's website by June 2016. These protocols had a launch or implementation date included in the policy documentation. Just 5 boards (7%) had a concussion policy in place before the initial introduction of the PPM in March 2014. In total, 33 boards or about 46% of the whole sample had a concussion policy in place by the January 30, 2015 PPM deadline. The remaining 39 boards launched their concussion protocols over the following 16 months with the last school board introducing their policy in June 2016.

All 72 boards were contacted but only 25 agreed to participate in the study, a 34.7% response rate. Twelve school boards returned a completed questionnaire, 6 declined participation after initially agreeing to participate, 7 more stopped responding to contact attempts after initially

agreeing to participate. Most of the respondents, 15/18, had included at least 5 out of the 9 concussion policy components in their protocol, while 3/18 school boards had only 3/9 components. Only 1 school board indicated that they had curriculum-specific provisions, and only 5 had any mention of in-game monitoring. A further 7/18 boards did not have a knowledge-sharing component in their protocol, and 5/18 were missing a safe-removal component. Almost all boards, (16/18) had a RTP and a RTL component in place, while 14/18 boards had concussion prevention and assessment strategies as well as required staff training as part of their protocol.

Roughly half (7/18) of all school boards reported that they found training staff to be a challenging component of policy creation/implementation. A further 8/18 boards found had no issues in policy creation or declined to comment. About 10/18 school boards had a trained individual at every sports game and/or practice, although 5 of these indicated that they only had them on an irregular basis or only in "high risk sports". There was more consistency in the school boards' attempts to reduce the number of concussions at their schools, with 16/18 boards reported educating their coaches/trainers/staff, 10/18 provided education to their students, and 4/18 were more likely to limit contact during practice or aim to make the playing environment safer. There is also an almost universal agreement amongst the boards on what to do when there is a suspected concussion: 16/18 indicated immediate removal of the potentially injured athlete from the game, notified parents/guardians of the injury, and recorded the information about the incident. 8/18 would call an ambulance if the situation deemed it, or if there was no concussion-trained staff around. A few boards (6/18) indicated that they follow their own internal protocol, and 1 board said that they immediately contact their board's insurance after every incident.

All but 1 school board agreed that written permission from a health professional was required before the youth was allowed to return to sports and 13/18 boards required that the

individual be symptom-free for a period of time before RTP. The situation was similar for RTL where 12/18 boards had incorporated at least 7/10 suggestions into the concussion protocol with the more frequent choices being; allowing students to take frequent breaks (14/18), providing clear/simplified instructions (13/18), alternative assignments or examinations (12/18), limiting recreational activity (11/18), limiting computer and television use/reading (11/18), providing class notes or a student note taker (11/18) and participating in contactless sports (8/18). Some school boards proposed additional RTL measures such as allowing the use of hats, sunglasses and elevators, having "preferred seating", "eating in a quiet area" and not allowing recovering youth to play "wind/brass instruments". Most school boards (14/18) had a system in place to keep track of concussions.

The boards opinions diverged when it came to suggestions on improving the prevention and management of concussion. While 6/18 boards suggested improved awareness and education as well as more funding and training for school staff, 7/18 boards declined to comment, and several suggested alternative options including "a need to change sports perception, especially in hockey", greater education for students and parents on the nature of "post-concussion rest", "improve communication between schools and non-school sports teams/clubs/organizations" in order to ensure that the school is aware of injuries that occurred elsewhere, and "more funding for training and policy development". One board, for example, said that they "did not receive funding for policy development, initial training or ongoing training" - suggesting either a lack of time/money to train staff or lack of policy/research staff that could quickly and efficiently create a concussion policy using the basic OPHEA template. Finally, 10/18 school boards approached a Public Health Ontario branch or any other organization (OPHEA) for help and/or advice in creating their concussion policy.

Discussion

At the time of this study (June 2016), all boards had a concussion policy in place, but they varied in the components included in the policy. Some boards had policies that included many of the recommended elements, but others faced some barriers to implementation of the policy by the required deadline. These barriers were most often related to resources available for policy development. Most of the school boards used many components of the OPHEA safety guidelines in their protocols, but many boards were missing trained staff for monitoring high-risk games, and a safe-removal component. Research shows that in-game monitoring is difficult, and is made even harder if no trained personnel are available to recognize the subtle signs of a concussion or are trained to use sideline assessment tools (9). This component is key to any head injury policy because timely concussion assessments not only help remove injured individuals from the game, but they can also help prevent serious complications (e.g., Second Impact Syndrome) and/or additional injuries (10). Ensuring that a school has trained staff to monitor games is essential in timely identification of injuries, and is concerning why so many school boards did not devote much attention to this point. OPHEA lists a series of guidelines to help prevent concussions and a significant proportion of these deal with preseason teacher/coach/supervisor training. While there is no specific mention of actual training for these individuals, there are suggestions as to what they should know and be familiar with. While almost 78% of the sample (14/18) provided education for their coaches/trainers/staff, only 28% (5/18) indicated that they had a trained individual at every game/practice, with another 28% (5/18) having trained individuals only at high risk sports games. This suggests that either the "education" component is inefficient or for some reason many "trained" individuals are not called upon or used to monitor games. Almost 45% of all school boards found staff training to be

challenging and this could partially explain the low numbers noted above. Research suggests that while coach education is important, it is only a part of the solution. For example in a study by Rivara et al., almost 70% of all concussed athletes reported playing with symptoms, with another 40% reporting that the coach was unaware of their injury (11). Merely enacting concussion laws was not enough to change coach concussion education and athlete attitudes in reporting their symptoms (11).

Another important finding is the fact that most school boards consider awareness and education to be the most important components of concussion prevention. Alternatively, only 22% of the boards (4/18) reported that they were more likely to limit contact during practice or somehow make the playing environment safer, indicating the difficulty in changing sports culture and beliefs. One research study for example suggests that the current culture of sports may not only discourage athletes from reporting their concussion symptoms but also prevents them from leaving the game after an injury (12). In 2014, the National Academy of Sciences Committee on sports-related concussions in youth concluded that athletes, and in some cases, coaches and parents may not fully appreciate the health threats posed by concussions, and that the culture of sports negatively affects both the athletes' self-reporting of concussion symptoms and their adherence to return-to-play guidance (13). Other studies show that education alone is not enough and that many coaches still believe that there is such a thing as an acceptable amount of head contact that an athlete can receive without getting a brain injury (14). In addition, one 2013 study has found that more than 90% of high school football players indicated they would play a game with a concussion, *despite* the fact that 70% knew about the signs, symptoms and dangers of concussion (15). It is important to note that a combination of recent US laws and increased concussion awareness have possibly contributed to improved concussion awareness

amongst high school athletes in more recent studies. For example, Anderson et al. (2016) assessed high school (HS) football players' knowledge of concussions and determined that 53% would not report an injury and continue to play with a headache from an injury (16). The numbers are still high, but they are much better than the ~90% noted in a similar sample just three years earlier (15).

The OPHEA RTP/RTL guidelines were followed well, with most boards incorporating many suggestions and in some instances adding creative options that could reduce concussion-related symptoms (e.g., hats/sunglasses instead of trying to dim classroom lights). These guidelines may help with recovery, but school staff can fail to recognize the need for academic or classroom adjustments after an injury because most kids look "normal" after a concussion, especially a few days/weeks after the injury (17). It is difficult to identify the *best* RTL practices because there are no clear guidelines as to what cognitive rest entails for students (18). However, these practices can play a pivotal role in determining whether an athlete is symptom-free and must be introduced before any RTP protocols (19).

Even though most school boards indicated that they had a system in place to keep track of injured individuals, it was not always clear who had access to this information. For some it was just the principal, for others it was "school staff working with the Ontario School Board Insurance Exchange (OSBIE)", and in some cases HPE teachers and "HR staff" could also access this system. It was also interesting to note that some boards did not indicate that they sent injury reports to OSBIE, even though they are listed on the OSBIE website and should be submitting every incident report to them. But, as one author notes, the threshold for reporting injuries is very low and for an unclear reason, different school boards might not report injuries the same way (20). This is also true considering the difficulty diagnosing concussion, whereby many of these

injuries might simply not "reach" OSBIE and would thus be significantly underreported. OSBIE acknowledges this on their website pointing out research that shows an almost 40 fold difference in the rate of underreported concussions in youth hockey when comparing survey based information with official injury reports (21-22).

The main limitation to this study was that the authors were unable to get a response from all 72 school boards in Ontario. It is thus unclear whether the responses of other school boards would be similar or different to the ones presented in this study, and there is a possibility of reporting bias. School boards who found policy implementation challenging may represent a unique subgroup within the sample – potentially being more - or less- likely to respond to our questionnaire. Furthermore, as this study was done with Ontario boards, the findings cannot be generalized to other school boards across Canada that might have different curriculums, protocols and other factors. While the PPM acts in accordance with the Education Act, it is not clear if it can be provincially regulated, as the boards are only required to report policy implementation (1). Currently there are no clear subsets in the Education Act that discuss this in any detail. Nevertheless, since Ontario was chosen because it was the only province to have *any* concussion policy in place (enforced or not), the findings from this study can help shape or guide other provinces' efforts in their own concussion education policies.

It is encouraging that all school boards had a concussion policy, and that many of those that responded included numerous elements identified as important in PPM #158. This suggests that the PPM #158 was effective or at the very least served as a catalyst in prompting all school boards to create concussion protocols, and some school boards to put effort into raising concussion awareness, and could possibly lead to future improvements in concussion prevention, identification and management across the province and in other Canadian provinces and Territories.

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Chapter 3. Paper 2: Trends in concussions at Ontario schools prior to and subsequent to the introduction of a concussion policy - an analysis of the Canadian Hospitals Injury Reporting and Prevention Program from 2009-2016

Abstract

Introduction: Concussion is a preventable injury that can have long-term health consequences for children and youth. In Ontario, the Policy/Program Memorandum # 158 (PPM) was introduced by the Ministry of Education of Ontario in March 2014. PPM #158's main purpose was to require each school board in the province to create and implement a concussion policy. **Purpose:** To examine trends in school-based concussions prior to and subsequent to the introduction of the PPM. **Methods:** This report examined emergency department (ED) visits in 5 Ontario hospitals that are part of the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), and compared trends over time in diagnosed concussions, and suspected concussions identified as "other head injury". **Results:** From 2009-2016, there were 21,094 all-source suspected concussions, including 8,934 diagnosed concussions in youth aged 4-18 years. The average number of diagnosed concussions in the 5 years before the PPM was 89 concussions per month, compared to approximately 117 concussions per month after; a 30% increase in the monthly rate of concussions presenting to the ED. The total number of concussion or head injury-related ED visits remained relatively unchanged but the proportion of diagnosed concussions rose from 31% in 2009 to 53% in 2016. The proportion of diagnosed concussions in females also increased from 38% in 2013 to 46% in 2016. The percent of all diagnosed concussions occurring at schools increased throughout the study reaching almost 50% in 2016 with most injuries taking place at the playground (24%), gymnasium (22%) or sports field

(20%). **Conclusion:** The introduction of the PPM appears to have contributed to an increase in concussion awareness and may have improved the identification of concussions and direction to care to the ED.

Introduction

Concussions are traumatic brain injuries that can change the way the brain functions and may result in multiple transient effects including memory issues, headaches, confusion, dizziness and possible loss of consciousness (1-2). Children are more sensitive to the effects of concussion and are disproportionately more likely to suffer head injuries than any other age group (3). Complications of concussions can include post-concussion syndrome (PCS), epilepsy, recurrent headaches, second impact syndrome, depression, mild cognitive impairment and chronic traumatic encephalopathy (CTE) (4-6). According to recent research from the Canadian Institute for Health Information (CIHI) almost 95% of all emergency department (ED) visits for sport-related brain injuries in 2014–2015 were concussion-related (3). There was also 78% increase for 0- to 9- year olds and a 45% increase for 10- to 17- year olds in ED visits (3).

Known risk factors related to pediatric concussion include being involved in a motor vehicle collision, falling, being involved in high-risk sports (e.g., football, hockey, boxing), playing without proper safety equipment or adequate supervision, and having had a concussion in the past. Studies looking at sex and age differences have been inconclusive, often showing conflicting results that vary between sports, but recent research has found increasing evidence that female athletes sustain higher rates of concussion than males in sex-comparable sports and also have a longer recovery time (7-10).

There has been a recent emphasis on concussion prevention in children and youth. In 2009, Washington State passed the Zackery Lystedt Law, named after a youth athlete who suffered a serious and debilitating brain injury in 2006 while playing football. The number of reported concussions more than doubled after the introduction of this law, possibly a result of heightened awareness and/or closer monitoring (11). By 2013, all 50 US states had passed laws dealing with youth concussions. In Canada, on March 19, 2014, the Ministry of Education of Ontario passed the Policy/Program Memorandum # 158 (PPM) that mandates school boards to develop and implement a concussion policy (12). PPM #158 consisted of a series of expectations and guidelines that each publicly funded school board in Ontario is required to adhere to when developing and implementing their own concussion policy. The primary aim of the PPM was to ensure that school boards created policies related to concussion detection and treatment, including return-to-learn guidelines by January 30, 2015 (12). Previous attempts to enact concussion-related policy or legislation were not successful in Canada, making this PPM the first, and thus far, the only policy of its kind in the country. Acting in accordance with the Education Act, the PPM gives the Minister of Education the power, if necessary, to force the school boards to create and sustain the requested concussion policies (12). More recently, in February 2018, Ontario became the first province in Canada to pass a concussion policy (Rowan's Law), which is intended to provide guidelines on the prevention, diagnosis, treatment and surveillance of head injuries and their sequelae among children and youth (13). However, the recommendations from the Rowan's Law committee are general recommendations that may or may not result in the enactment of legislation.

One of the issues in assessing trends in concussion is underreporting and under-diagnosis. One US based analysis shows that the rates of undiagnosed concussions range from 14.5% in a

medium-sized sample of adolescent athletes, to as many as a third in a much larger sample (14-15). Another study found that nearly half (44.9%) of former collegiate athletes reported sustaining undiagnosed sport-related concussions (16). Similarly, a retrospective study of concussion rates in collegiate athletes found an unreported rate of about 12% (17) while other researchers placed this number much higher, to as many as 30% (18) and even as high as 80% in certain sports such as football (19). One problem with concussion diagnosis and reporting is the number of terms used to describe or define concussion. Frequently, these terms are used interchangeably and sometimes incorrectly, making any meaningful comparisons between studies or reports problematic (1). Concussion reporting within Ontario schools also appears to suffer from under-reporting. While data are routinely gathered by the Ontario School Boards' Insurance Exchange (OSBIE), in 2011 there were 634 reports of concussion or possible concussion out of 84,706 general incidence reports (20). At about 0.7%, of the total number of incidence reports, the number of reported concussions is disproportionately lower than reported in most other studies (21-22), thus suggesting underreporting of concussions to the insurance exchange by Ontario schools.

The objective of this study was to examine trends in school-based concussions (suspected and diagnosed) in Ontario, prior to and subsequent to the implementation of PPM #158.

Methods

CHIRPP overview

The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) was selected as the data source for this study for several reasons. First, when examining data from the OSBIE, the number of reported concussions appeared to be under-reported. Second CHIRPP

is an injury and poisoning surveillance system that is based on data drawn from the emergency rooms of 11 pediatric hospitals and 6 general hospitals in Canada (24). Out of these, 5 pediatric hospitals and 1 general hospital are in the province of Ontario (24). It began in 1990 and has since accumulated more than 2.8 million records nationally, with more than 80% of them being on individuals aged 19 and younger. The main objective of CHIRPP is to reduce the number and severity of injuries in Canada (24). Any time an injured person presents to the emergency room of a participating hospital, he/she (or caregiver) is asked to complete a short one-page questionnaire that requests detailed information on the nature of their injury. These questions deal with what caused the injury, what the activity was at the time of injury, the time and location of the injury, as well as sex and age. The reverse side of the CHIRPP Form is completed by hospital staff, providing details on the nature of the injury, diagnosis, injured body part and treatment received (24). The completed forms are entered into an electronic database by trained personnel who enter and code information on more than 40 variables and write a short overview on what transpired based on the account of the injured individual. Thus it is possible to include children who sustained an injury at school.

Participants

Data for this study was based on five children's hospitals in the province of Ontario. These hospitals were the *Children's Hospital of Eastern Ontario* in Ottawa, *Hotel Dieu Hospital, including Children's Outpatient Clinic* in Kingston, *Kingston General Hospital* in Kingston, The *Hospital for Sick Children* in Toronto, *and the Children's Hospital at London Health Sciences Centre* in London, ON. Children and youth aged 4 to 18 years who were treated at these hospitals between 2009 and 2016 were included in this study. The years 2009-2010 were the most recent years that encompassed complete data in the old CHIRPP system, before it switched

to an electronic version in 2011; thus the 8 years represented the latest available complete database. Individuals that were diagnosed with either a minor closed head injury or a concussion were included. Minor closed head injuries were defined as 'suspected concussions', signifying that even though they were not diagnosed as concussion at the time, they were still a cause for concern. A secondary analysis was also conducted on injuries that occurred in school, because the PPM only required concussion prevention and education in school boards. Ethics approval was obtained from York University and the Public Health Agency of Canada.

Variables of Interest

This study's primary outcome measure was a suspected or confirmed concussion, which included both minor head injuries and diagnosed concussions. The exposure variables were age, sex, month of injury, location of injury (school), and where in the school the injury took place. Age groups were separated into three categories: 4-9, 10-14 and 15-18, to align with developmental stages. The percent of diagnosed versus suspected concussions was examined for all locations and those that took place at a school, including examining where in the school the injury occurred.

Statistical Analyses

Descriptive statistics were calculated using SAS version 9.4 and Microsoft Excel. Data were only available until August 2016, making it an incomplete year. Fall 2016 was thus estimated for *graphing purposes only* using a linear approximation model. We modeled comparisons between diagnosed and suspected concussions, and for diagnosed concussions pre-/post- introduction of the PPM (March 2014), both generally and for school-incurred injuries

only. Statistical significance was set at $p < 0.05$, and differences between means were based on a two-tailed t-test.

Results

Diagnosed vs. Suspected Concussions

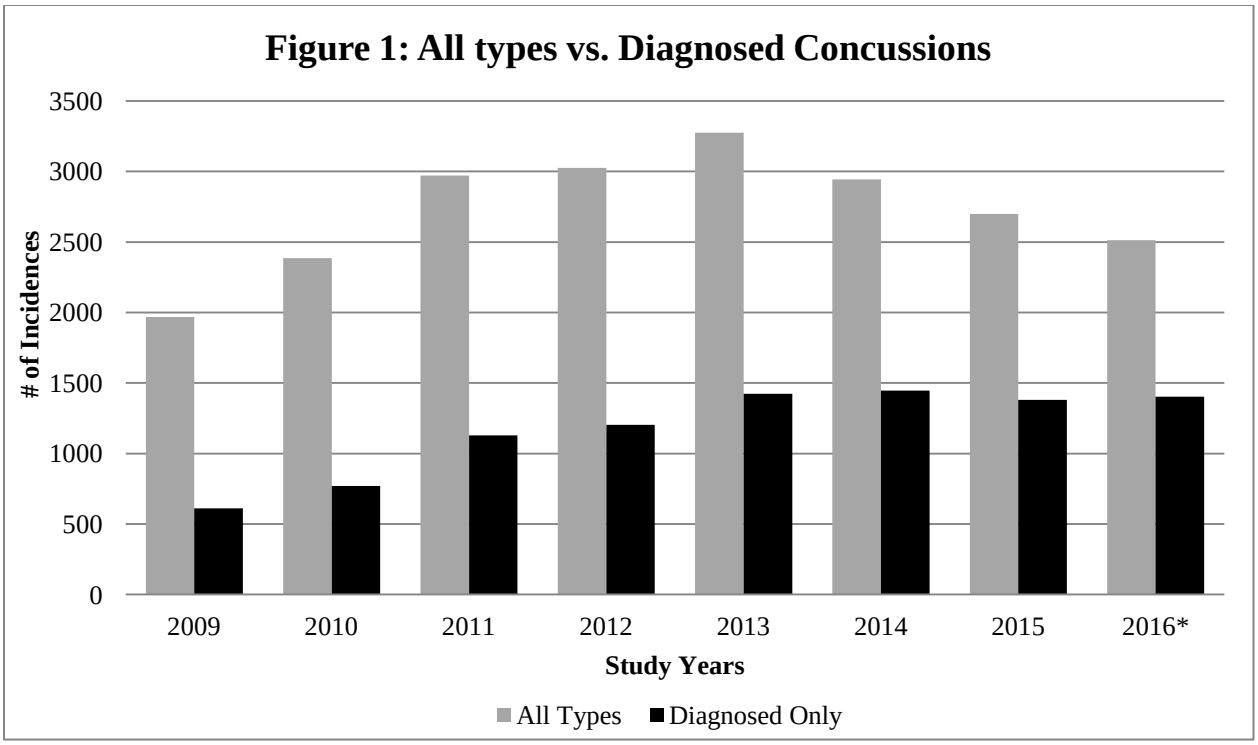
In total, between January 2009 and August 2016, there were 21,094 children and youth treated in participating EDs for head injuries, including 12,159 suspected concussion and 8,935 diagnosed concussions. In total, there were 164,766 ED injury-related visits recorded in CHIRPP during this time period, with diagnosed concussions accounting for 5.4% of injury-related visits and minor closed head injuries accounting for 7.4%. In 2009, there were 610 (31%) diagnosed concussions out of 1,969 suspected concussions. This number rose to 974 diagnosed concussions out of 1,822 suspected concussions (53.45%) in 2016 (**Table 1**). The actual number of emergency department visits for suspected concussions started to decrease in January-February 2014, just before the PPM was introduced (March 2014) but the number of diagnosed concussions remained similar (**Figure 1**). The monthly average number of suspected concussions before and including the March 2014 introduction of the PPM was 232 per month. The average number of suspected concussions after the introduction of the PPM was slightly lower at 229 per month. The average rate of *diagnosed* concussions before the March 2014 PPM was about 89 concussions/month. Subsequent to the introduction of the PPM this number increased significantly by more than 30% to about 117 concussions per month ($p<0.001$).

Table 1: Age and Sex Distribution of Diagnosed Concussions by Study Years							
Study Year	**N Diagnosed**	**Diagnosed as % of Suspected Concussions**	**Age group (years), N (%)**			**% Male**	**% In School**
			4-9	**10-14**	**15-18**		
2009	610	31.0 %	152 (23.1)	308 (46.9)	197 (30.0)	63.2 %	30.4 %
2010	770	32.3 %	160 (20.0)	383 (47.8)	258 (32.2)	65.3 %	26.9 %
2011	1128	38.0 %	227 (20.0)	553 (50.5)	335 (29.5)	64.8 %	25.6 %
2012	1203	39.8 %	273 (22.2)	588 (47.8)	368 (30.0)	64.8 %	28.2 %
2013	1423	43.4 %	342 (24.3)	663 (47.0)	404 (28.7)	61.8 %	32.2 %
2014	1445	49.1 %	369 (26.0)	600 (42.1)	454 (31.9)	56.7 %	35.4 %
2015	1381	51.2 %	325 (23.0)	638 (45.2)	449 (31.8)	56.8 %	44.9 %
2016*	975	53.5 %	208 (24.0)	401 (46.2)	259 (29.8)	54.4 %	42.3 %
Total	8935	42.3%	2056 (23.0)	4134 (46.4)	2724 (30.6)	60.5 %	33.8 %

* Incomplete year

Sex and Age Differences

The majority or 60.5% of the whole sample with diagnosed concussions were male but the difference between the sexes started to decrease in 2013-2014 (**Table 1**). A total of 46.4% of all diagnosed concussions were in individuals aged 10-14. The age group with the least amount of injuries, constituting 23% of the whole sample was children aged 4-9.



*** Fall 2016 numbers were estimated using a linear approximation model**

Diagnosed Concussions in Schools

For the school-incurred diagnosed concussions data, the two summer months, July and August were removed from the analysis. The difference between *possible* (suspected) concussions before/after the PPM is not statistically significant (<1% increase). However, the difference between diagnosed concussions was almost twofold ($p<0.001$). Prior to the PPM, the number of average monthly diagnosed concussions was about 23/month, then in the months following the PPM this number rose to 44 concussions per month (excluding the estimated fall months). **Figure 2** shows the percentage of ED visits for school-incurred diagnosed concussions for each month, and **Figure 3** shows the number of school-incurred diagnosed concussions relative to all locations incurred diagnosed concussions by year. Averaged out on a monthly basis, school-based concussions accounted for about 28% of all ED diagnosed concussions before and including March 2014 (PPM intro date). However, for the post-PPM months, this

number rose to almost 42%. Overall school-incurred concussions accounted for more than 34% of all diagnosed concussions **(Table 1)**. Some months had an almost 60% school-incurred diagnosed concussion rate out of all diagnosed concussion ED visits. The proportion of all school-diagnosed concussions increased throughout the study reaching almost 50% in 2016.

School Injury Location

Table 2 indicates locations within schools where diagnosed concussions occurred. The greatest proportion of all school-based, diagnosed concussions, occurred on the playground (23.7%), followed by the gymnasium (22.1%) and the sport field (20.2%). The *hallway* variable, which included the waiting area, foyer, and emergency room was combined with stairs and ramps. The lowest number of concussions happened in *other school areas*. These areas were collapsed into one category for ease of interpretation and included: the roadway, sidewalk/bus stop waiting area, school parking lot, bathroom, dining area, kitchen, office, veranda/porch, and other unspecified exterior/interior areas. Most of these areas had fewer than five diagnosed concussions over the 8-year study period.

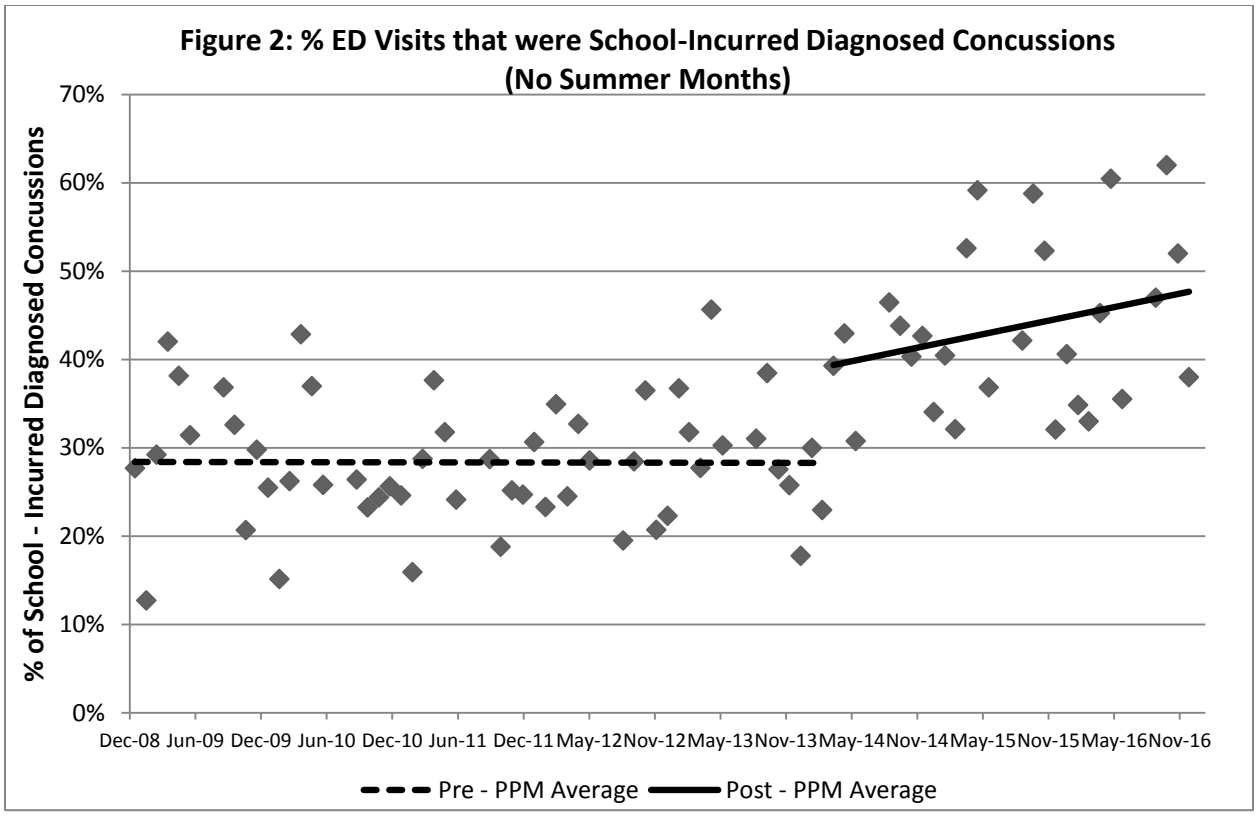


Figure 2: % ED Visits that were School-Incurred Diagnosed Concussions
(No Summer Months)
% of School - Incurred Diagnosed Concussions
70%
60%
50%
40%
30%
20%
10%
0%
Dec-08 Jun-09 Dec-09 Jun-10 Dec-10 Jun-11 Dec-11 May-12 Nov-12 May-13 Nov-13 May-14 Nov-14 May-15 Nov-15 May-16 Nov-16
Pre - PPM Average
Post - PPM Average

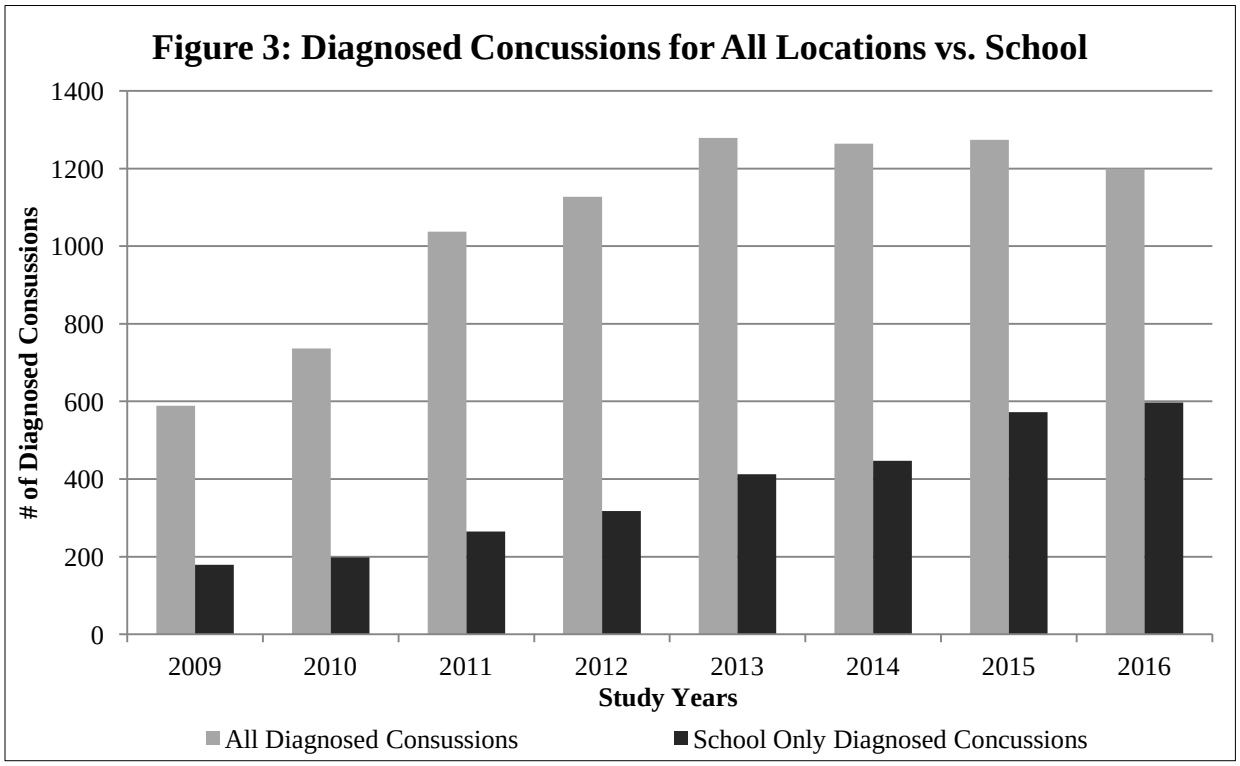


Figure 3: Diagnosed Concussions for All Locations vs. School
# of Diagnosed Consussions
1400
1200
1000
800
600
400
200
0
2009
2010
2011
2012
2013
2014
2015
2016
Study Years
All Diagnosed Consussions
School Only Diagnosed Concussions

Table 2: Locations in school where diagnosed concussions occurred		
Location		N (%)
Playground	(including swings, slides, other objects)	651 (23.7)
Gymnasium	(weight room, fitness room, locker room)	609 (22.1)
Sport Field	(track, sport court, rink, swimming pool)	557 (20.2)
Unknown Area	(also includes missing info)	354 (12.9)
Garden/Yard	(fields around the school)	310 (11.3)
Classroom	(daycare indoor, activity area)	126 (4.6)
Hallway/Stairs	(foyer, ramps, waiting room)	97 (3.5)
Other School Areas	(bathroom, dining, office, parking lot)	48 (1.7)
Total		2752 (100.0)

Discussion

The analysis of 8 years of CHIRPP data on concussions generally, and school based concussions specifically, revealed that there was a large proportion of suspected concussions and confirmed (diagnosed) concussions compared to all-cause injury. The number of diagnosed concussions increased significantly subsequent to the introduction of PPM 158 while the number of suspected concussions decreased. The past 10 years have seen an increase in ED visits for concussion in Ontario, which may be partially attributed to increased media attention, the rise of social media, numerous high profile athlete injuries and increased overall sports safety equipment, rules and regulations (23).

In general, males were more likely to sustain a diagnosed concussion but after the PPM's introduction in early 2014 the sex difference began to lessen. Recent research by Rajabali in 2011 and by the Canadian Institute for Health Information in 2016 show that males make up 50-62% of all emergency department concussion-related visits (25, 3). The reasons for the observed decrease in the sex-based differences are unclear. Some studies suggest that there is a lack of traumatic brain injury research in women and it is unclear how undiagnosed injuries affect women (26). Others suggest that females may sustain *more* concussions than males, but because their injuries are more often overlooked, they appear more under-diagnosed (27). Research

suggests that the recent increase in the rates of diagnosis could therefore lead to an increase in the number of confirmed concussions in women (28).

The analysis of CHIRPP data showed an increase in concussion-related ED visits until 2013 followed by a decrease by the middle of 2016 **(Figure 1),** but this finding goes against recent literature on concussion trends. In a recent review of physician office and emergency department (ED) visit rates for pediatric concussion from 2003 to 2013, Zemek et. al showed a 4.4-fold (95% CI 4.37-4.45) increase per 100 000, suggesting that the rates have greatly increased, particularly since 2010 (29). Alternatively, one study looking at various head trauma treated in U.S. emergency departments, found that concussions increased by 37.5 % over the 2007-2011 study period (30) somewhat mirroring our findings of an increase in diagnosed concussions. However these reports only go to 2013 and 2011 respectively, and the data in this paper shows a similar, increasing trend up to the end of 2013 (**Figure 1**). The reasons for the drop in ED visits after 2013 are unknown but could be due to changes in health service patterns (e.g., fewer patients seeking care at CHIRPP hospitals) , PPM-related increases in concussion awareness or due to chance as only five hospitals had CHIRPP data, compared to other larger, injury surveillance datasets.

The rates of suspected versus diagnosed concussions have never been analyzed in an emergency-department setting, thus it is unclear as to why the proportion of diagnosed concussions increased with time (**Figure 1)**. Increased awareness may have led to more confidence in diagnosing concussions rather than the more general closed head injury diagnoses.

Recent research into the effects of U.S. state concussion laws suggests that such laws are effective in improving the evaluation and detection of sports related concussions in high school

students (31-32). Adapted from Washington State's Zackery Lystedt Law (May 2009), these laws focus on concussion management in youth athletics via a combination of improved return-to-play and return-to-learn protocols, coach and player education, and other factors (31, 33). One study found that the implementation of a state concussion law in Connecticut (U.S.) has led to more than a two-fold increase in the number of concussion emergency department visits, but only in high school students (31). Similarly, not only has our study found an almost two-fold increase in the number of pre-/post- PPM school diagnosed concussions (**Figure 3)**, but the proportion of concussions coming from a school setting has also been increasing at a constant pace (**Figure 2)**. The majority of school-based concussions occurred either at a playground or while playing sports at the gymnasium or a sports field and this finding has been demonstrated in other Canadian studies (34).

Limitations

CHIRPP does not represent all ED visits for youth concussions in Ontario since it only accounts for five hospitals. Thus, this study was not able to capture all other children that were treated elsewhere, and CHIRPP is known to have a variable capture-rate, explained elsewhere (35). Thus, the findings in this paper are likely very conservative, significantly under-representing the population at risk. The database also does not contain information on critically and fatally injured children. However, we believe that the numbers are somewhat representative of Ontario children, especially when compared to OSBIE data. For example, in our CHIRPP school data in 2011 there were 265 confirmed, diagnosed concussions and 510 suspected concussions. OSBIE reported 634 instances of concussions or possible concussions, from all participating Ontario schools (36). The 265 confirmed CHIRPP concussions were reported in only the five participating Ontario hospitals. That five hospitals reported more ED visits for

concussion than official OSBIE reports for almost five thousand schools suggests significant underreporting or underestimation of youth concussion rates (37-38). Since OSBIE often works together with the Ontario Physical and Health Education Association (OPHEA) and other sports and athletics organizations across the province to develop various safety guidelines, it uses the insurance reports as the backbone or foundation for these guidelines (39). However one report found evidence that actual youth concussion rates, at least in some sports (e.g. hockey) are *40* times greater than the officially reported OSBIE numbers (39). It is unclear why this is the case but it raises questions about using insurance data for surveillance, and suggests that other data sources need to be considered when examining concussion trends.

Conclusion

This paper examines trends in pediatric concussion in the context of Policy/Program Memorandum # 158 in the province of Ontario. We cautiously suggest that the PPM and subsequent school board concussion policies have contributed to an increase in concussion awareness and improved concussion identification at the school level. This was not mirrored by a general increase in the frequency of overall head injuries, but has led to an increase in the number of diagnosed concussions. The current paper identified a few trends including an increase in diagnosed concussions, an increase in the proportion of school-based diagnosed concussions, as well as an increase in diagnosed concussion in females. This suggests that PPM #158 has contributed to improving concussion detection in schools. Ongoing research, into the effectiveness of PPM 158 in terms of prevention of concussions and student, teacher, and parental awareness is required.

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Chapter 4. Paper 3: Physical education teachers' perceptions of concussion policies in relation to Ontario's Policy/Program Memorandum #158

Abstract

Introduction: Concussions have been identified as a public health concern for people of all ages, but are of particular concern in school-aged children. Recent media and research focused on concussions in the United States have led to all States adopting mandatory concussion laws with the goal of reducing the number of concussions. There are no similar country-wide laws in Canada, outside of the recently passed Rowan's Law in Ontario. The Ministry of Education of Ontario introduced the Policy/Program Memorandum (PPM) # 158 in March 2014, requiring all publicly funded school boards in the province to create and maintain a concussion policy. **Purpose:** The purpose of this study was to examine the perceived effectiveness of the PPM #158 and subsequent concussion policies from the perspective of health and physical education (HPE) teachers. **Methods:** We developed and used a questionnaire-based approach to gather the perceptions of HPE teachers in schools across Ontario. **Results:** Twelve teachers responded to the survey. All were aware of their board's concussion policy; 83% reported that they had received training and/or relevant education, 75% had a trained individual present at every game/practice, 83% noticed a difference in parental involvement, 100% reported changes in the way return-to-play (RTP) and return-to-learn (RTL) protocols are implemented at the schools and 92% agreed that there was a need for government-mandated concussion law. **Conclusion:** Evidence from this study suggests that the PPM and subsequent school board concussion policies contributed to raising concussion awareness, improving knowledge and practice among HPE teachers, and subsequently improving concussion management.

Introduction

With the identification of concussion as a public health concern, there have been calls to enact provincial legislation on concussion identification and recovery. Such laws exist in the United States (U.S.), with the first being the Zackery Lystedt Law in the state of Washington (2009). Subsequently, all other states have enacted concussion safety laws establishing mandatory protocols regarding issues such as what to do when there is a concussion, return-to-play (RTP) and return-to-learn (RTL) protocols, concussion education for coaches, athletes and parents, credentials for individuals making the RTP decisions, and other components (1). There is variation amongst the different states' laws but the main goal is the same: to help protect children from the dangers of concussion and their sequellae. However, as of March 2018, there are no concussion laws of any kind in Canada outside of Rowan's Law that was passed in February 2018 (2).

Even though the U.S. state laws have been implemented, the extent to which they are having an effect is unclear. Studies have shown that compliance and implementation of the laws greatly varies across the states, especially in areas of concussion education, coach training and punitive consequences for ignoring these new laws (3). It is unclear whether the laws are having the desired effect, but some studies do show that they have contributed to increased education for the coaches and an overall increase in concussion awareness (4). In March 2014, the Ministry of Education of Ontario (Canada) introduced a Policy/Program Memorandum (PPM) # 158 that mandated all school boards in the province to create and sustain a concussion policy by January 30, 2015 (5). The Ministry of Education used the PPM to require School Boards to set guidelines and outline procedures and practices, but these established policies are not *laws* and thus do not have the same legal force as Statutes and Regulations in the U.S.

PPM #158 places the responsibility on individual school boards to create and implement their own concussion policy by using the Ministry documentation and the Ontario Physical and Health Education Association (OPHEA) guidelines as a template. The effectiveness of a PPM-approach for concussion has yet to be evaluated and it is not clear whether a non-legislative approach can have a positive effect on concussion identification, management, and treatment. The objective of this paper is to examine the *perceived* effectiveness of the school board concussion policies from the perspective of HPE teachers.

Methods

All 72 school boards across Ontario were contacted and asked to participate in this study by filling out a 3-page questionnaire on the nature of their board's concussion policy and other policy-specific questions. Of the 72 school boards, 25 or 34.7% demonstrated an interest in this study, out of which, 18 boards eventually sent back a completed questionnaire. Information about this questionnaire is presented elsewhere (**Study 1**). The last question asked the school boards' permission to contact physical education teachers and/or coaches about their concussion policy-related opinions and beliefs. School boards that agreed to participate were forwarded another (different) questionnaire that was distributed internally amongst the schools to HPE teachers. Due to school boards' privacy and ethics rules the authors were not given any teachers' contact information, nor were they allowed to contact them directly. This affected the scope and size of the acquired sample of respondents and also slowed the acquisition of responses, as the authors were required to wait for an extended period of time while the questionnaires were redistributed inside the school board's system. The potential respondents were contacted internally by each school board and were forwarded an introductory message from the primary authors, the HPE teachers' questionnaire, and a consent form that could be filled-out, signed and

returned either digitally, or printed off and sent by regular mail. As the PPM only applies to publicly-funded schools, only public-school teachers from 72 Ontario school boards that were listed on the Ontario Secondary School Teachers' Federation (OSSTF) website, and that are part of the Ontario School Board Insurance Exchange (OSBIE) were contacted for this study in May 2016 (6). The HPE teachers were given until May 2017 to complete and send back the questionnaire and consent form.

The questionnaire was developed under the guidance of the primary researcher's supervisor and Parachute Canada (a national, charitable organization) specifically for this study and was not taken from any other survey. Some questions were based on the OPHEA concussion guidelines, while other, questions were designed to simply gather information on the HPE teachers' thoughts, ideas, and reflections about particular aspects of sports concussion policy and regulations. There were 10 questions in total, with the primary focus centered on policy implementation and application. The questionnaire first asked the teachers about their knowledge of their board's respective concussion policy or protocol and whether they have had any concussion training, have heard of or participated in any concussion-related discussions, workshops, seminars, etc., and if not, the reasons for not participating, or not wanting to be involved (Question 1-4). The other questions (5-8) dealt with the presence of concussion-trained personnel at every sports game and/or practice, concussion protocol if a concussion is suspected, observed differences in RTP/RTL practices at the schools and whether there was a noticeable increase or decrease in parental involvement/interest in concussion. The last 2 questions (9 & 10) addressed the HPE teachers' beliefs in the effectiveness and need for concussion policies at the school and/or federal levels.

Table 1: Health and Physical Education Questionnaire Results	
Questions	**Yes n (%)**
Q1: Knowledge of board policy	12 (100)
Q2: Ever taken a course/educated in concussion	10 (83)
Q3: Heard of any concussion training, seminars, presentations, posters, pamphlets at school board	10 (83)
Q4: Participated in any of above (Question 3) events	9 (75)
Q5: Trained individual at every game/practice	9 (75)
Q6: Noticed a difference in RTP/RTL practices at school	12 (100)
Q8: Noticed a difference in parental involvement	10 (83)
Q9: Believe that concussion policies at board level work	10 (83)
Q10: Need for government level concussion policy	11 (92)

Results

There were 12 responses received from HPE teachers (and none from coaches). The respondents represented 5 different school boards from various regions of Ontario. The exact number of potential HPE teachers in the province is unknown but can be hypothesized to be greater than 5,000, considering the overall number of schools and the general lack of full-time HPE faculty in the province (7). All 12 respondents indicated that they knew about their board's concussion policy and the approximate date it was first implemented. Most of them (10/12) had taken a course or received education on concussion identification and management, however in some cases (3/12) this was just an extended component of the regular first-aid training course. One teacher, for instance, said that they only had first-aid and saw "posters and binders" with concussion info, while another said they attended multiple professional development sessions offered at the beginning of the year by their school board. A third teacher mentioned that they only had attended a doctor-led information session. A few teachers indicated that they had either taken an online course, attended lectures/training sessions with external organizations, or were involved in additional projects that required them to learn extra material (i.e., asked to give a

guest lecture). Most teachers had also heard of (10/12) and participated (9/12) in training or education sessions offered at their school board. A further 9/12 teachers indicated that they had a trained individual at every sports game and/or practice and in most cases (7/8), this individual was themselves.

All 12 respondents reported noticing a change in terms of return to play (RTP) and/or return to learn (RTL) practices at their school since the implementation of their board's concussion policy (**Table 1)**. A few more detailed responses pointed out that the RTP/RTL process was now much longer thanks to a greater parental involvement - "families seem to be more aware of risks" and the requirement to "sign-off" an injured individual by a qualified medical professional before allowing them to return to active sport. Greater parental involvement was noticed by 10/12 teachers but 3 of these teachers said that this involvement was disruptive and/or somehow negative. While one teacher said, "they (parents) seem to take it more seriously now thanks to the paperwork involved," another mentioned that parents would "call the school to report an injury that occurred elsewhere". A third teacher found completely the opposite: parents needed to be educated on the dangers of concussion, premature RTP, and, "some want to just send their child back as soon as possible", without reporting concussions suffered elsewhere or that the child was recovering from an injury. One teacher noted that he/she received "numerous follow up emails and phone calls after concussions" suggesting an overall increase in parental interest and involvement in their child's welfare. Another said that "parents are more cautious about return to play procedures" and are thus more concerned about the health of their children.

Most teachers were in favor of both government-level interventions (11/12), and strongly believed that concussion policies were working at the school level and could, potentially, help improve concussion detection and management (10/12). One teacher pointed out that the school

policy had brought attention to the fact that concussion is a "brain injury that can have serious consequences". Another teacher said that "some teachers think students that suffer concussions in sports are not affected in other school subjects", suggesting a need for consistency in teacher training, education and guidelines. Another teacher shared their opinion that "paperwork and tracking can't change that. More safety considerations are needed for high risk and moderate risk sports". Finally, the only questionnaire respondent that was against laws/mandates and also believed that current school policies were ineffective, counter proposed that "concussion policies can be implemented under administrative direction," but at the same time highlighted that "all teachers and coaches require time for concussion protocol professional development".

Finally, 10/12 teachers reported that in situations with suspected concussions they would immediately remove the child from the game, notify parents/guardians, call an ambulance or take the youth to a school nurse (if there is one) and make a note of the incident. Only 3/12 teachers said they would follow a concussion protocol and 1 teacher said they would also call parents afterwards to make sure the child was okay and that he/she was able to see a doctor.

Discussion

This was the first study to look at perceived implementation of school board concussion policies. At the time of data collection in 2016, most school board concussion policies in Ontario had only been in effect for 1-2 years given the PPM #158's deadline for implementation of January 30, 2015. All teachers who responded to this survey knew about their board's concussion policy and in most cases had participated in some sort of concussion education, training, or professional development instruction session. Similarly, most concussion state laws in the U.S. have a mandatory educational component. However, the extent of the education among participants was very diverse, ranging from actual courses to simple pamphlets with concussion

information (8). There appears to be a similar problem with Ontario school board policies, as in this study, it was noted that two different teachers within the same board reported participating in different education opportunities. The reasons for this are unclear but could be the result of the relatively open-ended nature of the PPM. The PPM outlined that individual school policies needed to have "strategies for providing regular and ongoing training on concussion awareness, prevention, identification and management..." but did not specify what these should be or how they can be measured, evaluated or compared (5). This would explain why there could be such significant differences inside one board, and that it is then possible that the intra-board differences are even greater. Education and training might benefit from a more harmonized approach within boards, and even across the province.

Another important concussion policy component that was not included in the ministry PPM documentation and OPHEA safety guidelines, but that is included in many of the U.S. state laws, is the presence of a designated trained individual at every game and/or practice. For example, athletic therapists or athletic trainers have been shown to increase the likelihood that a concussion will be diagnosed, and are less costly to train, hire and employ than medical doctors or specialized nurses (9-10). For this reason the authors included a question about training in the survey. Seventy-five percent of respondents did say that they had a trained individual at every game, however in almost all cases they considered themselves to be that trained individual. Logically, and from a financial standpoint, this makes sense, as it is more feasible and efficient to train school staff in concussion identification and management than to hire costly, external alternatives. However, research suggests that teachers/coaches are too busy watching the game to pay attention to individual players, suggesting that a designated staff member or sports therapist should be in charge of recognizing suspected concussions (11).

All of the teachers interviewed noticed a difference in terms of RTP and/or RTL practices at the school. Several noted that the implementation of the new school concussion policy may have resulted in more students and athletes being away after an injury, and for longer periods of time. Initial rest is important for recovery, so a longer RTP/RTL may contribute to a more successful, if albeit longer, recovery (12-13). This recovery period is critical and it is important to ensure that every participant (students, teachers/coaches and parents) is aware of the dangers of early RTP (13). Some teachers reported that the level of parental awareness or knowledge about concussion was very limited, and this finding has been seen in multiple studies of U.S. state policies (14-15). For example, one recent study looking at concussion knowledge in parents of young recreational football players found a large percentage of parents lacked concussion symptom knowledge, and had incorrect beliefs about the definition, symptoms, and treatment of concussion (16).

The teachers were very supportive of both concussion policy at the school level and government legislation. The general consensus was that the policies are not only helpful in their own right, but have also brought attention to the issues of concussion, youth injuries and injury policy effectiveness on the whole. Consistent with past research, most teachers are aware that concussion is not just a "bump on the head", but rather, they recognized that concussion can have a life-long impact on the injured individual (17). Another teacher suggested that government legislation can not only reduce injury risk in schools, but it can also help monitor injuries outside of school, ensuring that kids injured elsewhere don't show up to play sports the next school day while suffering from possible concussion symptoms. Other respondents emphasized that government legislation, in their opinion, is the *only* way to guarantee improved concussion prevention, through dedicated funding that could go into training, awareness, education, etc.

Recently, Rowan's Law was passed in Ontario – a bill that establishes a committee in response to recommendations outlined in a coroner's inquest into the death of Rowan Stringer, a 17-year old rugby player from Ontario (18). It has raised public concussion awareness and has been the only concussion-related policy that passed senate hearings so quickly and without any major setbacks or delays (18). It is possible that Rowan's Law may lead to the creation of a government-mandated provincial or nation-wide concussion policy in the near future (18). Currently however, Rowan's Law is simply a series of recommendations that have yet to become law, and may or may not lead to policy changes in the near future.

This study is not without its limitations. The main limitation is that it cannot be stated for certain whether the HPE teachers received their training after the introduction of PPM #158 or the corresponding school board concussion policies were already in place by the time of the PPM's release. Secondly, the questionnaire that was used is new, and has not been validated or used in any other study. Thirdly, this study had a small sample size that could be in part explained by the various gatekeepers that delayed or restricted our recruitment for the study. The nature of the school boards' ethics and various contact rules and protocols prevented us from contacting the schools and the HPE teachers directly, delaying the overall study time and greatly reducing the potential pool of eligible participants. The novelty of the concussion policies and the lack of time that the boards had to train personnel and implement policy protocols could have played a role in boards', schools', and teachers' reluctance to participate in the study, or in many cases, seeming disinterest in the research project. Nevertheless, this led to a very biased self-selected sample, where it could be argued that only HPE teachers that were interested in the study or had previous knowledge and/or experience with these policies agreed to participate in

the research. Unfortunately, due to time study time constraints, board policies, and methodological restrictions, there was no way to work around this limitation.

Conclusion

Our findings suggest that HPE teachers in this study perceived that the policies after the launch of PPM #158 were having a positive effect. All of the HPE teachers involved in this study were aware of their respective school board's concussion policy and 83% of them had received some sort of concussion training or education. In addition, most teachers were in favor of government laws and school-based policies. With the introduction of concussion school board policy, the respondents had also noticed a general increase in concussion awareness, a change in RTP/RTL protocols at their schools, a greater involvement of parents and an attempt to have a concussion trained individual at every game/practice in at least, the high-risk sports. These positive (perceived) outcomes could potentially contribute to improvements in the concussion outlook in public schools across the province of Ontario, moving forward. Future research should focus on evaluating the effectiveness of the school concussion protocols by establishing whether or not the new RTP protocols, teacher education, mandatory medical clearance and other elements of new policies reduce the actual youth concussion incidence rates across the province.

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5. Extended Methodology Overview

5.1 Study 1 Methodology

The main question of the first study was to see whether or not the school boards followed the PPM guidelines and actually developed and implemented a concussion policy either by January 30, 2015 or the current study period (February 2017). These concussion policies were then compared across the different school boards to get a better sense of the variability between the programs and to see whether or not the OPHEA regulations were implemented. The study was separated into multiple phases to account for various school board's responses and to maximize the number of respondents.

First, the Ministry of Education of Ontario provided the primary authors a list of contact emails and some phone numbers for about 30 school boards. The other 42 school boards were contacted directly via emails that were found on the respective school board's websites, or called if a telephone number was provided instead of an email. In addition to the 72 school boards, there were 7 special needs schools that are considered and designated by the ministry as independent school boards. One of these special schools was contacted directly to inquire about their concussion policy. After a lengthy and very interesting conversation with the vice-principal of said school, it was determined that while the school did indeed have a concussion protocol in place, they were very unlikely to have any sports-related concussions for the sheer reason that the vast majority of the special needs kids at their school could not and did not participate in any sort of risky or contact sports. Thus it was agreed by the primary researchers that due to the nature of research in question (sports, physical activity, concussions) and the very low student enrollment at these schools they were not considered in the final analysis.

All school boards were forwarded a letter of consent, the policy questionnaire (**Appendix A)** and a brief introductory letter. This policy questionnaire will be discussed in greater detail in the next chapter of this report (**Chapter 5.2**). There were 14 responses (19.4% response rate) after the first round of communications in March - April 2016. 3 school boards have filled out the questionnaire and the consent forms while the other 11 asked for more time, to wait until their monthly committee meeting, to wait until the end of the school year (when they are less busy), for additional info, or to submit a school-specific ethics approval package.

A second round of communications was sent to all school boards in October 2016. There were an additional 12 new responses, bringing the total number to 26 (36% response rate) after two rounds of communication. Some school boards declined participation for various reasons including "no time", "not the right time" and "no implementation personnel". By January 2017 there were 10 responses with completed study packages (questionnaire + consent), 6 responses declining participation, and 10 were still in the process of being completed and/or reviewed. The 6 boards that have declined participation have sent an electronic version of their policy for our review. In addition to the two rounds of communication, an online search was conducted to identify whether or not all Ontario school boards have an online version of their concussion policy and if yes, the date it was established.

5.2 Study 1 Questionnaire

The questionnaire was created based on previous policy evaluations and included questions guided by the PPM documentation and the OPHEA guidelines. Further, Parachute Canada and the Ministry of Education were consulted (**Appendix A)**. There are 12 questions primarily focusing on policy concussion policy components. There are also 2 additional

questions for school boards that indicate they *do not* have a policy in place. The first question asks whether the board has a concussion policy or protocol in place, and the date it was established. Questions 2, 4, 5, 6, 7, 8 ask about different components of the PPM/OPHEA protocol guidelines that were converted into question form. For example; there is an outline of a RTP protocol in the OPHEA guidelines. Question 7 in our questionnaire asks "*What has to happen for the child to be allowed to return to play?*" with the selectable tick options being the ones suggested in the guidelines. Questions 3 and 10 are opinion-based and focus on difficulties encountered in policy creation and suggestions as to what can be done to improve youth injuries in Canada. The inclusion of Question 11 was suggested by Parachute Canada and deals with whether or not the school boards asked any organization (such as their local Public Health Ontario branch) for help and/or advice in creating their policy. The Ministry of Education proposed the inclusion of Question 9 to identify issues or gaps in security and/or student safety and confidentiality. Finally, Question 12 ties into the third study **(Chapter 4)** and simply asks the school boards' permission to contact physical education teachers and/or coaches about their concussion policy-related opinions and beliefs. Information gathered from this survey will be used to evaluate the effectiveness of the PPM, analyze the differences in the various concussion polices across the school boards, and to help improve the development of any future injury, school and sports-related youth policies.

5.3 Study 2 Methodology Overview

The initial plan was to use the Ontario School Boards' Insurance Exchange (OSBIE) data to identify pre-/post- PPM youth concussion trends in Ontario public schools. However due to problems with data acquisition, problems with communication and time constraints the authors instead decided to use the Canadian Hospitals Injury Reporting and Prevention Program

(CHIRPP) to see if the PPM had any effect on youth concussion-related emergency department visits in select Ontario hospitals. We predicted that the reporting of concussion, particularly related to targeted contact sports activities will show an increasing trend over the study years. If this is the case, then it would suggest that concussion education and prevention policies increase reporting in the short term.

Launched in 1990 by the Canadian government, CHIRPP is a is a unique, richly detailed database of "pre-event" injury and poisoning information that collects and analyzes data on injuries to people who are seen at the emergency rooms of 11 pediatric hospitals and 6 general hospitals across the country [163]. The program started following a visit to Australia in 1988 by one of CHIRP's primary authors, and seeing their National Injury Surveillance and Prevention Program (NISPP) in action. Afterwards, directors of hospitals were invited to a conference and convinced that such a system was important and feasible in Canada [164]. The Ministry of Health of Australia allowed the use, at no cost, of the NISPP software, coding system, and data collection forms [165]. Data obtained from the participating CHIRPP sites was then sent to Ottawa at monthly intervals for incorporation into the main database, and for subsequent analysis and reporting [165]. This was also done to avoid an unacceptable number of errors, coding issues and other discrepancies.

What makes CHIRPP a truly unique injury surveillance tool is the amount of detail that is present in the database. An injured person coming to the emergency room of a participating hospital, he/she (or the caregiver accompanying a child) is asked to complete a one-page questionnaire or "CHIRPP form" [163]. The questions in this form deal with the circumstances surrounding the injury: action at the time of injury, injury cause, contributing factors or issues, time and place of the injury, as well as the age and sex of the injured individual. The second part

of the form is filled out by hospital staff, and includes info on the type of injury, what body part was injured and the type of treatment received [163-165]. There is also a context-based description of the accident and more specific info on injury location, intention, and the specific sport the individual was participating in (in cases of sports injuries). What's more, CHIRPP makes it easy to track any type of injury whether they are common or rare. For more detailed and specific information on CHIRPP, please refer to the Public Health Agency of Canada website and other discussed sources [163-165].

For this project, data was obtained for the past 8 years (2009-2016) from all the Ontario reporting sites (5 hospitals) for children and youth ages 4 to 18. These hospitals were the *Children's Hospital of Eastern Ontario* in Ottawa, *Hotel Dieu Hospital, including Children's Outpatient Clinic* in Kingston, *Kingston General Hospital* in Kingston, The *Hospital for Sick Children* in Toronto, *and the Children's Hospital at London Health Sciences Centre* in London, ON. Information was available for diagnosed concussions and minor closed head injury, or what the authors termed "suspected concussions". The authors wanted to identify specific concussion trends in relationship to the pre-/post- PPM. Multiple variables were considered including whether or not there was a difference in the rate of diagnosed vs. suspected concussions, whether sex, age or month/season played a role in concussion incidence and if schools were the primary place where youth concussions occurred. The results of this report can be found in **Chapter 3** (Paper 2).

5.4 Study 3 Methodology Overview

Study 3 is tied to the answer to Question 12 that was briefly mentioned in **Chapter 5.2.** If the individual school boards gave permission to contact their physical education teachers and/or

coaches about concussion policy-related questions, opinions and thoughts, then these individuals were approached with another, shorter 10-question survey (Health and Physical Education Questionnaire). This questionnaire was designed to understand whether or not the concussion policies are having an effect and are being implemented by school staff and personnel. Information will be garnered on topics such as concussion awareness, concussion education, and feelings/beliefs about concussion policy usefulness and applicability. This would give us an overview of the ***perceived*** effectiveness of the policy.

Neither we, as external researchers, nor the physical education teachers or other school staff can say for certain whether a concussion policy or any policy for that matter is having an effect (whether positive or negative). However, the Health and Physical Education teachers and coaches are in a unique position, as the first line of defense so to speak, to implement any new policies, guidelines or rule changes and, most importantly, can determine or gauge the day-to-day differences that these changes might convey. To reiterate, they are the ones that are actually putting the policy words into action. They are often the first-responders to an injury (unless athletic therapists are present) and are forced to make the withdrawal-from-game decisions during gameplay. That is why perceived effectiveness, from the point of view of first-line policy implementers (i.e. the Health and Physical Education teachers), was chosen as the primary objective of this study.

Similar to the Policy questionnaire (**Appendix A)** discussed in chapters 5.1 and 5.2 the Health and Physical Education questionnaire was based on the PPM and OPHEA guidelines, but has more open-ended questions that allow for more in-depth and unconstrained answers (**Appendix B**). While some questions provide the respondents with options in brackets, these were designed as examples, or suggestions in case the individual is unsure what the question is

asking. Like the Policy questionnaire, the Health and Physical Education questionnaire first asks the teachers about their knowledge of their board's respective concussion policy or protocol. Whether they have heard about it, or know when it was first introduced. Questions 2, 3, 4 discuss concussion training, participation in seminars, workshops, professional learning in-service, etc. The respondents are asked whether they have heard of or attended any concussion-related courses or training sessions, and the reasons why did/did not. Question 5 deals with the presence of concussion-trained personnel at every sports game and/or practice while question 7 asks about the concussion protocol that is followed when there is a suspected concussion. Questions 6 and 8 focus on the difference between observed differences (if any) in RTP/RTL practices and whether there is an increase or decrease in parental involvement or parental interest in concussion and well being of their children. Finally, the last 2 questions (9 & 10) address the Health and Physical Education teacher's personal beliefs in the effectiveness of concussion policies at the school level and the need or requirement for government intervention or control.

The main goal behind the Health and Physical Education survey is to understand whether or not the top-down structure of school boards' concussion policies reaches or is implemented by the school teaching/coaching staff. Simply put, we wanted to know the answers to the following key questions. First, do these teachers feel the polices are necessary and are having an effect (i.e. less concussions, more time away after an injury, better RTP/RTL protocols)? Second, have the policies led to training opportunities, courses, workshops, or anything at all to improve the actual injury outlook (i.e. injury awareness, better injury identification and diagnosis skills, more knowledge of injury symptomatology, etc.)? Finally, is government legislation necessary, is it the next logical step in reducing youth concussion incidence? The answers to all these questions can be found in **Chapter 4** (Paper 3) of this report.

Chapter 6. Extended Discussion

The primary goal of this thesis was to establish whether or not the PPM #158 has had an effect on concussions in children and youth in the province of Ontario. While only about 45% of all the school boards had an established concussion policy in place by the ministry-set January 30, 2015 deadline, the other boards introduced their respective policies over the next year or so. An analysis of CHIRPP data identified some key trends in pre-post PPM concussion incidence and reporting. These include an increase in diagnosed concussions, an increase in the proportion of school-based diagnosed concussions, as well as an increase in diagnosed concussion in females. While the rate of youth concussion-related ED visits rates has not gone up, there was a perceived marked increase or a sudden improvement in the rate of concussion diagnosis, which could be possibly attributed to a heightened awareness of the issue but also in some capacity, to the introduction of the PPM and various, subsequent school concussion policies. Finally, from the small sample of school physical education teachers that we were able to interview, we have concluded that HPE teachers are predominantly in favor of government-regulated concussion policy, and perceive that the PPM #158 and associated school policies were having a positive effect on the concussion outlook in Ontario schools. Most of the HPE teachers were aware of their respective school board's policies, participated in concussion training/education/seminars and reported that they noticed an improvement in RTP/RTL practices at their schools.

In essence, the Policy/Program Memorandum #158 that was introduced by the Ministry of Education of Ontario is an attempt to promote concussion awareness and policy at a more local, school board level. Circumventing the multiple failed attempts at federal and provincial legislation, this PPM approach can have a dual role; first as an unofficial policy of sorts and second as a pilot study laying a foundation for possible future, more successful legislation

attempts. From a brief glance it seems that the PPM is a great success, doing what multiple years of legislation attempts could not. But there are multiple issues with the PPM and subsequent board concussion policies and these need to be addressed before any definitive conclusions can be drawn. The following chapter will address some of the issues encountered, including individual policy complexity and effectiveness, questions around policy implementation, feedback and evaluation, as well as policy consequences, enforcement and other identified factors.

6.1 Concussion: Policy Effectiveness and Complexity

Many concussions can be described as 'invisible' injuries in that there are no visible signs or damage from the injury and many symptoms don't appear until sometime after the initial accident. This fact, combined with the often erroneously attributed "mild" injury status, makes the condition seem insignificant or superficial. This has traditionally been the case in many elite sports and only recently, at the turn of the century, has there been a change in perception [166-168]. This change in perception is in turn, a contributing factor to the many concussion policy attempts as discussed in **Chapter 1.7**.

There are so many factors at play when trying to understand the policy creation process that one needs time, knowledge and resources to be able to brainstorm and come up with an efficient, *usable* policy in a given timeframe. Frequently, this task is a team effort, especially when there is a need to create a policy from scratch. Ontario school boards had an opportunity to use the OPHEA documentation, government injury resources, the ability to approach their local public health unit (PHU), and access to many U.S. state policies (as examples) to create their own concussion policy. There is a lot of research on this topic already and more studies are

coming out on a regular basis. It can be considered a hot topic, to say the least, especially considering the recent extensive concussion lobbying campaigns and media focus. The first or main question that arises is then whether or not the created policies are strong enough. Are they actually viable and include all of the key principles or necessary components to be useful in a day-to-day setting or are they just empty shells, carcasses devoid of any meaningful information [169-171]?

To answer this question, it is important to consider two points. First the circumstances surrounding the nature of the PPM launch, especially the short (~10 months) deadline given to all the school boards in the province. Second, the specifics of the so-called OPHEA minimum standards on concussion are debatable. With the short implementation timeframe comes the innate assumption that all school boards have the personnel, knowledge and capability to quickly develop the new policy. While it's true that the OPHEA guidelines could be used as a foundation for their own policy, the boards still must take into account their unique factors and circumstances, such as, for example, the type and diversity of the population, yearly injury prevalence and statistics, sports played at the schools, and of course, budgetary concerns. As pointed out by some respondents in **Chapter 2 (Paper 1),** some boards were just physically unprepared to develop a concussion policy or didn't have the resources to hire or ask for policy-related help. A few boards also pointed out that time was a big issue, with some of the boards that refused participation hinting at or implying that their policy is not fully implemented to warrant an analysis or an evaluation.

Based on the observed responses, and after looking at the electronically-accessible policies of some school boards, it is the opinion of the primary author of this report that some boards have not actually implemented their policies, especially considering the low response

rate to this study and the simplistic nature of many of the policies that were available online. Not only do many of them lack the complexity and thoroughness that is inherent in such an important policy that can have potential long-lasting effects on youth health, but they also seem very light on specific steps and/or directions as to what to do during a concussion, how to approach teacher/coach/parent education, how to handle RTP/RTL and other crucial policy components. Some devote pages to roles and responsibilities, but mention nothing about promoting concussion education (either for the teachers, athletes or both), improving sports safety or reaching out to parents and external partners (e.g. community sports clubs, leagues, etc.). There is also frequently no mention of the need to have training for Health and Physical Education teachers/coaches, the presence of trained personnel present at sport events, or just anything in general that could illustrate *how* the policy will actually be applied.

These findings are not surprising. A recent analysis of the U.S. state laws by the Associated Press revealed that only about 40% contain all of the key principles in the initial bill passed in Washington state in 2009 that is often considered the "Golden Standard" [170]. The analysis also suggests that not only were the laws passed with remarkable speed, but they also had to make multiple sacrifices especially in the areas of costs, enforcement and regulation. As quoted by Jeff Miller, the NFL Senior Vice President of Health and Safety Policy: "Better to get something good, and get something in place, as opposed to shoot for something fantastic in all places - and fail." [170]. This idea is comparable to what was witnessed in our study, whereby many school board policies were created quickly, just to meet the ministry's deadline, but they have many weaknesses that have to be addressed by the boards before they can say that they have a functional concussion policy in place. It is not enough to just have it there on the board's website and to hand out concussion fliers and posters around the schools. The

policies need to be well-built and detailed enough; clearly outlining the steps or ways to educate teachers and coaches, including a clear protocol on removal from the game after a suspected concussion, the need for mandatory medical clearance to return to play, and effective concussion management procedures (RTP/RTL protocols). Without these critical components, the individual board policies cannot be considered viable, and subsequently cannot be successfully implemented and evaluated or compared.

The outright effectiveness of the school polices cannot be compared because of the novelty of the policies and because the actual OPHEA "minimal standard" has never been evaluated. The protocol has been developed in partnership with the Ministry of Education, the ThinkFirst Concussion Education and Awareness Committee, and the Recognition and Awareness Working Group of the Mild Traumatic Brain Injury/Concussion Strategy, but there are no studies that have looked at the protocol or have evaluated it to a significant extent [172]. Similarly, the nature or the extent to which the individual school policies are actually contributing to a reduction in concussion incidence is unknown. Some individual components of the concussion polices have been shown to work. For example, there is evidence that education about concussion leads to a reduction in the incidence of concussion and improved outcomes from concussion [18, 173]. There is little evidence to suggest that this is happening in Ontario but emergency room findings from **Chapter 3** (**Paper 2)** hint at the possibility that concussion policies have had an effect on halting the increase in yearly concussion prevalence. Using CHIRPP data, we have noticed a sudden, minor decrease in the number of hospital admissions for concussion-related issues, coinciding with the introduction of the PPM in 2014 (**Chapter 3, Figure 1)**. There were more than 300 less suspected concussions in 2014 than in the previous year. The following two years also saw a significant drop in suspected

concussions, suggesting that something was contributing to these unexpected decreases. Nevertheless, not enough time has passed to make any conclusive statements and more research is necessary to examine the overall effects the individual school board concussion policies have had on concussion-related hospital admissions and overall province-wide concussion incidence rates.

6.2 Policy Implementation, Feedback and Evaluation

Of particular interest, especially from a policy analysis perspective, are the concepts of policy implementation, feedback and future evaluation. The evidence in our studies is not conclusive enough to suggest that all school boards in Ontario have implemented a concussion policy. While it's true that they all have an electronically accessible policy on their boards' websites, it is not clear whether or not they have actually been implemented and are in fact, active and working. Unfortunately, very little research exists on the topic of concussion policy implementation with most U.S. studies focusing on evaluating the RTP aspect of the laws [163]. They center heavily on the impact and outcome of the policies and don't devote much time on the aspects of concussion education, training and prevention. The CDC even refers to them as RTP Laws; designed to reduce the *impact* of concussion, not prevent them [174]. Contrarily, the school laws in Ontario do not just focus on RTP but involve multiple other components, at least on paper. Evidence from the physical education teacher's responses from Study 3 suggest that while some boards have implemented a clear, multi-component concussion policy at their schools, others didn't go farther than an information binder, and/or some pamphlets.

It is quite possible that the lack of efficient implementation of the concussion policies at the school level have affected the observed difference in suspected vs. diagnosed concussions at

the CHIRPP hospitals. The boards that have a viable concussion policy in place, have trained (or are in the process of training) their staff and have introduced concussion awareness seminars, presentations and training sessions. These measures have contributed to an improvement in concussion diagnosis by allowing the supervising staff (Health and Physical Education teachers/coaches) to better differentiate amongst concussions thus improving overall identification of the injury. This could also partially explain the spike in diagnosed concussions witnessed at the school level (**Chapter 3, Figure 3)**, especially taking into account some of the responses given by Health and Physical Education teachers about their recent training and/or participation in concussion awareness/information seminars. However, in a couple of cases the teachers have reported that they did not have a concussion training session at their school and were instead given an info pamphlet to "familiarize" themselves with new concussion information. Others said they only had taken a mandatory CPR - First-Aid course that had a concussion component included in the lessons. The primary researcher hypothesizes based on some of the responses that the teachers were not asked for input or weren't consulted in any other way about their board's policy and in some cases, were even unsure of the exact month that the policy was implemented.

This could all be tied to a major flaw in the PPM that most likely also extends to the school board policies. Particularly, the lack of feedback. There is limited opportunity for policy feedback included in the PPM itself [141]. There is support for the boards on a web portal that was established by the ministry, along with a ServiceOntario Infoline contact number, but it is not clear how one can leave feedback or comment on the issue at hand [175]. Despite the fact that it is *NOT* law, the PPM positions itself as one, indicating that all school boards must report to the Ministry of Education as per paragraph 27.1 of subsection 8(1) of the Education Act [141].

The boards have to, in theory, report the implementation of the policy and respond to any board inquiries about meeting the PPM-outlined concussion policy expectations. The actual "Implementation" section of the PPM is 2 sentences long; one highlighting the PPM deadline (Jan. 30, 2015) and the second stating: "*School boards should ensure that a process is in place to support ongoing implementation and compliance with the board policy at the school level"* [141]. There is no mention of what or how this implementation is going to look like, nor how it will be evaluated, measured or even used. Does having one general concussion lecture and placing concussion posters all over the school count as policy implementation? And if not, where do you draw the line, and most importantly how do you know that it is working or having any effect at all? It is important to understand, especially after taking into account the multiple failed policy attempts discussed in **Chapter 1.7**, that feedback is essential when creating public policy of any kind and that it can serve to both improve the attitudes about an issue and can enhance or contribute to future policy making, in our case, improving the future injury outlook and helping create better and more effective province- or nation-wide concussion prevention and management policies.

A useful approach to implement in this case could be the policy feedback effect first described by Andrea Campbell in 2011 [176]. The approach stipulates that the policy-specific design influences the attitudes and political behaviors of both target populations and other members of the public and policy-generated attitudes and behaviors can feed back into the political system, shaping the political environment and the possibilities for future policy making [176]. But the PPM and the way it is worded leaves little room for possible feedback and instead outlines a vague course of action to, hopefully, reduce the number of concussion in the school system. It is important to note however, that there are tools on the Ministry website that provide

reliable, evidence-based information on preventing, identifying, and managing concussions to parents, children and youth, educators, coaches, athletes, and health care providers [141]. The tools are there to be used, it is just not clear whether they are being implemented in an effective way. This could be described as the so-called "partial solution" whereby the response to address a problem undermines the issue in general and then the focus or interest shifts to other, possibly more serious policy needs [176]. Public opinion, and in our concussion policy discussion case, the opinion of the teachers and to some extent, students and parents need to be somehow incorporated into the concussion policy to create an environment that is conducive to further policy developments in the desired direction (i.e. concussion prevention). These first school board concussion policies should be considered no more than pilot projects, designed to pave the way for future, larger-scale laws and policies.

6.3 Perceived Effectiveness of the PPM

The ultimate goal of the PPM was to ensure that every school board in Ontario had a concussion policy in place by the ministry established deadline. While it could be argued that the PPM did not achieve its immediate goal, considering that less than 50% of the boards had their policy in place by the deadline, the other boards did manage to launch their respective concussion policies over the subsequent 12-16 months. Considering that only 5 boards had a policy in place *before* the introduction of the PPM, the fact that the rest of the boards (67) also followed suit, suggests that the PPM served as a strong motivator in concussion policy creation across the province. Perhaps the 10-month time frame to create a policy was too short of a time for some boards. Others might have been in the process of developing a concussion policy already and were thus able to meet the ministry deadline. The exact specifics of each of the

school boards' concussion policy creation and implementation process is out of the scope of this thesis, but all three studies presented in this dissertation suggest that the PPM has had an effect on concussion awareness, identification and management in the province of Ontario.

We were unable to get the responses of each school board in Ontario. There were multiple gatekeepers and limitations as various other reasons that prevented us from getting all of the boards' responses. These will be discussed further in the following **Chapter 6.4**, but suffice to say that the boards that did respond, not only implemented various elements of the PPM and the associated OPHEA protocol, but were in general, very supportive of concussion policies, guidelines and regulations. Most understood the key principles of successful concussion policies (teacher education, concussion awareness, RTP/RTL, parental involvement) and included them in their own protocols. The nature of our recruitment strategy and the inability to reach out directly to each board's policy personnel does expose our paper to a response bias but the detailed analysis of each school boards' available-online policies suggest that the responses that we did get offer a realistic representation of the general concussion policy situation across the province. It is impossible to state for certain which boards have actually launched an effective policy and which only have a simple or yet-to-be implemented "paper" policy, but after multiple discussions the primary authors had with some school board and ministry representatives, there is a sense of a positive direction in the struggle against concussion and a change in the actual incidence rates as can be seen in our CHIRPP analysis.

The limited geographic scope of the CHIRPP hospitals does not represent all of the ED visits across the province but it is useful in demonstrating an effective snapshot of the population in question. While there was a clear increase in the number of diagnosed concussions, the number of all-type concussions actually started to decrease from October 2014 (**Appendix C,**

Figure 1). The reasons for this are unclear, but could be the result of heightened concussion awareness that inadvertently led to an increase or improvement in concussion diagnosis. As discussed in the limitations section of **Chapter 3**, the database does not contain information on critically and fatally injured children and heavily underestimates youth injury rates and over represents South and South-Eastern regions of Ontario. It is unknown what it is happening in the northern portions of the province and whether any concussion policies launched in those region's school boards have had an effect on ED concussion visits, school concussion incidences or other head-injury related factors. Time of the year (month) also does not seem to factor into concussion occurrence, besides the obvious reduction in concussion-related ED visits during the two summer months when there is no school (**Appendix C, Figure 2).** Nevertheless, the CHIRPP results demonstrate a few clear trends that started to appear or in some cases became more apparent after the introduction of the PPM. Most importantly, the introduction of the PPM and/or subsequent school policies have led to an increase in the number of diagnosed concussions while at the same time, reducing the overall number of ED head-injury related visits (**Appendix C, Figures 3 & 4)**.

There could be a couple of explanations behind this novel trend. First, studies looking at the effectiveness of other concussion policies have noted a consistent increase in concussion incidence as a result of either improved concussion reporting or an increase in concussion diagnosis [177]. Improved concussion awareness and/or teacher training can also indirectly improve concussion diagnosis by affecting the ways the teachers/coaches instruct the players, heightening head injury watch during matches and practice and making necessary adjustments to RTP guidelines [177]. Second, the recent emphasis on injury prevention and the frequency of concussion-related media pieces in conjuncture with the launch of the PPM could have enhanced

the focus on school-based head injuries and subsequently raised the school-based concussion injury detection rate. This would explain the two observed trends in **Chapter 3, Figure 3:** the numerical increase in Post-PPM at-school diagnosed concussions and the associated increase in the overall proportion of all ED diagnosed concussion visits. Not only are there more school-based head injuries that are getting diagnosed as concussion in general, but a significantly larger chunk of all diagnosed concussions seem to come from the schools. Since there have been no changes to the way that concussions are managed at the hospital-level, it is not illogical to assume that the PPM, along with the subsequent board concussion policies has played a part in this observed change in concussion-related ED visits.

The results from the questionnaire for the HPE teachers were very promising but, unfortunately we were limited in terms of the number of participants that we could get for our study. The limited sample gave us a glimpse into the implementation aspects of concussion policy and demonstrated a general interest and need for concussion policy and protocols at all four levels of the education system (school, board, provincial, national). Perhaps most important is the finding that all 12 of the participating teachers knew of their respective board's concussion policy and the vast majority of them have received some form of instruction and/or additional concussion-specific training. Since the HPE teachers are essentially the first responders when it comes to injury and accidents, it makes logical sense to approach them with questions about whether or not a program is working or not. They are the ones that are spearheading the changes because they have to actively implement the new curriculum, protocols, and are "on-the-field" to see how all of these new changes are effectively working (or not). Without evaluating the teachers' work or garnering their opinion, there is no realistic way to measure an outcome based on a new policy or program, especially if it does not have a clear, numerically measurable

outcome. For example, as previously mentioned in the Methods section of **Chapter 2**, we did a general web search of all the 72 school boards of Ontario, trying to find out if they have an active concussion policy in place. They all had an online-accessible version by June 2016. However, that is just a virtual policy and it is not clear how well it translates into actual school changes or whether or not it has even been implemented at all.

Effectively, the HPE teachers' answers and opinions serve as a snapshot into the effectiveness and the overall feasibility of school concussion policies. If the teachers don't notice a change after any given policy is introduced, then it can be argued that the policy is ineffective or for whatever reason is not leading to a desired outcome. It is critical to educate teachers on the importance of concussion symptomatology, and subsequent RTP/RTL practices in order to better spot, manage, and reduce the number of concussions [178]. While it is true that HPE teachers or any other school staff cannot *diagnose* a concussion, they must stay vigilant and be able to spot one and take the appropriate action (eg. pull athlete from the game, call an ambulance, report the incident, follow-up afterwards, etc.) to ensure that the injury is immediately attended to and does not lead to further injury or devastating complications such as the Second-Impact Syndrome. It is difficult to draw any final conclusions about the usefulness or effectiveness of the PPM without first understanding some limitations that prevented us from a more in-depth analysis of this ministry policy.

6.4 Study Problems and Limitations

For ease of clarity, management and understanding, study limitations, issues and other observed nuances will be separated into different categories to underline and highlight the

general difficulty with policy research in general and particularly in topics dealing with any school-related changes, injury prevention and youth health.

6.4.1 Low Response Rate

First, there was an issue with school board contacts. Despite a meeting the primary authors had with the Ministry of Education and the heightened interest expressed by the ministry employees, they were not very forthcoming with school board contacts, only providing information on about 40% of the boards. In some cases there were emails and phone numbers but the majority of them only had an email address. A significant portion of these did not respond to email messages after we contacted them. We searched for other school boards' contact info online either on the respective boards' official websites or through ministry documentation found elsewhere on the internet. In some instances, there was no direct contact info at all for any policy related board personnel and in those instances we sent out emails to the boards' general email addresses or called head offices directly and asked to be redirected or given additional contact info for policy staff or directors/principals involved in policy research and/or implementation. Some boards, citing ethics and privacy reasons refused to give out employee emails, phone numbers or, in a few cases, both, requiring us to leave our contact info and await subsequent contact from their end.

There were also many instances when board employees listened to our research invitation, expressed interest, but then stopped communication altogether. In addition there were situations where one policy employee started discussing the research project with us, accepted the questionnaire and additional info but a few months later stopped communicating. After an inquiry, we were told by another board member that they didn't know anything about the project;

the previous person was reassigned, retired or quit and that now they needed a lot of additional time (e.g. 6 months plus) to get the project reevaluated at the next board committee meeting or to get additional ethics approval and so forth. But overall, a large chunk of the school boards just didn't respond to our three rounds of contact attempts. We have hypothesized that this was either due to internal board miscommunication, lack of interest, lack of time and/or possible issues with email/phone call redirections or other unknown logistic or personal reasons. These issues have not only reduced our sample of participants for the first study but also significantly lowered the amount of prospective participants for our third study, effectively cutting off our access to a large amount of HPE teachers across the province.

6.4.2 School Board Gatekeepers and Blockers

In situations where the school boards showed initial interest in our study we came across other problems that either directly, considerably increased our study rollout and completion time or indirectly led to strategic and logistical problems that we had to work around. For example, the way most school boards are set up in Ontario, there are general meetings for board committee members where they decide what research projects to pursue, how to alter the curriculum, any new changes, and other education-related matters concerning their schools. For some of the smaller, Northern Ontario school boards, these meetings happen as infrequent as once a year. For others, there is at maximum one meeting in the fall and one in the spring. Any external research topics, such as ours, is brought up at one of these meetings and a committee decides whether to accept or decline. Not only is there a fair chance that our project might not get accepted but some boards only accept **1!** external research project per school year. In addition, most of the boards that have agreed to participate in our project required us to complete additional, their own board-specific ethics, fill-out research information packages and some even asked for a police check.

Further complicating this already time-consuming process was the need to physically mail this whole package, often in multiple copies.

A couple of other issues with this whole process involved the need to go back and revisit some of the ethics protocols to answer additional questions that the boards might have had for us. Furthermore, there were situations where, even though we submitted the research package on time (i.e. before the scheduled board meeting), and everything was fine with it (no further questions), it was not discussed at the board meeting and we were told that it would be brought up at the next meeting, which would be another 4-6 months away. Rarely would we actually hear anything back, even after subsequent prompts 2-4 months after this next, supposed meeting took place. This predicament coupled with a limited time frame to complete our project led to multiple delays and affected our overall response rate. In most cases, the boards that agreed to participate in **Study 1** were unwilling to let us approach HPE teachers for our third study. In most instances this decision was left unexplained but the few reasons that we did get pointed to an overall apparent lack of readiness in the actual implementation of the school concussion policies. This is of course, just our hypothesis but one board's response highlights this idea. This board said that they don't want us to interview HPE teachers because they were in the process of training and educating the teachers on the new concussion protocol. So, despite officially launching the concussion policy about eight months prior, the actual implementation of the policy was in its initial stages. This serves to illustrate the fact that just having the concussion policy posted somewhere on the school board's site is not enough. It only works when it has an actual effect in the "field" so to speak; inside the schools, during gym classes, sports matches and other school athletic events.

Most school boards had protocols in place that prevented us from contacting the HPE teachers directly. This has already been briefly explained in the limitations section of **Paper 3 (Chapter 4**) but will be discussed in more detail in this paragraph. The boards were not only unwilling to share the teachers' contact info, but they even refused to provide a total approximate count of the HPE teachers employed by the board. Some of the boards that agreed to the project took it upon themselves to redistribute our study questionnaire internally, but, unfortunately, failed to send anything back, even after follow-up prompts.

At this point we could only guess the reasons for this but in theory can be anything from miscommunication, to lost and/or forgotten emails or various personal reasons. Suffice to say, that our inability to approach the HPE teachers directly in any way possible, along with reluctance of most school boards to participate in the project left us with a very small, possibly very biased sample of HPE teachers. With a high possibility of responder bias, the teachers that agreed to answer our questions could, by chance, represent the boards with the most complete, implemented and thorough concussion policies out of all Ontario schools. Knowing about our research project and perhaps understanding its importance, the boards that wanted to "look good" or so to speak, sent our questionnaire to HPE teachers who already undertook the necessary training and were well versed in concussion education, policies and might have even had knowledge about the ministry PPM 158. These are of course just speculations, but since there is no evidence to the contrary, this potential for heavy bias must be kept in mind, especially when looking at the findings of our third study.

6.4.3 CHIRPP limitations

In addition to the more significant limitations of the CHIRPP dataset as mentioned at the end of **Study 2**, there are a couple of minor issues with the dataset that have to be discussed

further. Because of the concentration of the CHIRPP's pediatric hospitals primarily around the Southern portion of the province (near lake Ontario), it heavily underrepresented the rest of the province, particularly the more northern school boards and predominantly most rural regions of the province. But the issue is more than just geography, since the fact that the CHIRPP hospitals are located in major cities effectively means that certain groups are missed altogether including most rural inhabitants (including many Aboriginal people), older teenagers, and others [179]. Many teens are increasingly likely to seek care at general hospitals even before they become "too old" to be treated at children's hospitals [165].

An additional limitation was related to timely data. Due to our study's time constraints and the lack of data for the rest of 2016 and 2017, we didn't have a large enough sample size to see more clear trend(s) for the post-PPM years. Another year of data would have been helpful in establishing the prolonged effect that the introduction of the PPM had on the concussion injury profile in the province. This is not CHIRPP's fault as it is understandable that it takes time to update and upload the new info into the online database especially considering the recent switch to an electronic format.

6.5 Conclusion

This concussion PPM accomplished something in Ontario that no other policy, or legislation could before. In a very short time frame, it forced *every* publically funded school board in the province to create a concussion policy. Every previous legislation attempt across the country failed. While the PPM only accounts for school-based concussions, it could be considered the first step in the right direction. Now that the policies are there at each school board, it could pave the way for regional or provincial concussion legislation(s). From our

preliminary overview of some of the boards' policies, it looks like they have used the majority of suggestions outlined in the PPM documentation and the associated OPHEA documents. The limited answers that we did get from HPE teachers suggest that the struggle against youth concussions is moving in the right direction. An overview of concussion-related ED visits in children's hospitals in Southern Ontario before/after the introduction of the PPM has revealed an increase in the number of diagnosed concussions, an increase in the proportion of school-based diagnosed concussions, as well as an increase in diagnosed concussion in females. It is not clear whether the PPM or the subsequent school policies have had an effect on these observed trends, but we can conclude that it is a possibility. How well these policies are constructed and whether or not they have been effectively implemented remains to be seen, but the results so far are promising and suggest that an education PPM-like approach is a good strategy in addressing various youth-related issues in the province.

However, our research into the PPM and the subsequent school board policies has raised many questions. Are the policies effective? Have the policies being implemented and if they have, are they having an effect on concussion incidence rates, RTP/RTL time, improved recovery, or any other factors associated with concussions? The answers to these questions are not clear. Evaluating or testing each school board's concussion policy would be a long and difficult process, especially without any clear templates or quantitative measures. Looking at implementation is even worse. While it is true that one can look at injury rates at each school board before/after the introduction of their respective policies, there are too many unknowns and issues with this approach. Simple increase or decrease in the rate of concussion might mean that a policy is having an effect, but how can it be compared to other school boards. If every board keeps clear and detailed records of every injury or incident, then maybe it is possible to see

which policies are better and where there is a greater need for alternative approaches. Making concussion teacher education standardized or requiring similar RTP/RTL practices is a couple of ways of easing future analysis, evaluation and comparisons. It gets harder with mandatory medical check-ups and sign-offs, especially in more rural areas, without access to easily available and/or specialized medical care. It therefore becomes necessary to create a policy that is tailored towards the population and region in question, using guidelines like the ones presented in the PPM as a template but not necessarily trying to match or duplicate similar policies in other, perhaps much larger metropolis-based school boards.

This rapid introduction of concussion policies in school boards across Ontario can help pave the way for similar policies in amateur and professional sports associations across the country. Many sports associations still use a seven day RTP policy and a large proportion of medical health professionals still rely on traditional concussions symptoms when making their RTP decisions [13, 180]. Yet, even though an athlete might be symptom free at each stage of the step-wise recovery program, it does not mean that they have fully recovered and their brain might still be vulnerable anywhere from 4 to 6 weeks [180]. Some spectroscopy studies looking at cerebral content have established that the recovery of brain metabolism is not linearly related to time, further underlining the need for an individualized RTP/RTL decision making process [181]. Some research suggests that government legislation, teacher education and safety equipment doesn't make much difference and that the culture of youth sports need to change to have any sort of positive effect and reduce injury rates [182]. The results of a recent Safe Kids Worldwide report points out a couple of scary findings. Using data from U.S. CPSC NEISS and various online surveys, the report states that as many as 50% of all youth athletes play with some sort of injury [182]. Many youth also down-play an injury or lied about their recovery just so that

they can keep playing. This is especially relevant in concussions since they are "invisible" injuries to begin with. Individuals can recover quickly from concussion but lingering or residual symptoms can still make them vulnerable to further brain injury, even from seemingly minor collisions or hits [182]. Since it is so easy to hide or lie about possible concussion after-effects, concussion policies *must* ensure that they have a stipulation to have a medical expert sign-off a recovering individual before they are allowed to return to sports. This might not always be possible, especially considering our earlier point about medical care provision in rural areas. Nevertheless, it seems like the most foolproof way of ensuring successful recovery and hopefully preventing or at least reducing the risk of concussion complications.

Brain injuries are an unpredictable but preventable part of any sport and physical activity. They have coexisted with sport for a long time and affected the lives of countless athletes. Some rough estimates suggest that by 2035 preventable injuries (which include concussion) will cost the Canadian economy a shocking $75 billion per year [183]. It is clear that something needs to be done to improve this situation and the PPM #158 might just be that all important first policy that will raise concussion awareness, improve detection, management and recovery and maybe even reduce the incidence rate of this debilitating injury.

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Appendix A: School Board Concussion Policy Questionnaire (Paper 1)

The purpose of this questionnaire is to first and foremost identify the individual adherence (by each school board) to the Policy/Program Memorandum # 158 (PPM) that was passed on March 19, 2014 by the Ministry of Education of Ontario. This memorandum consists of several components, including strategies to develop concussion awareness; concussion identification, prevention and management strategies; and training for school and board personnel. Information gathered from this survey will be used to evaluate the effectiveness of the PPM, analyze the differences in the various concussion polices across the school boards, and to help improve the development of any future injury, school and sports-related youth policies. Please answer each question with as much detail as possible. For tick-box questions, check off all that apply.

Question 1: Does your school board have a concussion policy or protocol in place? If Yes, when was this protocol established (month, year)? **If No, please skip to question 13**).

Question 2: What components does your policy include?

- ☐ Knowledge-sharing protocols
- ☐ Curriculum-specific provisions
- ☐ Safe-removal protocols
- ☐ Prevention strategies
- ☐ Concussion assessment strategies
- ☐ Return-to-play guidelines
- ☐ Return-to-learn guidelines
- ☐ In-game monitoring
- ☐ Staff training
- ☐ Other (Specify)

Question 3: What were some of the difficulties with creating the policy?

- ☐ No difficulties
- ☐ Understanding the PPM
- ☐ Writing the policy protocol itself
- ☐ Making students & parents aware
- ☐ Convincing management, or stake holders
- ☐ Explaining the policy to school personnel
- ☐ Training staff
- ☐ Other (Specify)

Question 4: Do you have a trained individual at every sports game and/or practice? If Yes, who is it? (Coach, parent, school staff member, nurse, athletic therapist or other). If No, how are you monitoring the games?

Question 5: What has been done to reduce the number of concussions in your schools?

- ☐ Limit contact during practice
- ☐ Better safety equipment
- ☐ Safer environment
- ☐ Educate coaches/ trainers/staff
- ☐ Educate students
- ☐ Nothing has been done
- ☐ Change drills, sports techniques
- ☐ Other (Specify)

Question 6: What happens if there is a suspected concussion?

- ☐ Child removed from the game
- ☐ Parents/guardians notified
- ☐ Child sent to school nurse
- ☐ Ambulance called
- ☐ Info on the incident recorded
- ☐ Other (Specify)

Question 7: What has to happen for the child to be allowed to return to play?

- ☐ Mandatory rest period
- ☐ Symptomless for a set period of time
- ☐ Child/Parents say they are healthy
- ☐ Coach permission
- ☐ Written permission from a health professional
- ☐ Other (Specify)

Question 8: How are you helping injured youth return to learn?

- ☐ Limit recreational activities
- ☐ Participate in contactless sports
- ☐ Limit computer/TV use & reading
- ☐ Frequent breaks
- ☐ Clear/Simplified instruction
- ☐ Alternative assignments & examinations
- ☐ Smaller, darker classrooms
- ☐ Work in groups
- ☐ Provide class notes or peer note takers
- ☐ Limit loud noise exposure
- ☐ Other (Specify)

Question 9: Do you have a system in place to keep track of concussions and injured individuals? If Yes, who has access to this data?

Question 10: In your opinion, can anything be done or is there anything else that you think might improve the current brain injury outlook amongst Canadian youth?

☐ Different/Altered policy
☐ More nurses & athletic therapists
☐ More funding & training for school staff
☐ Improve awareness & education
☐ Improve safety equipment/facilities
☐ Other (Specify

_____

_____

Question 11: Did you approach your local Public Health Ontario branch or any other organization for help and/or advice in creating the concussion policy? Please specify which organization, if any.

_____

Question 12: Would you allow us to interview high school gym teachers and/or coaches working in your school board about their concussion policy-related opinions and beliefs?

☐ Yes ☐ No

End of Questionnaire. Thank you for your interest and time!

Individuals that answered **No** to question 1 please complete the following two questions.

Question 13: What is the reason why you don't have a concussion policy in place?

☐ Didn't know about it
☐ No sports at the school
☐ Lack of qualified personnel
☐ Lack of funding
☐ School refused or strong opposition to policy
☐ No time or skilled policy personnel
☐ PPM unclear or unsure about policy creation
☐ Don't want or don't need one
☐ Other (Specify)

_____

_____

Question 14: Do you require assistance in creating a concussion policy or protocol? If Yes, what type of assistance do you require (more concussion-educated personnel involved, financial assistance, help with drafting the policy, etc.)

_____

_____

Appendix B: Phys-Ed Teacher Questionnaire (Paper 3)

The purpose of this study is to first and foremost identify the individual adherence (by each school board) to the Policy/Program Memorandum # 158 (PPM) that was passed on March 19, 2014 by the Ministry of Education of Ontario. This memorandum consists of several components, including strategies to develop concussion awareness; concussion identification, prevention and management strategies; and training for school and board personnel.

The following short questionnaire is designed to understand whether or not the concussion policies are having an effect and are being implemented by school staff and personnel. Information will be garnered on topics such as concussion awareness, concussion education, and feelings/beliefs about concussion policy usefulness and applicability. This would give us an overview of the *perceived* effectiveness of the policy.

Please answer each question with as much detail as possible. For tick-box questions, check off all that apply.

Question 1: Do you know if your school board has a concussion policy or protocol in place? If Yes, when have you first heard or read about it?

_____

Question 2: Have you ever taken a course (including conference seminars, online modules, workshops, professional learning in-service, etc.) or been educated/trained in concussion management?

_____

Question 3: Have you heard of any concussion related information sessions, educational courses, seminars or relevant presentations (including posters, flyers, pamphlets) offered by your school or school board? If Yes, list them.

_____

_____

Question 4: Did you participate in or attend any of the above events? If No, why not?

_____

_____

Question 5: Do you have a trained individual at every sports game and/or practice? If Yes, who is it? (yourself, coach, parent, school staff member, nurse, athletic therapist or other).

_____

Question 6: Have you noticed a difference in terms of return to play (RTP) or return to learn (RTL) practices at your school? For example, athletes with suspected concussion tend to be away from school for a longer period of time.

_____

_____

Question 7: What usually happens if there is a suspected concussion? What do you do?

☐ Removed child from game
☐ Child sent to school nurse
☐ Info on the incident recorded
☐ Parents/guardians notified
☐ Ambulance called
☐ Other (Specify)

_____

Question 8: Have you noticed any difference in terms of parental involvement or parental interest in concussion and well being of their children? (i.e. do they call/email you more often after a suspected concussion).

_____

_____

Question 9: Do you personally believe that concussion policies at the **school board level** are working and can help improve concussion detection and management? If no, please explain your reasoning.

☐ Yes ☐ No

_____

_____

Question 10: Do you think that intervention at the **government level** (legislation, laws, mandates, PPMs, etc.) is necessary to help reduce the number of concussions and improve the injury outlook of Ontario schools? If no, please explain your reasoning.

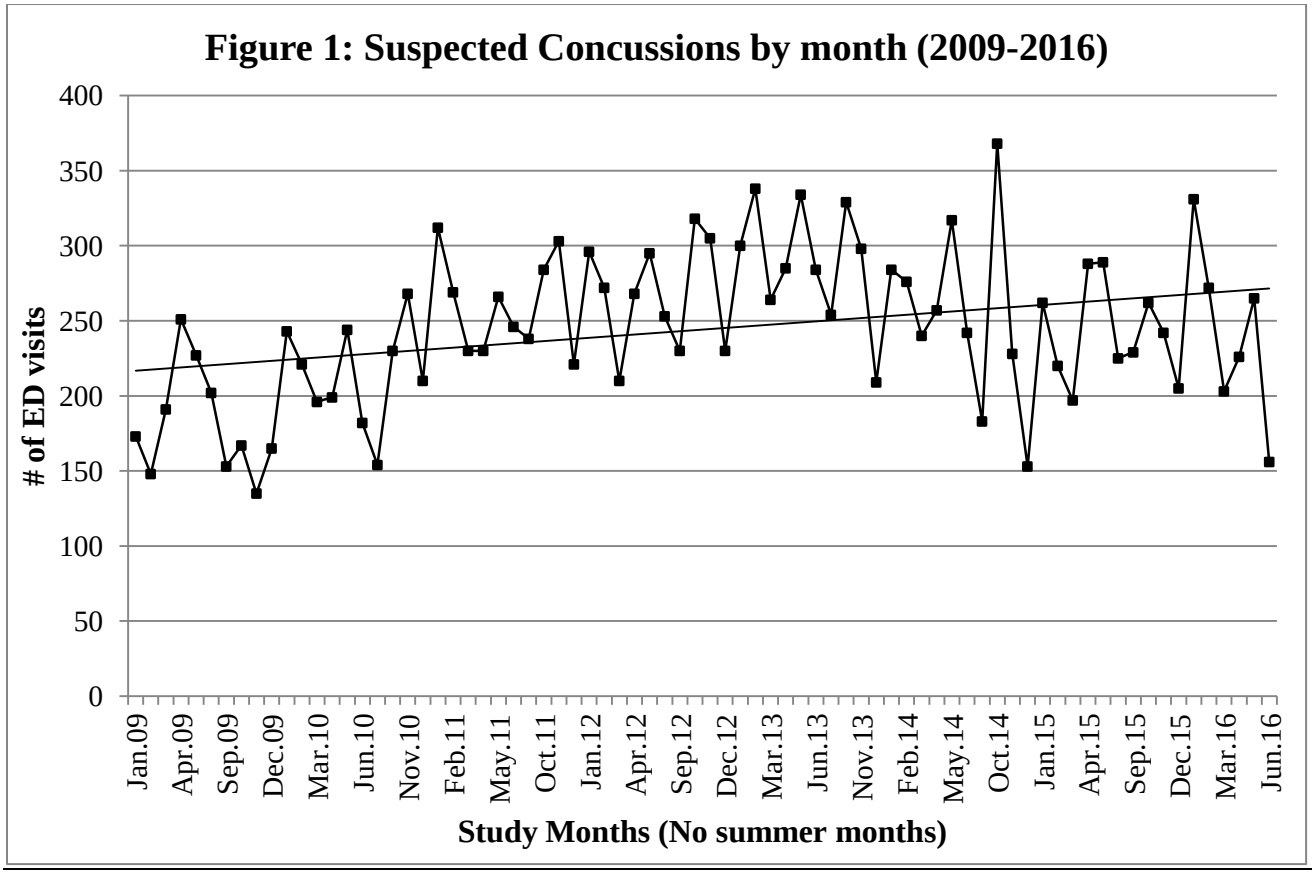
☐ Yes ☐ No

_____

_____

End of Questionnaire. Thank you for your interest and time!

Appendix C: Additional Figures and Tables



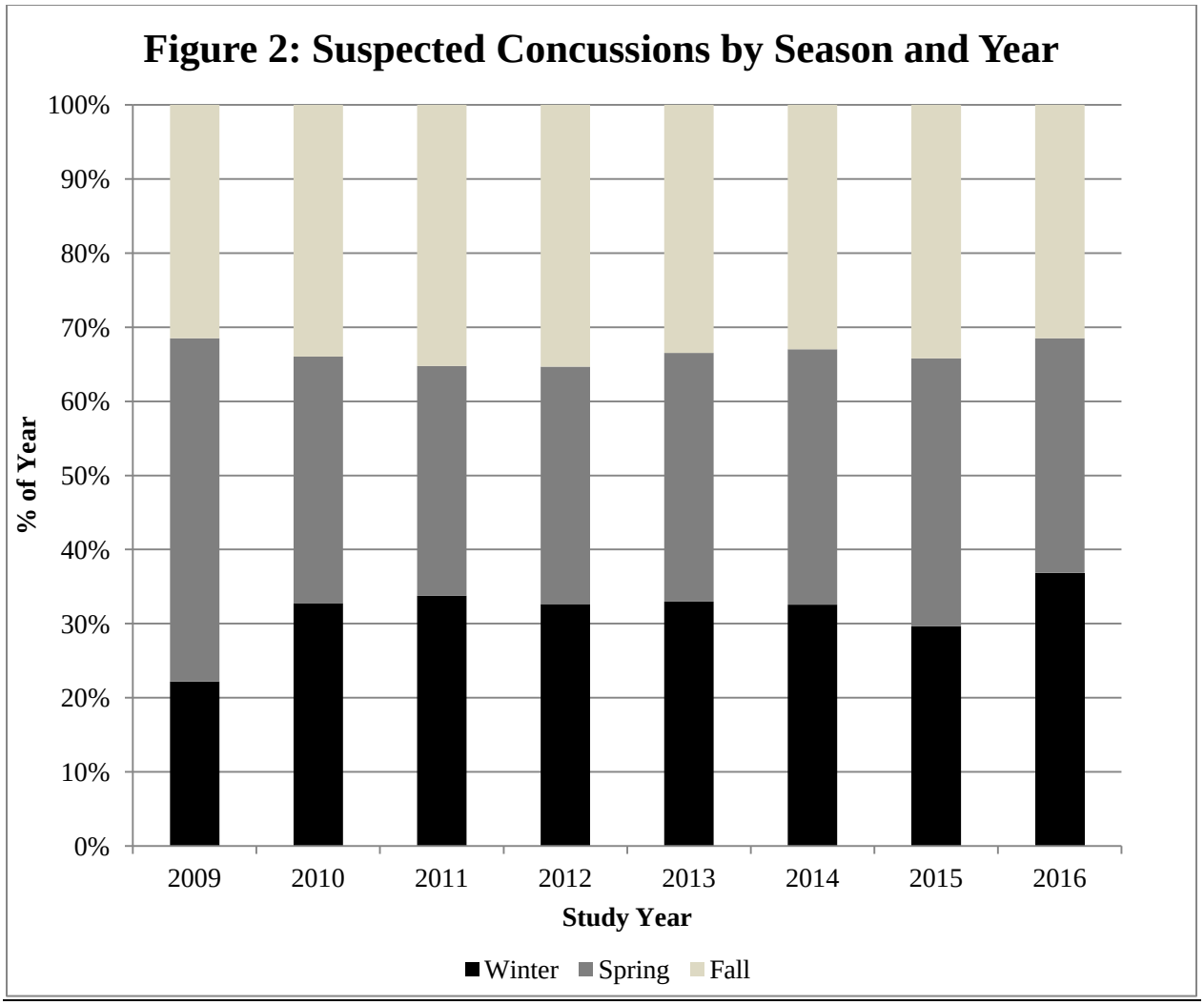


Figure 2: Suspected Concussions by Season and Year
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% of Year
2009
2010
2011
2012
2013
2014
2015
2016
Study Year
Winter
Spring
Fall

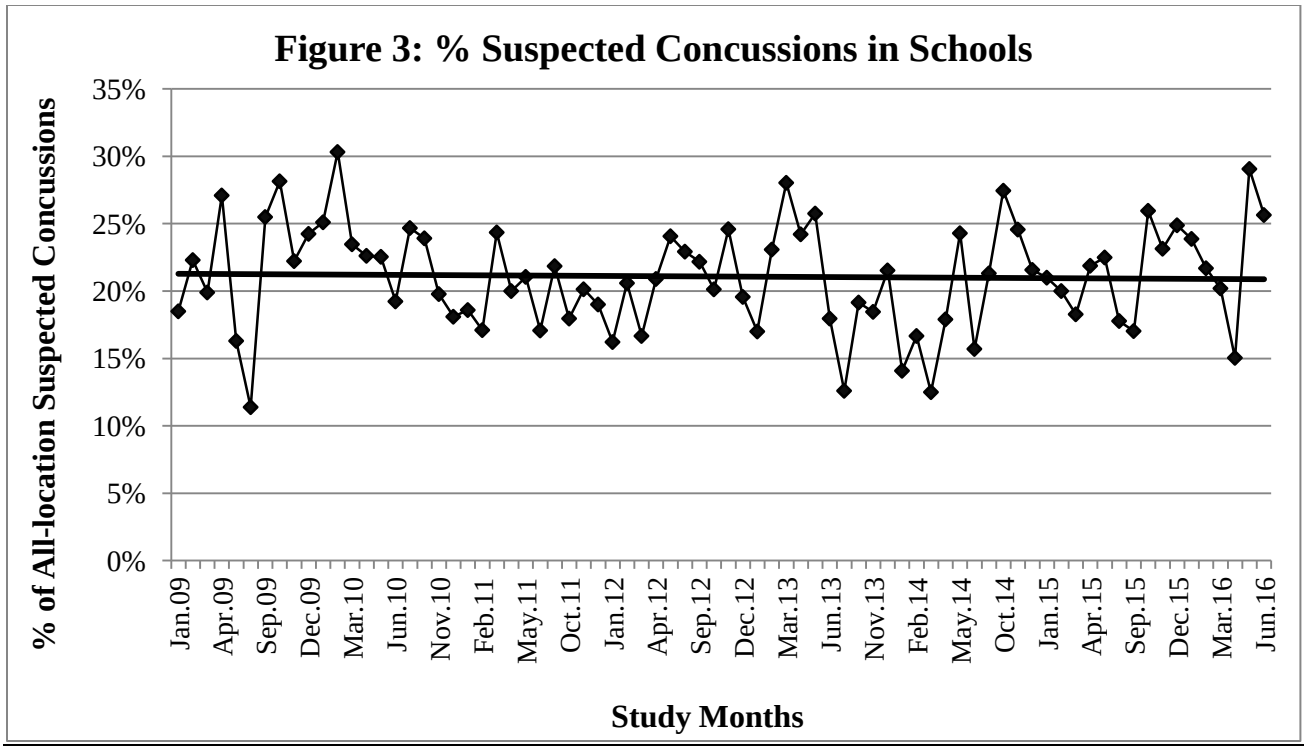


Figure 3: % Suspected Concussions in Schools
% of All-location Suspected Concussions
35%
30%
25%
20%
15%
10%
5%
0%
Jan.09
Apr.09
Sep.09
Dec.09
Mar.10
Jun.10
Nov.10
Feb.11
May.11
Oct.11
Jan.12
Apr.12
Sep.12
Dec.12
Mar.13
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Apr.15
Sep.15
Dec.15
Mar.16
Jun.16
Study Months

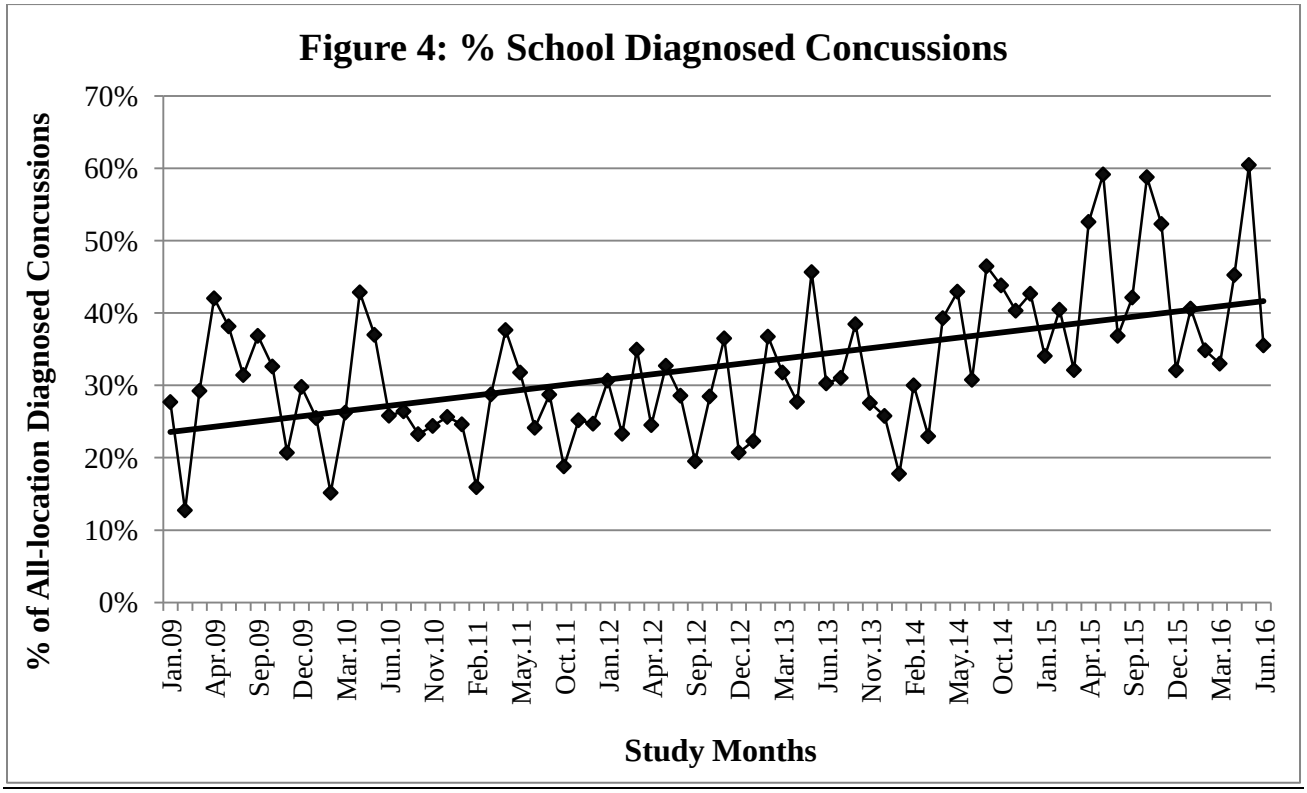
Figure 4: % School Diagnosed Concussions
% of All-location Diagnosed Concussions
70%
60%
50%
40%
30%
20%
10%
0%
Jan.09
Apr.09
Sep.09
Dec.09
Mar.10
Jun.10
Nov.10
Feb.11
May.11
Oct.11
Jan.12
Apr.12
Sep.12
Dec.12
Mar.13
Jun.13
Nov.13
Feb.14
May.14
Oct.14
Jan.15
Apr.15
Sep.15
Dec.15
Mar.16
Jun.16
Study Months