

# Sport and recreation musculoskeletal injuries in Irish primary school children

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## ABSTRACT

Musculoskeletal injury in children can lead to negative physical, psychological and socio-economic effects. This study aimed to examine sport and recreation injury incidence in Irish primary school children. A cross-sectional survey of 842 male and female Irish primary school children (9.62 ± 1.7 years) was conducted. Parents completed a questionnaire examining estimated weekly participation in sport and recreation and any injuries sustained in the previous 12 months that resulted in restricted performance, restricted ability to fully take part in or time lost from sport, recreational activities or school. Overall, 28.3% sustained an injury in one year, of which 30% presented to their local hospital emergency department. Sports injuries (.15 per 1,000 hours) were significantly more common than recreational injuries (.04 per 1,000 hours). Contact injuries were predominant (78.4%), with falling (19.3%), running (16.9%) and tackling/being tackled (16.5%) most common. Finger/thumb and ankle injuries were most common. Knee injuries resulted in the greatest injury burden (4.77 days absent per 1,000 hours of sport and recreation) and 3 in 10 injuries were referred for a scan. A multi-level approach to managing and reducing sport and recreation musculoskeletal injuries in primary school children that targets all relevant stakeholders including parents, teachers, coaches and the children themselves should be considered to promote safe play and sporting participation for children. **Keywords:** Musculoskeletal injury; Elementary school; First aid; Physical activity; Child.

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## INTRODUCTION

The physical, cognitive, mental and social health benefits that occur in school children due to participation in sport and recreation are vast (Abernethy and MacAuley, 2003; Bloemers et al., 2012; Warburton et al., 2006). However obesity has now become a global epidemic (Wang and Lobstein, 2006) and the percentage of obese or overweight Irish children aged between 6 - 13 is increasing (Whelton et al., 2007). In fact in Ireland, 30% of 9 year old girls and 22% of 9 year old boys were overweight or obese (Layte and McCrory, 2011). While many children partake in sport and recreational activities both during and outside of school, encouraging increased participation in exercise and sport in Ireland may be essential in this population to reduce the incidence of obesity. An inherent risk of injury exists during physical activity. When a child sustains an injury, the resulting pain and disability can lead to absence from school, sport and recreation, reduced socialisation, enhanced future injury risk and increased socioeconomic burden to the parents and health service (Abernethy and MacAuley, 2003; Collard et al., 2011; O'Connor et al., 2016; van Mechelen and Verhagen, 2005). The negative psychological effects following injury may also lead to a reduced enthusiasm for sport and recreation (Bloemers et al., 2012) and injuries have been shown to reduce the development in physical fitness by 18% in primary school children over a two and a half year period (Rexen et al., 2016).

While sport and recreation injuries are predominant in children and youth (Conn et al., 2003; Harmon et al., 2018), most research examines sport and recreation injuries across all ages (Cassell et al., 2003; Conn et al., 2003; Finch et al., 1998; Mummery et al., 1998) and those that have examined these injuries in children, are limited to hospital presentations only (Fridman et al., 2013; Harmon et al., 2018; O'Toole et al., 2008). The sole study that has examined sport and recreational injuries in Irish children found that these injuries account for 55% of all presentations to two Irish paediatric orthopaedic outpatient departments over four months (O'Toole et al., 2008). Upper limb injuries predominated, particularly the wrist (30%), hand (15%) and elbow (11%) (O'Toole et al., 2008). International research from Canadian (Fridman et al., 2013) and US (Harmon et al., 2018) hospitals has also noted that upper extremity injuries are frequent, along with fractures, sprains/strains and head injuries. However, hospital emergency department and orthopaedic outpatient data likely over-represents severe acute injuries (van Mechelen et al., 1992).

The introduction of injury prevention strategies in school children may lead to substantial public health gain (van Mechelen and Verhagen, 2005), due to reducing injuries which ensures children circumvent the negative implications of injury and maintain participation in sport and recreation. In school children these sport and recreation injuries can be largely avoidable and the adults who influence children's behaviours and attitudes, such as their parents, teachers and coaches play a critical role in preventing injuries in this population (van Mechelen and Verhagen, 2005). In order to develop appropriate injury prevention strategies, current research recommends that injury incidence and aetiology be initially assessed to gain an idea of the magnitude of the injury problem in the population studied (Finch, 2006; van Mechelen et al., 1992). To date there has been no research investigating sport and recreation injuries in Irish school children outside of those presenting to hospital. Thus, the aim of this study was to describe the current injury incidence retrospectively in male and female 1<sup>st</sup> to 6<sup>th</sup> class Irish primary school children.

## MATERIALS AND METHODS

### *Participants*

A cross-sectional study was conducted. Parents or legal guardians of 842 male and female children from 15 primary schools in the Republic of Ireland completed a retrospective questionnaire. Children in 1<sup>st</sup> to 6<sup>th</sup> class only were recruited, which corresponds to Year 3 to Year 8 of an eight-year primary school cycle.

### ***Instrumentation***

A retrospective questionnaire that comprised of 20 questions examining any injuries that occurred to the child in the previous 12 months was developed. The questionnaire was composed of two sections. Section one included 12 questions that identified sport and recreation levels, sports played by the child and whether they sustained an injury during the previous 12 months. Section 2 of the questionnaire was filled in separately for each injury and requested information including: body part injured, injury nature, type, mechanism, injury outcome (treatment received, hospital attendance, scans or surgery required and impact on school, sport and recreational activities), sport and location the injury occurred in. An injury was defined as any injury sustained during sport or recreation which resulted in time lost from sport, recreational activities or school, or restricted the child's performance or ability to take part fully in sport or recreational activities. A sport was defined as an official activity involving physical exertion and skill where the child, or their team, competed against another or was training to compete against another. It was also clarified that a sporting injury could occur in both training and competition. Recreation was defined as an unofficial leisure activity involving physical exertion. Parents and legal guardians were also informed that while recreational activities might be similar to sporting activities they are not officially organised. A contact injury was stated to be any injury that happened by hitting against an object, the ground or another person or an object hitting the child. In addition, a sports facility was defined as a building or area where you train or compete in a sport. Examples of sports facilities were provided to the parents and legal guardians including: GAA pitch, soccer pitch, rugby pitch, basketball court, gymnastics centre, track etc. The questionnaire was reviewed for face validity by the research team and two primary school teachers. Each question was assessed for clarity, acceptability and to minimise respondent burden. Following this feedback, the questionnaire was piloted with ten parents of primary school aged children. The questionnaire took approximately 5 - 10 minutes to complete.

### ***Procedure***

Ethical approval was received from the local institution's Research Ethics Committee. A recruitment letter detailing the purpose and what was involved in the study was initially sent to the principal of a convenience sample of 17 schools in the Munster, Leinster and Connacht regions of the Republic of Ireland. The principal was then contacted over the phone to assess interest in the study and answer any questions the principal had. The principals of fifteen schools confirmed they wanted to partake in the study and one teacher, or in some cases the principal, was identified as the designated point of contact in that school. The study and the questionnaire was explained in detail to the point of contact at each school. The point of contact then provided the research team with the number of questionnaires required for each class group in the school. A questionnaire, plain language statement and informed consent form was posted to the point of contact for each child in 1<sup>st</sup> to 6<sup>th</sup> class and was given to each class teacher to distribute to the children to bring home to their parents. The class teacher instructed the children to ask their parents to read the plain language statement first which detailed the study and study procedure in full. If the parent or legal guardian and child agreed to take part in the study they were asked to complete the informed consent and assent form and complete the questionnaire within 1 week and return it to the school with the child for the attention of their child's class teacher. A reminder was sent out as a note to all parents later in the week. The point of contact collected all informed consent forms and completed questionnaires from the class teachers and posted them to the principal investigator. The principal investigator reviewed all informed consent forms and completed questionnaires. A questionnaire was only included in the study if an accompanying fully completed signed informed consent form was returned. Overall, 842 questionnaires were included in the study, with an overall response rate of 31.3% (12.5 - 51.2%).

### **Data Analysis**

The questionnaire was analysed using IBM SPSS Statistics 23 and Excel version 16.2. Descriptive statistics were used to summarize the data. Average injury risk was calculated using incidence proportion by dividing the number of injured participants by the number of participants in the study (Knowles et al., 2006). The risk of repeat injury was measured by dividing the number of injured participants that sustained more than 1 injury by the number of injured participants (Knowles et al., 2006). Injury rate was measured by calculating injuries per 1,000 hours (number of injuries divided by the total hours playing sport and recreation over the year multiplied by 1000) and per 1,000 exposures (number of injuries divided by the total times they played sport and recreation over the year multiplied by 1000). 95% Confidence Intervals (CI) were calculated using Poisson distribution. Injury rates were also calculated individually for males and females, and whether they resulted from sporting and recreational activities. A significant difference in injury rates was identified if the 95% CI of the two variables did not overlap. Injury burden was calculated for sport and recreation injuries, by examining the total days absent per 1,000 hours in sport and recreation (total days absent due to the injury divided by the total hours participating in sport and recreation for the year multiplied by 1,000) for each specific injury location separately.

## **RESULTS**

Eight hundred and forty-two male and female Irish school children ( $9.62 \pm 1.7$ , 6 - 13 years) completed the questionnaire. Females accounted for 60.4% of the sample.

### **Participation in sport and recreation**

Children primarily took part in sport (87.4%), with more males (93.4%) taking part than females (83.5%). Gaelic football (49.9%), hurling/camogie (36.0%), soccer (35.1%), athletics (15.8%), gymnastics (15.8%) and rugby (8.6%) were frequently played by participants. Almost half of all participants were involved in swimming (51.9%). Participation in gymnastics (24.2%) and dance (14.5%) was more common in females than males (4.2%, 1.0%). More males played soccer (66.5%) than females (12.1%) in this sample. Children commonly played more than 1 sport (79.4%), ranging from 1 to 9 sports played and an average of  $3.4 \pm 1.4$  sports played. Children spent a mean of  $6.6 \pm 3.9$  (.5 - 45) hours per week playing sport and took part in sport  $3.6 \pm 2.1$  (1 - 21) times a week. For recreation, children were active for  $7.0 \pm 5.8$  (.5 - 36) hours per week and  $5.2 \pm 3.1$  (1 - 28) times per week.

### **Injuries due to sport and recreation**

Overall, 238 school children sustained 365 musculoskeletal injuries during the previous 12 months during sport and recreation. Therefore, 28.3% sustained an injury during the year and 36.1% of those that sustained one injury sustained at least one other. When taking into account exposure, .09 injuries per 1,000 hours of sport and recreation and .05 per 1,000 exposures to sport and recreation were noted (Table 1). Most of the injuries occurred during sport (67.7%) compared to recreation (32.3%), with a significantly higher injury rate noted during sport (.15 [95% CI: .14 - .17] per 1,000 hours) than recreation (.04 [95% CI: .03 - .05] per 1,000 hours) (Table 1). In sport, males presented with a higher injury rate (.17 [95% CI: .14 - .20] vs .13 [95% CI: .11 - .16] per 1,000 hours; .23 vs .17 per 1,000 exposures), but this was significant for injuries per 1,000 exposures only. In contrast, females displayed a significantly higher injury rate for injuries resulting from recreational activity (.06 [95% CI: .05 - .07] vs .02 [95% CI: .001 - .003] per 1,000 hours; .08 [95% CI: .06 - .10] vs .03 [95% CI: .02 - .04] per 1,000 exposures).

Table 1. Number, injuries per 1,000 hours and injuries per 1,000 athletic exposures and their 95% CI.

	Sport & Recreation			Sport			Recreation		
	All	Male	Female	All	Male	Female	All	Male	Female
<b>Number of Injuries</b>	365	177	186	264	154	109	100	23	76
<b>Injuries per 1,000 hours (95% CI)</b>	.09 (.08-.10)	.08 (.07-.10)	.09 (.07-.10)	.15 (.14-.17)	.17 (.14-.20)	.13 (.11-.16)	.04 (.03-.05)	.02 (.01-.03)	.06 (.05-.07)
<b>Injuries per 1,000 exposures (95% CI)</b>	.05 (.05-.06)	.11 (.10-.13)	.11 (.10-.13)	.19 (.17-.22)	.23 (.20-.27)	.16 (.13-.19)	.02 (.02-.02)	.03 (.02-.04)	.08 (.06-.10)

### What injuries occur?

Most injuries occurred to the lower limb (50.3%), followed by the upper limb (32.3%), head and neck (11.4%) and trunk (6.0%) (Table 2). In particular, the fingers and thumb (15.2%), ankle (14.9%), knee (13.8%) and wrist (8.0%) were most frequently injured. Injuries were primarily acute in nature (89.6%). The same injury had occurred previously to the child in 24.3% of injuries. Common types of injuries included sprains (25.8%), bruises (19.4%), strains (18.5%) and fractures (15.0%) (Table 3). Injuries to the muscle (30.6%), ligament (21.6%) and bone (20.1%) were frequent.

Table 2. Region and body part injured for sport and recreation injuries, sport injuries, and recreation injuries.

	Sport & Recreation % (n)	Sport % (n)	Recreation % (n)
<b>Head and neck</b>	11.4 (40)	9.8 (23)	14.5 (16)
<b>Head</b>	4.6 (16)	4.3 (10)	4.5 (5)
<b>Neck</b>	2.0 (7)	2.6 (6)	.9 (1)
<b>Face</b>	2.3 (8)	1.3 (3)	4.5 (5)
<b>Eye</b>	1.7 (6)	1.3 (3)	2.7 (3)
<b>Ear</b>	.3 (1)	.0 (0)	.9 (1)
<b>Mouth</b>	.6 (2)	.4 (1)	.9 (1)
<b>Upper limb</b>	32.3 (113)	28.5 (67)	39.1 (43)
<b>Shoulder</b>	1.7 (6)	.9 (2)	2.7 (3)
<b>Upper arm</b>	.9 (3)	.9 (2)	.9 (1)
<b>Elbow</b>	2.0 (7)	.4 (1)	4.5 (5)
<b>Forearm</b>	2.6 (9)	1.7 (4)	4.5 (5)
<b>Wrist</b>	8.0 (28)	6.0 (14)	11.7 (13)
<b>Hand</b>	2.3 (8)	1.7 (4)	3.6 (4)
<b>Fingers &amp; thumb</b>	15.2 (53)	17.5 (41)	10.8 (12)
<b>Trunk</b>	6.0 (21)	7.2 (17)	3.6 (4)
<b>Lower back</b>	2.3 (8)	2.1 (5)	2.9 (3)
<b>Mid back</b>	1.7 (6)	2.1 (5)	.9 (1)
<b>Upper back</b>	.3 (1)	.4 (1)	.0 (0)
<b>Chest</b>	1.1 (4)	1.7 (4)	.0 (0)
<b>Stomach</b>	.3 (1)	.4 (1)	.0 (0)

<b>Lower limb</b>	50.3 (176)	54.5 (128)	42.7 (47)
<b>Hip &amp; groin</b>	2.0 (7)	2.6 (6)	.9 (1)
<b>Thigh</b>	6.9 (24)	9.0 (21)	2.7 (3)
<b>Knee</b>	13.8 (48)	12.0 (28)	18.0 (20)
<b>Shin</b>	2.3 (8)	3.0 (7)	.9 (1)
<b>Ankle</b>	14.9 (52)	16.2 (38)	12.6 (14)
<b>Foot &amp; toes</b>	10.3 (36)	11.5 (27)	8.1 (9)

Table 3. Type of injury.

	<b>Sport &amp; Recreation % (n)</b>	<b>Sport % (n)</b>	<b>Recreation % (n)</b>
<b>Sprain</b>	25.8 (88)	27.0 (62)	23.6 (26)
<b>Bruise</b>	19.4 (66)	21.7 (50)	14.5 (16)
<b>Strain</b>	18.5 (63)	22.2 (51)	10.9 (12)
<b>Fracture</b>	15.0 (51)	9.6 (22)	26.4 (29)
<b>Cut</b>	7.6 (26)	5.2 (12)	14.5 (16)
<b>Dislocation</b>	2.1 (7)	1.7 (4)	2.7 (3)
<b>Concussion</b>	1.5 (5)	1.7 (4)	.9 (1)
<b>Tendinopathy</b>	1.5 (5)	2.2 (5)	.0 (0)
<b>Cartilage</b>	1.2 (4)	.9 (2)	.0 (0)
<b>Dental injury</b>	.3 (1)	.0 (0)	.9 (1)
<b>Unsure</b>	7.3 (25)	7.8 (18)	5.5 (6)

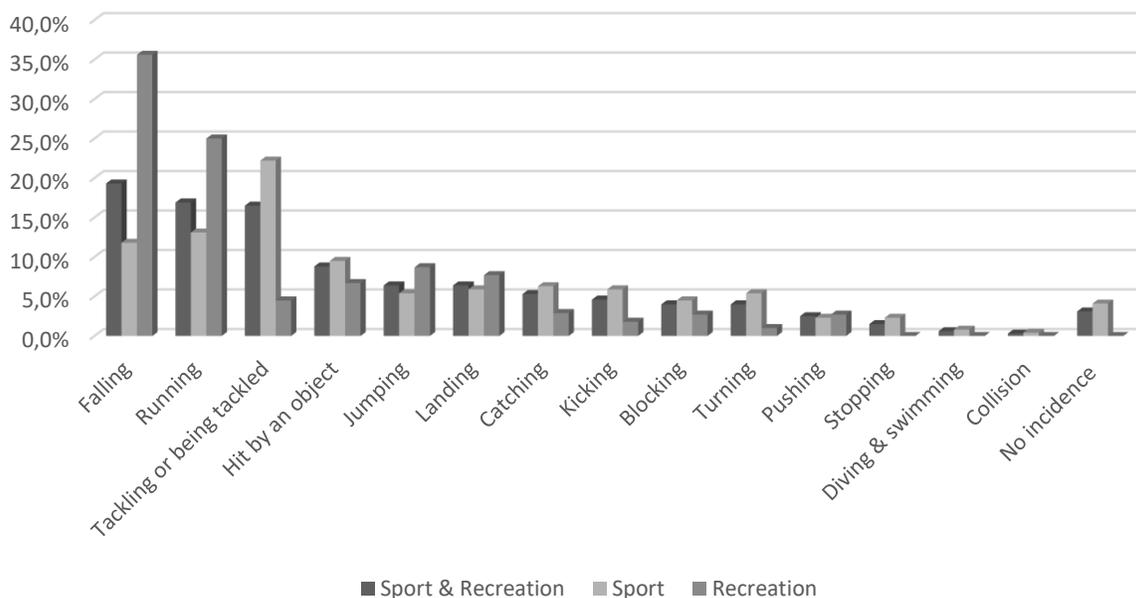


Figure 1. Mechanism of injury for sport and recreation injuries, sport injuries and recreation injuries.

***How do those injuries occur?***

Most injuries were contact injuries (78.4%). Contact injuries primarily occurred due to contact with the ground (39.0%), with another person (31.3%) and with equipment (29.7%). Falling (19.3%), running (16.9%) and tackling or being tackled (16.5%) were common mechanisms of injury (Figure 1). Falling (35.6%) and running (25.0%) were more common mechanisms in recreation injuries than sport (11.8%, 13.1%). In contrast, tackling or being tackled was more frequent during sport (22.2%) than recreation (4.5%). Foul play was reportedly involved in 14.7% of all injuries, particularly in males (19.8%) than females (6.5%).

***Where do these injuries occur?***

Recreation injuries more commonly occurred in the home (34.9%), school (27.8%), recreation area (18.3%) and street (11.0%). However, sports injuries occurred primarily in a sports facility (75.6%) or at school (13.9%). Most injuries to males that occurred during sport happened during soccer, (42.9%), Gaelic football (30.8%), hurling (14.3%) and rugby (5.5%). For females, injuries commonly occurred during Gaelic football (33.3%), gymnastics (10.3%), camogie (6.4%) and athletics (6.4%).

***What is the outcome of these injuries?***

The injury the child sustained was examined by a medical professional in 54.7% of all injuries, mostly by a physician (74.3%). Thirty percent of all injuries required presentation at the emergency department at their local hospital. A scan was ordered in 29.7% of injuries, mostly X-rays (93.5%) or an MRI (6.5%). Surgery was only required in 2.6% of injuries. The injury lead to school absence in 17.5% of injuries, with an average absence of  $3.3 \pm 3.3$  (1 - 14) days. Knee injuries ( $6.0 \pm 5.7$ ), hip and groin ( $3.5 \pm 2.1$ ), fingers and thumb ( $3.4 \pm 4.3$ ) and wrist injuries ( $3.3 \pm 2.1$ ) lead to the longest absence from school. Absence from sport (64.1%) and recreation (65.8%) was more frequent, with an absence of  $25.0 \pm 66.7$  and  $19.0 \pm 33.0$  days reported respectively. Knee injuries lead to the greatest injury burden, with 4.77 days absent per 1,000 hours of sport and recreation. Forearm (3.78), ankle (2.95) and wrist (2.82) injuries lead to the highest days absent per 1,000 hours of sport and recreation.

**DISCUSSION**

Over a quarter of all Irish primary school children sustained a musculoskeletal injury during sport and recreation in one year and over a third of those that became injured would sustain at least one other injury that year. Primary school children displayed a lower injury risk than Irish male secondary school adolescents (35.6%) (O'Connor et al., 2016) and injury rate (.09 per 1,000 hours) than older Dutch children aged 10 - 12 years (.48 per 1,000 hours) (Collard et al., 2011) that were prospectively followed over one academic year. In contrast, a higher repeat injury risk was noted in the current study (36.1%) compared to Irish adolescent secondary school adolescents (27.9%). The higher injury risk in male secondary school students and older children is more than likely due to their age and more advanced biological maturity, therefore potentially generating more force on contact due to them being faster, stronger and heavier (Caine et al., 2008). However, the primary school children in the current study that did sustain an injury were more likely to sustain a second injury during the year. There are methodological differences between the studies however, as the current study was retrospective in nature and incorporated injuries from the previous 12 months, not solely the academic year.

Injuries during sport were significantly more frequent than in recreation, possibly due to the greater competitive nature, contact and intensity of play associated with sport. As expected, most sporting injuries occurred during sports with the highest-level participation levels, such as field sports (Gaelic games and soccer) and gymnastics. This finding was also noted in Irish sporting and recreational injuries treated at a

paediatric orthopaedic outpatients department (O'Toole et al., 2008). Females sustained significantly more recreation injuries than males, with more sporting injuries occurring in males. This may be partially due to the manner in which male and female children typically engage in activities. Males are typically more competitive and focused on winning (Garcia, 1994), which may result in difference in play and sporting interactions which consequentially may increase injury risk. Children had sustained the same injury previously in a quarter of all cases, indicating that these children may have returned to sport and recreation without addressing potential risk factors for injury that predisposed them to sustaining the injury in the first place, or with physical deficits such as poor strength, flexibility or range of motion (O'Connor et al., 2016). Thus, encouraging school children to rehabilitate sufficiently and moderate any potential pre-disposing factors to injury is important.

Half of all injuries were to the lower limb, just under a third were to the upper limb, with injuries to the fingers and thumb, ankle, knee and wrist most common. In addition, sprains, bruises, strains and fractures were frequent. Injuries predominantly happened suddenly, and were contact injuries, with falling, running and tackling/being tackled common mechanisms of injury. Similarly, 28% of injuries that occurred to Dutch children were due to falling (Collard et al., 2011) and running and tackling/being tackled were frequent mechanisms in Irish secondary school adolescents (O'Connor et al., 2016). To effectively reduce sport and recreation injuries, a multi-level approach that engages and targets stakeholder education and behaviour, the environment, and the introduction or adaption of policy and enforcement of rules may be necessary (Adirim and Cheng, 2003). All relevant stakeholders should be targeted including parents, teachers, coaches and the children themselves to maximise effectiveness. Simple strategies that could be considered include appropriate adult supervision during all sport and recreation activities and regular mandatory checks to ensure all equipment and recreation locations such as playgrounds, playing fields and surfaces are safe (Adirim and Cheng, 2003). Due to the higher level of sporting injuries, the introduction of specific preventative strategies in children's sports should be encouraged, in particular, sufficient warm-up periods, use of protective equipment, appropriate surfaces, adequate conditioning levels and coaching techniques (Purvis and Burke, 2001). Foul play was reportedly involved in a fifth of all male injuries, and so ensuring adequate officiating during sports and enforcements of rules is important (Adirim and Cheng, 2003). In addition, educating children on the importance of fair play and the potential risks associated with foul play may be beneficial.

While injuries most frequently occurred at the home, sports facilities and recreational areas, injuries also often occurred at school, with 27.8% of recreation injuries and 13.9% of sporting injuries occurring during school. Therefore, teachers are required to provide immediate care to these musculoskeletal injuries, and sufficient first aid training is important to provide this care. First aid training is not taught to primary school teachers during primary school third level education presently and while some schools may have designated first aid trained staff members, this is not a mandatory requirement for all Irish primary schools. Thus, it may be up to the individual school or teacher to become certified and maintain their first aid skills. It is mandatory for each school to have a school accident/injury policy, which details the procedures teachers should take following incidents that range from minor to very serious injuries and include injuries such as cuts, sprains, strains. This however is individual to each school and the content and procedures may vary. In Ireland, in secondary schools, no first aid trained PE teacher was available in 33.4% of schools (Abernethy et al., 2003). In addition, a fifth of Turkish primary school teachers could not accurately identify the correct way to manage a sprain (Başer et al., 2007), a common injury experienced by Irish primary school children in the current study. Therefore, first aid training should be taught to all primary school teachers and standardisation between schools of all procedures to deal with musculoskeletal injury would be helpful to facilitate adequate and consistent management across Irish schools. Preventative strategies that could reduce injury risk in school children, could also be implemented as part of physical education during school. In addition, teachers

involved in extracurricular sporting activities should have appropriate coaching qualifications to ensure effective techniques are taught to children to minimise risk of injury.

An assessment by a medical or allied health professional was required in more than half of sports and recreation injuries, with a third attending their local hospital emergency department. For every ten injuries, three scans were ordered, which were primarily X-rays, likely due to the predominance of fractures or severe sprains where a fracture may be suspected. The mean total cost of a sport and recreation injury was noted to be €188 ± 317 in Holland (Collard et al., 2011), highlighting the substantial financial costs incurred by parents, insurers and the healthcare system due to sport and recreation injury. The negative impact musculoskeletal injuries can have on a school child's daily life was revealed by the substantial average absence reported from sport (25.0 ± 66.7 days), recreation (19.0 ± 33.0 days) and school (3.3 ± 3.3 days) due to injury. While thumb and finger injuries were most frequent, knee and forearm injuries lead to the greatest injury burden, with 4.77 and 3.78 days absent per 1,000 sport and recreation hours respectively. Knee injuries also lead to the greatest days absent from school (6.0 ± 5.7 days). Thumb and finger injuries were shown to negatively impact school more than sport and recreation, leading to an average absence of 3.4 days. Such injuries may also affect their schooling by hindering their ability to write if the injury occurred on their dominant hand. Therefore, prioritising the prevention of not just frequent injuries, but particularly those that lead to a greater absence from sport and recreation and have the largest negative impact on schooling is important.

## LIMITATIONS

While this study was a large novel cross-sectional study examining sport and recreation musculoskeletal injuries in 842 male and female school children, it was retrospective in nature and was a proxy questionnaire which required parents to their children's estimated weekly sport and recreation participation and any injuries sustained over the previous twelve months. Therefore, the self-selected nature of the study design and recall bias may have adversely impacted the results. Despite these limitations, this initial cross-sectional survey is an important first step in identifying sport and recreation injuries in this population and highlights the need for prospective epidemiological research to be conducted.

## CONCLUSIONS

This was the first large scale Irish study, to our knowledge, examining sport and recreation injuries in male and female primary school children. This is an important study to investigate how common sport and recreation injuries are in this population, the potential negative short and long-term implications these injuries can have on school children and highlight the importance of developing strategies to prevent and manage these injuries. Over a quarter of school children are at risk of becoming injured every year, and of those that sustain an injury, over a third will receive 2 or more injuries throughout the year. Most injuries occurred to the thumb and fingers, ankle, knee and wrist, with strains, bruises, sprains and fractures frequent. Serious injuries commonly occurred however, leading to time away from sport, recreation and school, and a third of all injured school children having to attend their local hospital emergency department. Therefore, the burden due to injury can be substantial, leading to adverse physical, social, psychological and financial implications, emphasizing the significance of prioritising injury prevention. A multi-level approach to managing and reducing sport and recreation musculoskeletal injuries in primary school children that targets all relevant stakeholders including parents, teachers, coaches and the children themselves should be considered to promote safe play and sporting participation for children. Priority should be given to the injuries that lead to a greatest injury burden, including absence from sport, recreation and school or those with the most harmful

consequence to their schooling. Ensuring all stakeholders are first aid trained and capable of managing musculoskeletal injuries is recommended.

## AUTHOR CONTRIBUTIONS

SOC designed the study. SOC and NNC completed the data collection. SOC and EW analysed the data. SOC, NNC and EW wrote the first draft and prepared the final manuscript. All authors have read and approved the final version of the manuscript.

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