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Journal of Science and Medicine in Sport

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Original research

Epidemiology of injury in male adolescent Gaelic games

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ARTICLE INFO

Article history:

Received 18 March 2015
Received in revised form 19 May 2015
Accepted 1 June 2015
Available online xxx

Keywords:

Gaelic football
Hurling
Teenage
Injury incidence

ABSTRACT

Objectives: There is a lack of epidemiological research in adolescent Gaelic games, with previous research primarily focusing on elite adult males. This study aimed to prospectively capture the epidemiology of injury in male adolescent Gaelic games over one year.

Design: Prospective cohort study.

Methods: Two hundred and ninety two (15.7 ± 0.8 years) male adolescent Gaelic footballers and hurlers took part in a one year prospective epidemiological study. Injuries were assessed weekly by a certified Athletic Rehabilitation Therapist and an injury was defined as any injury sustained during training or competition resulting in restricted performance or time lost from play. An injury report form was utilised to standardise injury information.

Results: Match injuries were more frequent in Gaelic footballers (9.26 per 1000 h) and hurlers (11.11 per 1000 h) than training injuries (2.69 and 3.01 per 1000 h, respectively). Over a quarter of injuries in adolescent Gaelic footballers (26.7%) and hurlers (26.5%) were overuse in nature. Recurrent injuries were also frequent, particularly in adolescent Gaelic footballers (47.3%). Lower limb injuries predominated (football 74.7%, hurling 58%), particularly in the knee (18.7%, 20.0%) and ankle (12.0%, 10.0%). Hamstring injuries were more frequent in footballers (13.3%), with lower back injuries more common in hurlers (22.0%). Minor injuries were common in hurling (61.7%), with moderate (20.8%) and severe (37.5%) injuries predominant in Gaelic football.

Conclusions: Injuries are frequent in adolescent Gaelic games and this study sets the scene for the establishment of injury prevention strategies for this at risk population.

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1. Introduction

Gaelic football and hurling (Gaelic games) are Ireland's national sports. They last up to 60 min for adolescent players and consist of two opposing teams of 15 players (goalkeeper, six defenders, two midfielders and six forwards).^{1,2} Gaelic games are played on a rectangular field (length 130–145 m, width 80–90 m) and are multidirectional contact games that necessitate players performing at a high level of intensity and velocity.³ Gaelic football has been described as a mixture of soccer and rugby and is similar to Australian Rules football.⁴ Essential movements include sprinting, tackling, kicking, soloing (kicking the ball to yourself when running), shouldering (shoulder to shoulder charge), jumping, turning and catching.⁵ Hurling on the other hand is similar to shinty, lacrosse or field hockey and participants use a stick called a hurley to hit a small, hard leather ball (sliotar).² Movements essential to

hurling include sprinting, catching, striking (throwing the sliotar into the air and hitting it using the hurley), shouldering, blocking the sliotar with the hurley, soloing (running while keeping the sliotar balanced or bouncing on the hurley) and hooking (using the hurley to prevent the opposition swinging their hurley to hit the sliotar).²

While participation in sport provides numerous health and social benefits, an innate risk of injury exists.^{6,7} The trauma, pain and loss of function accompanying injury can be substantially detrimental to the participant, by preventing sports participation or negatively affecting performance.^{5,8} However, the occurrence and magnitude of the effects of many injuries may be reduced with the implementation of injury prevention strategies.^{7,9} The initial step to prevent injury is to establish the incidence of injury in the sport.¹⁰ The amount of published epidemiological studies in Gaelic games is small in comparison to international sports, with only six studies in Gaelic football and three in hurling. Not only do these studies vary in their research design, study length, definition of injury and reporting procedures, they also have primarily focused on elite adult players.^{5,11,12} In fact, no epidemiological data is

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available on adolescent hurling injuries and only a single study has been published on adolescent Gaelic footballers.¹³ In addition, it is relatively common for adolescents to play both Gaelic football and hurling. Thus, this study will prospectively examine the epidemiology of injury for one year in adolescent Gaelic games.

2. Methods

This was a prospective cohort study in under-16 male adolescent Gaelic footballers and hurlers for one year. To standardise the information gathered, an injury report form was developed. The injury report form was developed by three clinicians; a sports medicine physician and two certified athletic rehabilitation therapists. The form was primarily based on the National College Athletic Association Injury Surveillance System¹⁴ and was also influenced by epidemiological research studies in Gaelic games and consensus statements on epidemiological research studies. The developed form was then externally reviewed by three clinicians and researchers with extensive experience researching the epidemiology of sporting injuries. The injury report form captured information on the injury received, including: the sport injured in, onset of injury, side of injury, location of injury, type of injury, nature of injury, how many minutes into sporting activity the injury occurred at, severity of injury, mechanism of injury, month injury occurred, protective equipment worn if any and any further investigations required. The number of days absent from sport was also noted. Ethical approval was granted by the X Ethics committee.

Male under-16 adolescents that played Gaelic games were eligible for this study. Two hundred and ninety two (15.7 ± 0.8 years) adolescents were recruited from six secondary schools. 46.8% of participants primarily played Gaelic football, 33.9% hurling and 19.3% played Gaelic football and hurling to similar extents.

An injury was defined as any injury sustained during training or competition resulting in restricted performance or time lost from play.¹⁵ Injury severity was defined according to days missing from full participation and was sub-classified into minor injuries (<7 days), moderate injuries (8–21 days) and severe injuries (>21 days).¹¹ A recurrent injury was any injury of the same type and site as the original injury that occurred after a participant returns to full participation.¹⁶ This was further sub-classified as early recurrent (<2 months), late recurrent (2–12 months)¹⁶ and persistent injuries. "Muscle tightness" was classified according to the Munich consensus statement on muscle injuries in sport as fatigue-induced muscle disorder.¹⁷

Recruited participants attended an information session in their school to explain the purpose, benefits and testing procedure of the study. Informed consent was obtained from participants and their legal guardians. Weekly injury clinical examinations took place in the school by the primary researcher (a certified athletic rehabilitation therapist) alongside two final year students recruited from an athletic rehabilitation therapy degree course. Each tester immediately filled out the injury report form after each clinical examination. At the end of each clinical examination session, the primary researcher reviewed the injury report forms and injuries.

Incidence proportion, repeat incidence proportion and injuries per 1000 h were calculated. Incidence proportion was measured using the following calculation:

Incidence proportion (IP)

$$= \frac{\text{Number of injured participants during a specified time*}}{\text{Number of participants at risk during a specified time}}$$

*Number of participants who sustain at least 1 injury.
95% confidence intervals were calculated using:

$$95\% \text{ CI} = \text{IP} \pm 1.96 \times \text{SE}(\text{IP})$$

where, the Standard error (SE) was calculated using:

$$\text{SE}(\text{IP}) = \frac{\sqrt{\text{IP} \times (1 - \text{IP})}}{N}$$

where, N is the number of participants at risk.

Incidence proportion does not account for participants who become injured multiple times, thus repeat incidence proportion was calculated:

Repeat incidence proportion

$$= \frac{\text{Number of repeat injured participants during a specified time}}{\text{Number of injured participants during a specified time}}$$

Incidence rate per 1000 h was calculated as follows:

$$\text{Incidence rate (IR)} = \frac{\text{Number of injuries}}{\text{Total hours playing sport}} \times 1000$$

95% confidence interval was calculated using:

$$95\% \text{ CI} = \text{IR} \pm 1.96 \times \text{SE}(\text{IR})$$

With the Standard error (SE) calculated using:

$$\text{SE}(\text{IR}) = \frac{\sqrt{\text{Number of injuries}}}{\text{Total hours playing sport}}$$

Frequency of sports played, onset, type, side, location, nature, severity, mechanism, month, protective equipment and further investigations were also measured.

3. Results

There were 125 injuries in 292 adolescent Gaelic footballers and hurlers. Ninety five participants became injured with 25 of these receiving two or more injuries. Incidence proportion indicated that 32.5% (95% CI: 27.1%–37.9%) of adolescent players became injured in a single year. Of the participants that became injured, 26.3% (95% CI: 17.4%–35.1%) developed a subsequent injury. Match injuries accounted for a higher injury incidence than training in both Gaelic football and hurling; however, the match injury incidence in hurling was higher (Table 1). Acute injuries were predominant with just over a quarter of injuries being overuse in nature (Table 2). A larger proportion of footballers (47.3%) sustained a recurrent injury than hurlers (33.3%), in particular early recurrent and late recurrent (Table 2).

A similar percentage of right sided injuries occurred (41.9%, 38.8%); however, bilateral injuries were more frequent in hurlers (18.4%), with left sided injuries more common in football (50.0%). Lower body injuries were predominant; however, they were more common in footballers (74.7%) than hurlers (58%). Injuries to the lower back (22.0%), knee (20.0%), ankle (10.0%) and pelvis and groin (10.0%) were predominant in hurlers (Table 2). Injuries to the knee (18.7%), hamstring (13.3%) and ankle (12.0%) were most frequent in Gaelic footballers. The regional distribution of injury was similar between both sports; however, injuries to the trunk/spine were more frequent in hurlers (34.7%) than footballers (5.3%) and hip/groin/thigh injuries in footballers (34.7%) than hurlers (17.0%).

Strains (30.7%), sprains (22.7%) were the primary nature of injury noted in footballers with fatigue-induced muscle disorders (28.6%), contusions (20.4%), strains (14.3%) and sprains (14.3%) common in hurlers (Table 2).

A similar percentage of Gaelic footballers (66.7%) and hurlers (68.1%) continued playing and training after the injury occurred. Minor injuries were more common in hurling (61.7%), conversely moderate (20.8%) and severe (37.5%) injuries were more predominant in football (Table 2). Just 6.7% of footballers and 8.0% of hurlers required surgery due to an injury. Further investigations were

Table 1
Injury rate.

Injuries per 1000 h	Combined		Gaelic football		Hurling	
	IR	95% CI	IR	95% CI	IR	95% CI
Total	4.87	4.02–5.73	4.89	3.78–5.99	4.39	3.17–5.60
Training	2.69	2.02–3.38	3.01	2.05–3.96	2.29	1.33–3.25
Match	13.16	9.31–17.00	9.26	5.63–12.89	11.11	6.24–15.98

ordered in 18.7% and 18.1% of footballers and hurlers respectively, with MRI scans and X-rays the most commonly completed.

Injuries primarily occurred during training and matches (79.7%, 80.4%), with more injuries occurring in the warm up (17.4%, 10.9%) than cool down (2.9%, 8.7%) in footballers and hurlers, respectively. Injuries predominantly occurred in the 2nd half (61.8%, 56.0%) with injuries most frequent in the last 15 min (36.0%, 41.2%) for both footballers and hurlers, respectively (Table 2). Injuries were most frequent from January to May (Table 3). Injuries were particularly common in January (17.4%), March (17.4%), and April (17.4%) in footballers and February (30.4%) and April (17.4%) in hurlers.

Non-contact injuries predominated in Gaelic footballers (64.0%) and hurlers (63.3%). No specific mechanism of injury (24.3%, 27.1%), sprinting (25.7%, 20.8%) and being tackled (12.2%, 16.7%) were frequent in both Gaelic footballers and hurlers, respectively. Jumping/catching (10.8%) and kicking (9.5%) were also common in football with falling common in hurling (10.4%) (Table 3). Tackling (being tackled and tackling) was more common in hurling (25.0%) than football (14.9%).

Injuries per playing position were adjusted for the amount of players in each position. Midfielders were most frequently injured accounting for 33.9% and 43.4% of injury in footballers and hurlers, respectively. Injury to backs (25.7%, 23.7%) and forwards (24.4%, 25.0%) were also frequent. Gaelic football goalkeepers were more commonly injured (16.0%) than hurlers (7.9%). Foul play was involved in 14.3% and 9.3% of injuries to adolescent footballers and hurlers. Protective equipment was primarily not worn by Gaelic

footballers (73.3%) and hurlers (95.9%) beside the mandatory gum shields in Gaelic football and helmets in hurling.

4. Discussion

This study aimed to implement a high quality standardised epidemiological study to prospectively examine the incidence of injury in adolescent Gaelic games.

A third of all adolescent players received an injury in one year and over a quarter of injured participants sustained a subsequent injury throughout the year. Recurrent injuries were also frequent in footballers (47.3%) and hurlers (33.3%). In particular, early recurrent injuries were frequent in adolescent footballers (14.9%). This rate of re-injury is worrying as it suggests adolescent players may be returning to Gaelic games without adequate rehabilitation consequently increasing their injury risk.^{18,19} Match injuries were more frequent than training injuries despite players spending 6.5 times more time in training. This trend is also reported in adult Gaelic games^{1,5,12} and other adolescent sports^{20,21} and is attributed to the higher intensity, physicality and effort in a competitive match.^{1,5} Adolescent players had a similar training injury rate as adolescent Gaelic footballers observed by Watson¹³ (3.1 per 1000 h). Adolescent Gaelic footballers presented with a higher match injury rate than high school soccer players (7.2 injuries per 1000 h).²² Adolescent hurlers displayed a higher total injuries per athletic exposures than adolescent lacrosse under-15 boys.²³ Adolescent Gaelic players presented with a lower match injury rate than adult

Table 2
Location, type, nature, new and recurrent, quarter and severity of injury.

	Gaelic football (%)	Hurling (%)		Gaelic football (%)	Hurling (%)
Body part injured			Nature of injury		
Foot and toes	2.7	2.0	Acute	73.3	73.5
Ankle	12.0	10.0	Overuse	26.7	26.5
Shin	0.0	2.0			
Calf	6.7	6.0	New and recurrent injury		
Knee	18.7	20.0	New	52.7	66.7
Hamstring	13.3	4.0	Early recurrent (<2 months)	14.9	8.3
Quadriceps	8.0	4.0	Late recurrent (2–12 months)	16.2	8.3
Hip	5.3	0.0	Persistent	16.2	16.7
Pelvis and Groin	8.0	10.0			
Lower back	5.3	22.0	Quarter of injury		
Neck	1.3	2.0	1st quarter	20.0	14.7
Ribs and chest	0.0	4.0	2nd quarter	24.0	23.5
Head	0.0	0.0	3rd quarter	20.0	20.6
Shoulder	6.7	6.0	4th quarter	36.0	41.2
Elbow	0.0	2.0			
Wrist	1.3	6.0	Severity of injury		
Hand and fingers	10.7	0.0	Minor	41.7	61.7
			Moderate	20.8	8.5
			Severe	37.5	29.8
		Type of injury			
Strain	30.7	14.3			
Sprain	22.7	14.3			
Fatigue-induced muscle disorder	13.3	28.6			
Contusion	8.0	20.4			
Tendinopathy	10.7	10.2			
Fracture	4.0	6.1			
Cartilage	5.3	2.0			
Osgood Schlatters disease	4.0	0.0			
Intervertebral disk	0.0	4.1			
Dislocation	1.3	0.0			

Table 3
Mechanism and month of injury.

Mechanism of injury	Gaelic football (%)	Hurling (%)	Month of injury	Gaelic football (%)	Hurling (%)
Sprinting	25.7	20.8	January	17.4	10.9
No specific mechanism	24.3	27.1	February	11.6	30.4
Being tackled	12.2	16.7	March	17.4	8.7
Jumping/catching	10.8	6.3	April	17.4	17.4
Kicking	9.5	0.0	May	11.6	8.7
Falling	2.7	10.4	June	1.4	0.0
Turning	5.4	4.2	July	1.4	0.0
Tackling	2.7	8.3	August	2.9	4.3
Landing	4.1	4.2	September	7.2	8.7
Blocking	1.4	2.1	October	1.4	2.2
Punching ball	1.4	0.0	November	7.2	8.7
			December	2.9	0.0

Gaelic footballers (51.2–64.0 injuries per 1000 h)^{1,5,11} and hurlers (61.8–102.5 injuries per 1000 h)^{2,12} Match injuries were more frequent in hurling than football which could be due to the enhanced physicality of hurling² and has been demonstrated in previous research in adult Gaelic games.^{2,12}

Lower limb injuries were predominant with a similar rate noted in adolescent Gaelic footballers as the 70–77% reported in adult players.^{1,12,15} However, lower limb injuries were less frequent in adolescent hurlers than adolescent footballers and adult hurlers (70.1%),² most likely due to the high prevalence of lower back injuries noted in this population. This high incidence in adolescent hurlers could be due to the twisting nature of the sport, increased physicality of the game of hurling or poor posture in adolescent males.²⁴ Knee injuries were common in adolescent players and were higher than noted in adolescent Gaelic footballers previously (5%)¹³ and could be caused by poor neuromuscular control at the knee.²⁵ Hamstring injuries were frequent in adolescent Gaelic footballers and higher than previously noted (6.5%)¹³ in this population. This higher incidence in football may be because it is recently becoming more of “a running game” with players using a series of short passes that require them to cover longer overall distances. However, in hurling the use of the hurley allows for quick passes of the sliotar to further areas of the pitch which reduces the amount of running required. In addition, soloing (a skill specific to Gaelic football) requires players while running/sprinting to kick the ball to their hands repeatedly, which may consequently cause greater elongation of the hamstrings. Ankle injuries were common in adolescent players and more frequent than reported previously in adolescent Gaelic footballers (15.1%).¹³ This could be indicative of poor landing technique and balance in adolescents.²⁶

Soft tissue injuries were predominant in adolescent Gaelic games. Strains were more frequent in footballers (30.7%) than hurlers (14.3%) and then previously reported in adolescent Gaelic footballers (21%).¹³ This may be related to the higher occurrence of hamstring injuries in adolescent Gaelic footballers. While sprains were also more frequent in adolescent footballers (22.7%) than adolescent hurlers (14.3%), a similar percentage was reported in adolescent Gaelic footballers (22.3%)¹³ and adult hurlers (15.2%)² previously. Fatigue-induced muscle disorder was the primary nature of injury noted in hurlers (28.6%), mostly likely largely due to the higher rate of lower back injuries noted. Contusions were far more common in hurlers (20.4%) than footballers (8.0%) and adult hurlers (7.5%),¹² presumably due to the increased physicality of hurling and lower skill level in adolescents. Adolescent Gaelic footballers presented with a slightly higher percentage of contusions than previously reported in this population (6.5%).¹³ Fractures were relatively uncommon in adolescent footballers (4.0%) and hurlers (6.1%) and were similar or slightly lower than reported levels in adult footballers (4.4–10%)^{1,5,15} and hurlers (7.4–9%).^{2,12}

Injuries to adolescent hurlers were primarily minor, which could be linked to the predominance of fatigue-induced muscle disorder and contusions. In contrast, moderate and severe injuries were more frequent in adolescent footballers, which may be linked to the higher prevalence of strains and sprains. Despite differences in the distribution of severity of injury, no significant difference was noted between adolescent players for mean days lost from training or full participation ($p > 0.05$). A third of adolescents did not take time off to allow the injury to heal and while this is lower than reported in elite adult Gaelic footballers (46%),¹⁵ it may have contributed to the high re-injury or reoccurrence rates previously noted.

Injuries were more frequent in the second half, particularly in the last quarter of the session, which is similar to adult Gaelic games^{1,2,5} and primarily attributable to fatigue.^{1,27} Injuries were most frequent at the beginning of the calendar year between January and April, corresponding to the preseason and start of the underage club season, where players have more matches and a larger training load.^{15,28}

Adolescent players commonly had no specific mechanism of injury (24.3%, 27.1%) which may be due to the relatively high proportion of overuse injuries reported. In fact, adolescent players had a higher percentage of overuse injuries than previously reported in adult Gaelic footballers (13.5%, 17.4%),^{5,13} adult hurlers (19%),² adolescent soccer players (10.3%)²⁹ and adolescent lacrosse players (8.5%).²³ Thus injury prevention strategies to reduce the risk of overuse injuries in adolescents, such as tracking training load, ensuring appropriate biomechanics, sufficient rehabilitation post injury and education to players and coaches regarding the negative effects of playing through injuries are required. Sprinting was a common mechanism of injury in both football and hurling (25.7%, 20.8%), with the higher frequency in football possibly related to the higher incidence of strains and hamstring injuries. Tackling, particularly being tackled, was also a frequent mechanism of injury and so the introduction of more stringent rules on tackling by the GAA may reduce this. However, one of the biggest attractions of Gaelic games, particularly hurling where tackling injuries were more common, is the physicality of the game and any rule change must not change the inherent nature of the game.³⁰

Midfielders were found to have the highest injury proportion in adolescent footballers and hurlers, which is similar to adult Gaelic footballers.⁵ Midfielders are required to cover large portions of the field, jump and catch high balls repeatedly and are expected to both defend and attack during the match, thus they are placed under a higher level of intensity and physicality than other playing positions.³ Foul play was more frequent in adolescent Gaelic football than hurling, but was still less than half of what was previously reported in adolescent Gaelic footballers (34.8%) by Watson in 1996.¹³ This may be explained by changes in, and stricter enforcement of, the rules of play. Protective equipment besides the

mandatory helmets in hurling and mouth guards in Gaelic football were rarely worn, particularly in adolescent hurlers. The introduction of protective padding to reduce muscular contusions or education to coaches and players on the benefits of preventative taping may be beneficial to reduce injury risk in this population.

A limitation of this study is that it captured injury information in male under-16 players only, and so generalisation to younger or female adolescents should be performed with caution.

5. Conclusion

This study presented comprehensive epidemiological information in male adolescent Gaelic games. Injuries are prevalent, with a third of all adolescent players developing an injury in one year and over a quarter of injured participants sustaining a subsequent injury throughout the year. Epidemiological research such as this can pave the way for the design and implementation of injury prevention strategies. Further prospective epidemiological research is needed in female and younger adolescent Gaelic footballers and hurlers.

6. Practical implications

- This study adds to the literature by providing prospective epidemiology of injury data in adolescent Gaelic footballers and hurlers that has not yet been reported
- Injuries are frequent in adolescent Gaelic games, with a third of all adolescent players sustaining an injury in one year.
- The high occurrence of recurrent and overuse injuries in adolescents highlights the need for medical staff, coaches and players to track training load, ensure appropriate biomechanics and sufficient rehabilitation prior to return to full sporting participation.
- Injuries to the lower limb were predominant, with knee, hamstring and ankle injuries frequent; however, adolescent hurlers commonly sustained lower back injuries
- The use of protective equipment was very low in adolescent Gaelic games.

Acknowledgements

We thank Hannah Mathews and Catherine Corcoran for their assistance with data collection. The authors would also like to thank the external clinicians and researchers that assisted in reviewing the injury report form: Dr Catherine Blake, Dr Philip Glasgow and Dr Mike Ferrara.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jsams.2015.06.002

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