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ORIGINAL ARTICLE

The science of shinty: A needs analysis and training considerations

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ABSTRACT

Shinty is a traditional Scottish invasion sport for which there is currently no empirical evidence describing its physical or physiological demands. This study aimed to develop an athlete profile and quantify match-play demands in senior male players. Forty-eight players (age: 22 ± 7 years; height: 177 ± 6 cm; body mass: 74 ± 12 kg) from three Premiership clubs completed a battery of field-based fitness tests, including handgrip strength, countermovement jump, sprint performance (5 m and 10 m), change of direction, and a 1,500 m maximal aerobic speed test to estimate $\dot{V}O_{2max}$. In addition, GPS data were collected across seven competitive matches to assess movement demands. No significant positional differences were observed across fitness measures (p > .05). Mean values included countermovement jump (35.2 ± 6.2 cm), 10 m sprint (1.9 ± 0.1 s), and estimated $\dot{V}O_{2max}$ (43.4 ± 4.2 ml·kg^{-1}·min^{-1}). Match-play analysis indicated that players covered 8296.8 ± 2369.9 m, with intermittent high-intensity efforts characterized by sprinting, accelerations, and decelerations. These findings provide the first empirical dataset in shinty and establish preliminary normative benchmarks for the sport. The absence of positional differences and the substantial variability observed in match-play demands suggest that shinty may be characterized as a relatively non-specialized invasion sport, in which broad athletic qualities underpin performance and contextual factors strongly influence competitive outputs. These findings provide an evidence base to inform training prescription, performance monitoring, and future research.

Keywords: performance analysis; fitness field test; GPS; exercise physiology; exercise science; sport technology.

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INTRODUCTION

Shinty is a traditional Scottish invasion sport characterised by intermittent high-intensity activity, rapid changes in direction, and advanced stick-handling skills. Despite its cultural significance and continued participation across Scotland, there is a notable absence of scientific research examining its physical and physiological demands. This lack of empirical evidence contrasts with comparable stick sports such as hurling, field hockey, and lacrosse, where performance characteristics have been extensively investigated.

Due to these similarities, hurling has frequently been used as a comparative model for understanding shinty performance. Hurling has been described as "*shinty's sporting and cultural cousin*" (MacLennan, 1998), with both sports sharing common technical and tactical elements. Previous research has quantified the physiological demands of hurling through fitness testing and GPS analysis, highlighting the importance of aerobic capacity, repeated sprint ability, and neuromuscular coordination (Collins et al., 2017; Malone et al., 2021; Young et al., 2019, 2021). However, differences in pitch dimensions, match duration, and tactical approaches suggest that direct comparisons may not fully capture the unique demands of shinty.

In team sports, a needs analysis is essential for identifying the physical, physiological, and technical requirements of performance and for informing the design of sport-specific training programmes (Taylor et al., 2017). Typically, such analyses guide the development of testing batteries and performance benchmarks. However, in the absence of existing research on shinty, there is currently no standardised framework to inform training practices or evaluate player performance. As a result, many clubs rely on generalised or anecdotal approaches, which may limit performance development and increase injury risk.

Research across invasion sports indicates that athletes require a combination of aerobic endurance to sustain prolonged activity, anaerobic power to perform repeated high-intensity efforts, and muscular strength to support technical actions such as striking and tackling (Collins et al., 2022; Malone et al., 2016). Furthermore, speed, power, and mobility are critical for executing rapid directional changes, while neuromuscular coordination underpins effective skill execution. These qualities are typically assessed through field-based fitness testing and monitored during competition using GPS technology, providing valuable insight into both performance demands and training requirements.

Given the current lack of research in shinty, there is a clear need to establish baseline data describing player characteristics and match-play demands. Developing such evidence would support practitioners in designing targeted training programmes and enable the establishment of performance benchmarks across the sport. Additionally, a more systematic approach to data collection could contribute to talent identification and long-term athlete development within the shinty community.

Beyond establishing the first empirical performance profile of shinty players, this study also seeks to contribute to the broader invasion sport literature. Research in hurling, field hockey, and other invasion sports has demonstrated that positional specialisation often results in distinct physical and physiological profiles and movement demands (Collins et al., 2022; Reilly & Borrie, 1992). However, the tactical structure and amateur characteristics of shinty may necessitate a more generalised athletic profile characterised by shared physical demands across positions. Furthermore, ecological and contextual influences such as opposition quality, match circumstances, and environmental conditions have been shown to affect performance outputs in invasion sports (Malone et al., 2016; Lombard et al., 2021). Consequently, this study explores whether shinty may be conceptualised as a relatively non-specialised invasion sport in which physical demands are distributed more evenly across playing positions and match performance is shaped by contextual constraints.

Therefore, the primary aim of this study was to develop an athlete profile for senior male shinty players through the collection and analysis of fitness testing data. The secondary aim was to quantify match-play demands using GPS technology.

MATERIAL AND METHODS

Participants

Forty-eight senior male shinty players (age: 22 ± 7 years; height: 177 ± 6 cm; body mass: 74 ± 12 kg) were recruited from three Camanachd Association Premiership clubs in the Highlands of Scotland. All participants were actively competing at first-team level, free from injury, and provided written informed consent prior to participation. Ethical approval was obtained from the University of the Highlands and Islands Research Ethics Committee.

Participants were categorised into positional groups (defenders, midfielders, and forwards), consistent with classification approaches used in comparable invasion sports (Reilly & Borrie, 1992). Purposive sampling was employed to ensure that participants met the performance and participation criteria required for the study (Jones, 2014).

Procedures

All testing was conducted during scheduled club training sessions at the participants' usual training facilities to maximise ecological validity. The testing battery was completed within a single session per team and consisted of handgrip strength, countermovement jump (CMJ), sprint testing (5 m and 10 m), a 5-0-5 change of direction test, and a 1,500 m maximal aerobic speed (MAS) test.

A standardised warm-up based on the RAMP protocol (Jeffreys, 2007) was implemented prior to testing. Participants were provided with clear instructions and demonstrations for each test and completed familiarisation trials for all measures except the 1,500 m run. Testing order prioritised explosive movements early in the session, with adequate rest provided between trials to minimise fatigue.

Measures

Fitness testing

Handgrip strength was assessed using a Takei Grip-A dynamometer (Takei Scientific Instruments, Tokyo, Japan). Participants performed three maximal efforts with each hand, with the highest value recorded.

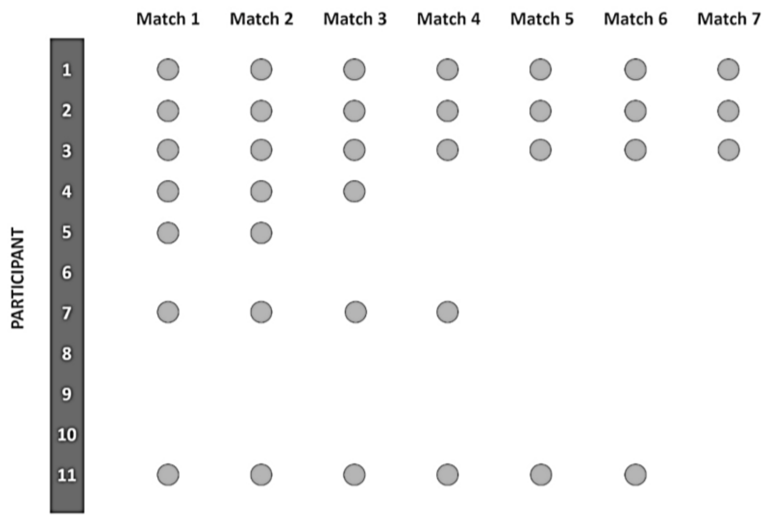
Lower-body power was measured using a bilateral countermovement jump (CMJ) on an Optojump Next system (Microgate, Bolzano, Italy). Participants performed three trials with hands fixed on hips to eliminate arm swing, and the highest jump height was recorded.

Sprint performance was assessed over 5 m and 10 m using a Microgate Witty timing system. Participants completed three trials for each distance from a standing start, with sufficient recovery between efforts.

Change of direction ability was measured using the 5-0-5 test, which required participants to accelerate, decelerate, and reaccelerate over a 5 m distance. Three trials were completed with adequate recovery.

Aerobic capacity was estimated using a 1,500 m field-based test to determine maximal aerobic speed (MAS) and estimated $\dot{V}O_{2max}$, following previously validated procedures (Baker, 2011).

Match-play analysis
Match-play demands were assessed using 10 Hz STATSports Apex GPS devices (STATSports, Northern Ireland). Eleven players from one team wore GPS units across seven competitive matches. Participant availability across the data collection period is presented in Figure 1. Due to incomplete data resulting from injury and non-compliance, seven players were included in the final analysis.



Note. Match participation by each of the 11 participants. Participants 8, 9 and 10 were injured for the entirety of data collection with participants 4, 5 and 6 injured during data collection.

Figure 1. GPS data availability across seven competitive matches.

Variables collected included total distance, distance per minute, high-speed running distance, maximum speed, number of sprints, sprint distance, accelerations, and decelerations. Devices were worn in manufacturer-provided vests positioned between the scapulae.

Statistical analysis
All data were analysed using SPSS (Version 28, IBM, USA). Descriptive statistics (mean ± standard deviation) were calculated for all variables. Data normality was assessed using Shapiro–Wilk tests.

One-way analyses of variance (ANOVAs) were conducted to determine differences between positional groups, with statistical significance set at $p < .05$. Effect sizes were calculated to assess the magnitude of differences.

Intraclass correlation coefficients (ICC) were used to evaluate reliability across fitness testing trials and GPS measures. Match-play data were analysed descriptively due to the limited sample size.

RESULTS

Participant characteristics
Forty-eight participants were included in the study, all of whom met the inclusion criteria of first-team involvement and absence of injury. The sample had a mean age of 22 ± 7 years, height of 177 ± 6 cm, and body mass of 74 ± 12 kg. No meaningful differences were observed between positional groups, indicating a relatively homogeneous sample across defenders, midfielders, and forwards.

Table 1. Participant characteristics.

Position	Age (years)	Height (cm)	Body mass (kg)
Defenders (*n* = 19)	22 ± 7	176 ± 5	75 ± 10
Midfielders (*n* = 10)	21 ± 7	179 ± 8	74 ± 11
Forwards (*n* = 19)	23 ± 7	174 ± 5	72 ± 5
Combined (*n* = 48)	22 ± 7	177 ± 6	74 ± 12
Range	16–40	164–190	52–94

Note. Values are presented as mean ± standard deviation unless otherwise indicated.

Fitness testing

Descriptive statistics for all fitness variables are presented in Table 2. No significant differences were identified between positional groups for any measure ($p > .05$), and effect sizes were trivial across all variables.

Table 2. Fitness testing results.

	Defenders (*n* = 19)	Midfielders (*n* = 10)	Forwards (*n* = 19)	Combined (*n* = 48)	Range	ICC	Effect size
CMJ (cm)	36.9 ± 6.7	35.3 ± 4.9	33.4 ± 6.1	35.2 ± 6.2	24.8–47.1	.976	.063
HGR (kg)	49.1 ± 9.7	45.4 ± 7.0	45.6 ± 8.8	47.0 ± 8.9	35.6–58.8	.813	.039
HGL (kg)	48.8 ± 9.8	43.1 ± 7.0	44.8 ± 10.0	46.0 ± 9.6	32.8–61.8	.792	.061
5 m (s)	1.1 ± 0.1	1.1 ± 0.1	1.1 ± 0.1	1.10 ± 0.10	0.95–1.3	.716	.092
10 m (s)	1.9 ± 0.1	1.9 ± 0.1	1.9 ± 0.1	1.9 ± 0.1	1.7–2.35	.856	.033
5-0-5 (s)	2.2 ± 0.4	2.0 ± 0.4	2.1 ± 0.4	2.1 ± 0.4	1.51–2.53	.389	.058
1500 m (s)	368 ± 31.4	369 ± 36.1	363 ± 45.4	366 ± 38.3	302–452	-	.004
MAS ($m \cdot s^{-1}$)	4.1 ± 0.3	4.1 ± 0.4	4.2 ± 0.45	4.1 ± 0.4	3.42–4.97	-	.009
$\dot{V}O_{2max}$ ($ml \cdot kg^{-1} \cdot min^{-1}$)	43.9 ± 3.6	43.1 ± 4.3	43.9 ± 4.8	43.4 ± 4.2	35.8–52.2	-	.010

Note. CMJ = countermovement jump; HGL = left-hand handgrip strength; HGR = right-hand handgrip strength; 5 m = 5-metre sprint; 10 m = 10-metre sprint; 1500 m = 1500-metre timed run; MAS = maximal aerobic speed; $\dot{V}O_{2max}$ *= estimated maximal oxygen uptake; ICC = intraclass correlation coefficient.*

Across the full sample, mean countermovement jump height was 35.2 ± 6.2 cm. Sprint performance was consistent across positions, with a mean 5 m time of 1.10 ± 0.10 s and 10 m time of 1.9 ± 0.1 s. Change of direction performance, assessed using the 5-0-5 test, recorded a mean time of 2.1 ± 0.4 s.

Handgrip strength values were similar between dominant and non-dominant hands, with mean scores of 47.0 ± 8.9 kg (right) and 46.0 ± 9.6 kg (left). Aerobic performance, assessed via the 1,500 m test, resulted in a mean time of 366 ± 38.3 s, corresponding to a maximal aerobic speed of 4.1 ± 0.4 $m \cdot s^{-1}$ and estimated $\dot{V}O_{2max}$ of 43.4 ± 4.2 $ml \cdot kg^{-1} \cdot min^{-1}$.

Intraclass correlation coefficients indicated acceptable reliability for most fitness measures, although lower reliability was observed for countermovement jump and 5 m sprint performance.

Match-play demands

GPS data were collected from seven competitive matches, with a final sample of seven players contributing usable datasets due to injury and non-compliance among the initial cohort. Overall data compliance was 73.5%.

Players covered a mean total distance of 8296.8 ± 2369.9 m per match, equating to 88.8 ± 25.5 $m \cdot min^{-1}$. High-speed running distance averaged 431.3 ± 177.4 m, while maximum speed reached 8.1 ± 0.8 $m \cdot s^{-1}$.

Sprint activity averaged 15.8 ± 6.3 efforts per match, with a total sprint distance of 306.5 ± 130.2 m. Players performed 55.6 ± 21.3 accelerations and 58.5 ± 19.2 decelerations during match-play, demonstrating the intermittent and high-intensity nature of the sport.

Reliability across GPS-derived variables was low, with intraclass correlation coefficients below .5 for all metrics, likely reflecting variability between matches and the limited sample size.

Table 3. GPS match-play data.

	Total distance (m)	Distance/min (m)	HSR (m)	Max speed ($m \cdot s^{-1}$)
Overall (*n* = 7)	8296.8 ± 2369.9	88.8 ± 25.5	431.3 ± 177.4	8.1 ± 0.8
Range (*n* = 7)	6046–12361	47.6–128.8	199–703	7.01–10.39
ICC	.159	.107	.243	.181
	Sprints	**Sprint distance (m)**	**Accelerations**	**Decelerations**
Overall (*n* = 7)	15.8 ± 6.3	306.5 ± 130.2	55.6 ± 21.3	58.5 ± 19.2
Range (*n* = 7)	6–31	104–601	20–120	21–99
ICC	.231	.351	.351	.112

Note. HSR = high-speed running; ICC = intraclass correlation coefficient.

DISCUSSION

To aid interpretation of the present findings, an Ecological Constraints Model of Shinty Performance (Figure 2) is proposed. The framework integrates athlete characteristics, match-play demands, tactical fluidity, and contextual constraints into a single conceptual model. Previous research in invasion sports has highlighted the interaction between physiological capacities and competition demands in the development of performance outcomes (Malone et al., 2016; Collins et al., 2022). Within this framework, broad athletic qualities underpin successful performance in shinty, while tactical and environmental influences shape the expression of these capacities during competition. Consequently, match demands may vary considerably despite relatively homogeneous physical profiles. The model therefore provides a theoretical foundation through which future investigations can examine the physical, technical, tactical, and contextual determinants of performance in shinty.

The findings of the present study provide the first empirical evidence describing the physical characteristics and match-play demands of senior male shinty players. Within the context of the proposed framework, several findings warrant discussion.

A key finding of the present study was the absence of significant differences between positional groups across all fitness variables. This finding contrasts with observations from several invasion sports, including hurling and field hockey, where positional roles are frequently associated with distinct physical and physiological characteristics (Collins et al., 2014; Reilly & Borrie, 1992). One explanation may be the highly fluid nature of shinty match-play, whereby players are regularly required to transition between attacking and defensive responsibilities. Such tactical fluidity may reduce the need for highly specialized physical characteristics and promote the development of a more generalized athletic profile.

Additionally, the predominantly amateur structure of shinty may contribute to relatively homogeneous physical development across playing positions. Unlike professional and semi-professional sporting environments, where conditioning programmes are commonly tailored to positional requirements, shinty players may undertake similar training regardless of role. Consequently, defenders, midfielders, and forwards may be exposed to comparable physical preparation and match demands. Similar relationships between participation structures and physical development have previously been discussed within Gaelic games and related sports (Reilly & Collins, 2008; Mullane et al., 2018). Collectively, these findings support the proposition that shinty may function as a relatively non-specialized invasion sport characterised by shared physical requirements rather than highly differentiated positional demands.

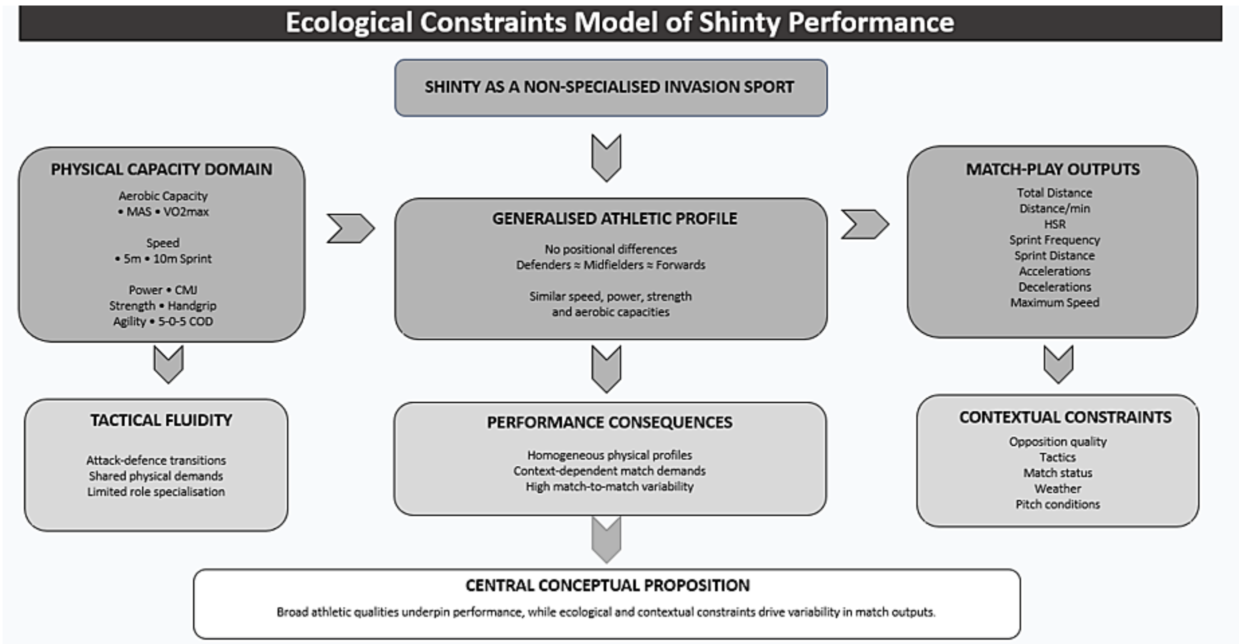


Figure 2. Ecological Constraints Model of Shinty Performance illustrating the proposed relationships between physical capacities, tactical fluidity, contextual constraints, and match-play demands in a relatively non-specialized invasion sport.

When compared with other stick-based invasion sports, particularly hurling, shinty players demonstrated lower values across several physical and physiological measures. Previous research has reported greater lower-body power, sprint performance, and aerobic fitness among elite hurlers than those observed within the present sample (Collins et al., 2014; Keane et al., 2021). While these differences may reflect variation in training status and access to strength and conditioning support, they may also indicate important distinctions in tactical structure and match organization.

Match-play data from the current study similarly suggests distinct movement strategies. Players performed fewer high-speed efforts and covered lower sprint distances than values commonly reported in hurling match-play investigations (Collins et al., 2017; Young et al., 2019). Given the longer duration of shinty matches and differences in tactical organization, players may adopt pacing strategies that distribute effort more evenly throughout competition. Variations in ball movement, pitch use, and spatial organization may also contribute to unique movement characteristics. Consequently, while hurling remains a meaningful comparative framework, the present findings suggest that shinty possesses a distinct physical and tactical profile deserving independent investigation within the wider invasion sport literature.

Match-play analysis confirmed that shinty is characterized by intermittent activity, with players covering substantial total distances alongside repeated bouts of high-intensity movement. The observed combination of sprinting, accelerations, and decelerations highlights the importance of developing both aerobic and anaerobic physical qualities. The ability to repeatedly perform high-intensity actions while maintaining technical proficiency is a characteristic shared across many invasion sports and reinforces the importance of comprehensive athletic preparation (Malone et al., 2016; Collins et al., 2022).

The relatively low reliability observed across GPS-derived variables represents an important finding and warrants careful interpretation. While the relatively small sample size undoubtedly contributed to reduced reliability estimates, substantial match-to-match variability may also reflect the inherently dynamic nature of competitive shinty. Factors such as opposition quality, tactical strategy, game state, environmental conditions, and pitch characteristics are likely to influence player movement demands during competition. Similar interactions between contextual variables and performance outputs have been reported in other invasion sports (Malone et al., 2016; Lombard et al., 2021).

Rather than representing solely a methodological limitation, the observed variability may indicate that shinty performance is highly context dependent. Fluctuations in total distance, sprint frequency, accelerations, and decelerations may reflect ecological constraints acting upon players during competition rather than stable positional demands. This interpretation aligns with the proposed conceptual framework and suggests that performance in shinty emerges from interactions among physical capacity, tactical requirements, opposition behaviour, and environmental conditions. Nevertheless, the low ICC values and restricted sample size reduce generalizability and reinforce the need for larger longitudinal investigations involving multiple teams and competitive contexts.

From an applied perspective, the findings highlight several areas for development within shinty. In particular, the comparatively lower levels of strength, power, and aerobic capacity observed relative to comparable invasion sports suggest that targeted strength and conditioning interventions could enhance performance. Resistance training, plyometric development, sprint training, and maximal aerobic speed-based conditioning may all provide practical benefits within the sport. Furthermore, the apparent absence of positional differences suggests that training programmes should initially prioritize broad athletic development before progressing toward more specialized physical preparation as the evidence base grows. The integration of systematic fitness testing and GPS monitoring may also support more structured and evidence-informed approaches to player development and performance monitoring.

This study is not without limitations. Most notably, the GPS analysis was based on a relatively small sample of seven players across seven competitive matches following data loss associated with injury and device non-compliance. Consequently, the match-play findings should be interpreted as preliminary normative data rather than definitive performance benchmarks. The limited GPS dataset also restricted robust positional comparisons and reduced the generalizability of movement demand estimates across the wider shinty population. Furthermore, reliability across GPS-derived variables was low, indicating substantial match-to-match variability and reinforcing the need for caution when applying these findings to individual performance profiling or training prescription.

While this variability may reflect the influence of contextual factors such as opposition quality, tactical approaches, environmental conditions, and match status, the current dataset does not allow the relative contribution of these factors to be determined. Future studies should therefore employ larger longitudinal datasets across multiple teams and competitive contexts to better understand sources of performance variability.

Furthermore, the present study focused exclusively on physical and physiological characteristics and therefore does not fully capture the multidimensional nature of shinty performance. Technical skill execution, tactical behaviours, perceptual-cognitive processes, and decision-making variables were not assessed despite their likely contribution to successful performance outcomes. While physical qualities provide an important foundation for performance, successful participation in invasion sports is also influenced by technical proficiency and tactical effectiveness (Collins et al., 2022; Lombard et al., 2021). Future investigations should therefore integrate physiological testing, GPS monitoring, technical performance indicators, and tactical analysis to develop a more comprehensive understanding of shinty performance. Such work would facilitate the refinement of the conceptual framework proposed in the present study and contribute to the development of integrated models of performance within the sport.

Practical applications

The findings of this study provide an initial evidence base to inform strength and conditioning practice in shinty. Given the lower levels of strength, power, and aerobic capacity observed compared to other stick sports, training programmes should prioritize the development of these key physical qualities. This may include the integration of resistance training, plyometric exercises, and sprint-based drills to improve rate of force development and explosive performance.

Aerobic conditioning should reflect the intermittent nature of the sport, incorporating maximal aerobic speed (MAS)-based and interval training methods to enhance both endurance and repeated high-intensity effort capacity.

The absence of positional differences suggests that players should develop a broad physical profile, with training programmes focusing on all-round athletic development rather than strict positional specialization.

Finally, the use of fitness testing and GPS monitoring is recommended to align training loads with match demands, support performance monitoring, and inform long-term player development within the sport.

CONCLUSIONS

This study provides the first empirical assessment of the physical characteristics and match-play demands of senior male shinty players. The findings demonstrate that shinty is an intermittent, high-intensity invasion sport requiring a combination of aerobic fitness, speed, power, and repeated high-intensity efforts. No significant positional differences were identified across any physical measure, suggesting that players require a broad and versatile athletic profile.

Collectively, these findings establish the first empirical evidence base for shinty and provide preliminary normative benchmarks for coaches, practitioners, and researchers. The absence of positional differences, combined with substantial match-to-match variability in competitive demands, suggests that shinty may be conceptualized as a relatively non-specialized invasion sport in which broad athletic qualities underpin performance and contextual constraints strongly influence match outputs. Consistent with observations from other invasion sports, performance appears to emerge from interactions among physical capacity, tactical requirements, and environmental influences (Malone et al., 2016; Collins et al., 2022).

The proposed Ecological Constraints Model of Shinty Performance provides a conceptual framework through which future multidisciplinary research can investigate the interaction between physical, technical, tactical, and environmental determinants of performance within the sport. Future investigations incorporating larger samples, longitudinal match-play monitoring, and integrated performance analyses will be essential for refining this framework and advancing the scientific understanding of shinty.

AUTHOR CONTRIBUTIONS

All authors meet the criteria for authorship in accordance with established ethical guidelines. Contributions are specified according to the CRediT (Contributor Roles Taxonomy) as follows: Conceptualisation: Jed McKernie. Methodology: Jed McKernie. Investigation: Jed McKernie. Writing – original draft: Jed McKernie. Writing – review & editing: Jed McKernie, Mykolas Kavaliauskas, Trish Gorely, Daniel Crabtree. Supervision: Mykolas Kavaliauskas, Trish Gorely, Daniel Crabtree.

All authors have critically reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used in the generation of scientific content, including the study design, data collection, analysis, interpretation of results, or the formulation of conclusions. The authors retain full responsibility for the content of the manuscript and confirm its originality, integrity, and accuracy.

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