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Yo-Yo Intermittent Recovery Test Performance in Subelite Gaelic Football Players From Under Thirteen to Senior Age Groups

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Abstract

Roe, M and Malone, S. Yo-Yo intermittent recovery test performance in subelite Gaelic football players from under thirteen to senior age groups. *J Strength Cond Res* XX (X): 000–000, 2016–Gaelic football is indigenous to Ireland and has similar locomotion profiles to soccer and Australian Football. Given the increasing attention on long-term player development, investigations on age-related variation in Yo-Yo intermittent recovery test level 1 (Yo-YoIR1) performance may provide useful information in talent identification, program design, and player monitoring. Therefore, the aim of this study was to evaluate Yo-YoIR1 performance across Gaelic football age groups. Male participants ($n = 355$) were recruited from division one, Gaelic football teams. Participants were allocated to one of the 7 groups according to respective age groups from under 13 (U13), under 14, under 15 (U15), under 16 (U16), minor, under 21 (U21), to senior age groups. Total Yo-YoIR1 distance (m) increased progressively from U13 (885 ± 347 m) to U16 (1,595 ± 380 m) equating to a rate of change of 180.2%. In comparison to U13, total distance at minor (1,206 ± 327 m) increased by 136.4%. Subsequent increases were observed in U21 (1,585 ± 445 m) and senior players (2,365 ± 489). Minimum (800–880 m) and maximum (2,240–2,280 m) total distances were comparable for U15, U16, and U21 players. Differences in total distance (m) for all age groups were statistically significant when compared to U13 players ($p < 0.002$). In comparison to U13 players, the magnitude of differences between age groups for total distance was deemed to be large (effect size > 0.8). Similar trends were observed for maximum velocity and estimated $\dot{V}O_2max$. The evolution of Yo-YoIR1 performance in Gaelic football players from adolescents to adulthood highlights how maturation may influence sport-related running ability. Changes in Yo-YoIR1 performance should be closely monitored to optimize interventions for individuals transitioning across age groups.

Key Words intermittent aerobic capacity, field testing, maturation AU4

Introduction

Gaelic football is indigenous to Ireland and is governed by the Gaelic Athletic Association (GAA). The sport has an amateur ethos superimposed on a professional work ethic (6). During competitive match-play, 2 opposing teams compete over a 60-minute period separated by a 15-minute halftime interval. Each team has 15 players and can make 5 substitutions. The aim is to outscore the opposition as with AU5 H-shaped goal posts, 1 point is awarded for striking or kicking the ball over a crossbar and 1 goal (3 points) is awarded for striking or kicking the ball over under the crossbar past a goalkeeper. Intercounty competition represents the elite level of Gaelic games, whereas club competitions represented subelite levels.

Activity profiles of Gaelic football match-play follow an intermittent pattern (12). Reilly et al. (21) reported that underage players (15 ± 0.7 years) cover a mean distance of 5,732 ± 1,047 m with 14.8% (851 ± 297 m) covered at high speed (≥17 $km \cdot h^{-1}$). Adult players have been reported to cover average total distances of 8,815 m with 10.3% of distance covered at high speed (1,695 ± 1,047 m). The Yo-Yo intermittent recovery test level 1 (Yo-YoIR1) has significant correlates to total distance ($r = 0.62$) and high-intensity distance ($r = 0.73$) within underage team sport athletes (9). As underage development pathways seek to optimize early detection and physical development of talented players, assessment of sport-related running ability across age groups may improve talent identification and long-term training interventions (7,14,21).

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Table 1. Yo-YoIR1 total distance (m) per age group.*†

	Sample size	Mean ± *SD*	Minimum	Maximum	95% CI	*p*	Cohen's *d*
Under 13	63	885.1 ± 347.3	320	1,920	801.91–974.57		
Under 14	41	1,326.0 ± 494.9	440	2,280	1,213.71–1,444.51	0.000	1.031
Under 15	62	1,470.9 ± 372.2	880	2,240	1,361.53–1,574.32	0.000	1.627
Under 16	53	1,595.0 ± 380.7	880	2,240	1,468.75–1,713.72	0.000	1.948
Minor	52	1,206.8 ± 327.3	600	1,840	1,109.27–1,313.17	0.002	0.953
Under 21	32	1,585.4 ± 445.3	800	2,480	1,426.15–1,755.31	0.000	1.753
Senior	52	2,365.4 ± 489.6	1760	3,400	2,178.58–2,551.52	0.000	3.487

*Pairwise comparisons reveal a statistically significant ($p \leq 0.05$) mean difference between (a) U13 compared with all age groups except minor, (b) U14 compared with U13 and senior, (c) U15 compared with U13, U21, and senior, (d) U16 compared with U13, U21, and senior, (e) minor compared with U15, U16, and senior, (f) U21 compared with U13 and senior, and (g) senior compared with all age groups.

†Age range for players: minor group (17–19 years) and senior group (19–33 years).

The Yo-YoIR1 has been assessed for validity in intermittent field sport players (3,9) and is considered a valid field test to assess changes in aerobic fitness within Gaelic football populations (17). The Yo-YoIR1 evaluates an athlete's ability to repeatedly complete short, high-intensity running efforts, which elicit maximal aerobic responses while significantly stressing the anaerobic energy system (3). Thus, Yo-YoIR1 induces physiological demands similar to those experienced during match-play (3,9,20).

Despite the popularity of the test, there is little information about the potential role of the Yo-YoIR1 to discriminate the aerobic performance across age profiles within Gaelic football. An understanding of how Yo-YoIR1 performance develops across age groups could be of practical value to practitioners developing talent identification and profiling procedures in Gaelic football. Therefore, the aim of this study was to evaluate Yo-YoIR1 performance differences across under 13 to senior age groups within a Gaelic football population.

Methods

Experimental Approach to Problem

In this cross-sectional study, we applied a between-subjects design to examine the group differences in the Yo-YoIR1 performance among young and adult Gaelic football players. All testing took place on a rubber-based third-generation (3 G) synthetic turf pitch (dimensions: 143 × 86 m; grass length: 55 mm) with a 50.8-mm shock pad underneath a synthetic grass carpet.

Subjects

Male participants ($n = 355$) were recruited from division one, Gaelic football teams. Participants were allocated to one of the 7 groups according to respective age grades, that is, either under 13 years (U13) (12–13 years, 48.4 ± 10.2 kg, 145.1 ± 3.4 cm), under 14 years (U14) (13–14 years, 52.4 ± 10.2 kg, 155.1 ± 8.4 cm), under 15 years (U15) (14–15 years, 61.9 ± 10.5 kg, 162.5 ± 7.7 cm), under 16 years (U16) (16–17 years, 70.9 ± 9.5 kg, 174.5 ± 8.7 cm), minor age grade (17–19

Table 2. Yo-YoIR1 maximum velocity ($m \cdot s^{-1}$) per age group.*†

	Sample size	Mean ± *SD*	Minimum	Maximum	95% CI	*p*	Cohen's *d*
Under 13	63	4.24 ± 0.27	3.89	5.22	4.17–4.30		
Under 14	41	4.49 ± 0.39	3.89	5.5	4.40–4.58	0.001	0.745
Under 15	62	4.61 ± 0.34	4.2	5.4	4.52–4.70	0.000	1.205
Under 16	53	4.82 ± 0.38	4.17	5.42	4.69–4.94	0.000	1.759
Minor	52	4.30 ± 0.14	4.03	4.58	4.26–4.35	0.948	0.278
Under 21	32	4.90 ± 0.39	4.19	5.67	4.75–5.10	0.000	1.967
Senior	52	5.54 ± 0.42	5.03	6.44	5.39–5.71	0.000	3.682

*Pairwise comparisons reveal a statistically significant ($p \leq 0.05$) mean difference between (a) U13 compared with all age groups except minor, (b) U14 compared with U13, minor, and senior, (c) U15 compared with U13, minor, and senior, (d) U16 compared with U13, minor, and senior, (e) minor compared with all age groups except U13, (f) U21 compared with U13, minor, and senior, and (g) senior compared with all age groups.

†Age range for players: minor group (17–19 years) and senior group (19–33 years).

Table 3. Yo-YoIR1 estimated $\dot{V}O_2$max ($ml \cdot min^{-1} \cdot kg^{-1}$) per age group.*†

	Sample size	Mean ± *SD*	Minimum	Maximum	95% CI	*p*	Cohen's *d*
Under 13	63	44.7 ± 2.6	41.4	49.2	43.97–45.69		
Under 14	41	48.5 ± 4.2	41.4	55.6	46.96–50.14	0.000	1.087
Under 15	62	49.8 ± 2.7	45.1	55.2	48.83–50.9	0.000	1.924
Under 16	53	50.8 ± 2.6	46.5	55.2	49.76–51.83	0.000	2.346
Minor	52	46.2 ± 2.9	41.4	51.9	45.11–47.28	0.002	0.544
Under 21	32	49.7 ± 3.7	43.1	57.2	48.38–51.15	0.000	1.563
Senior	52	56.3 ± 4.1	51.2	65.0	54.76–57.94	0.000	3.379

*Pairwise comparisons reveal a statistically significant ($p \leq 0.05$) mean difference between (a) U13 compared with all age groups except minor, (b) U14 compared with U13 and senior, (c) U15 compared with U13, minor, and senior, (d) U16 compared with U13, minor, and senior, (e) minor compared with U15, U16, and senior, (f) U21 compared with U13 and senior, and (g) senior compared with all age groups.
†Age range for players: minor group (17–19 years) and senior group (19–33 years).

years, 76.3 ± 7.6 kg, 180.1 ± 4.6 m), under 21 years (U21) (20.5 ± 1.5 years, 72.9 ± 9.5 kg, 179.5 ± 9.7 cm), or senior age grade (24.5 ± 6.5 years, 78.8 ± 3.6 kg, 180.4 ± 6.2 m). Inclusion criteria were no injury or illness within the previous 6 months and playing experience greater than 18 months. Data on goal keepers were excluded for analysis. Participants were informed of the investigation aims, testing procedures, and withdrawal process before providing written consent. Written consent was obtained from parents and guardians for participants less than 18 years. Ethical approval was granted by the institutions' human research committee. The study conforms to the Code of Ethics of the World Medical Association (approved by the ethics advisory board of Swansea University) and required players to provide informed consent before participation.

Procedure

This study was performed over a one-month period. All participants undertook a familiarization test of the Yo-YoIR1 in the 2-week period before testing. Testing was administered during the 2014–15 season. Participants were instructed to consume their usual diets before testing. Testing was then completed in line with the procedures described by Bangsbo et al. (3). This included participants completing a 15-minutes dynamic warm-up involving multijoint and running activities of progressive intensity. The Yo-YoIR1 consists of 2 × 20 m shuttle runs at increasing speeds, interspersed with a 10-second active recovery (controlled by audio signals from a compact disc player). Failure to complete a shuttle resulted in a verbal warning with participants being withdrawn on a second failure. Total distance and corresponding maximum speed at the final completed shuttle were recorded. Estimated $\dot{V}O_2$max was completed using the following formula by Bangsbo et al. (3). $\dot{V}O_2$max ($ml \cdot min^{-1} \cdot kg^{-1}$) = Yo-YoIR1 distance (m) × 0.0084 + 36.4.

Statistical Analyses

All data were analyzed using SPSS (version 21.0; IBM, Inc., Chicago, IL, USA). Descriptive statistics were used to report performance markers per age grade. Data are presented as mean ± *SD* with 95% confidence intervals. Minimum and maximum data per age grade are also presented. Quartiles

Table 4. Yo-YoIR1 total distance, maximum velocity quartiles, and estimated $\dot{V}O_2$max quartiles.*

	Total distance (m)			Maximum velocity ($m \cdot s^{-1}$)			Estimated $\dot{V}O_2$max ($ml \cdot min^{-1} \cdot kg^{-1}$)		
	Quartile 1	Quartile 2	Quartile 3	Quartile 1	Quartile 2	Quartile 3	Quartile 1	Quartile 2	Quartile 3
Under 13	600	840	1,120	4.03	4.17	4.31	41.44	43.46	45.81
Under 14	960	1,285	1,660	4.17	4.44	4.72	44.46	47.19	50.34
Under 15	1,180	1,480	1,720	4.31	4.53	4.89	46.31	48.83	50.85
Under 16	1,240	1,660	1,920	4.53	4.91	5.14	46.82	50.34	52.53
Minor	940	1,200	1,460	4.17	4.31	4.44	44.30	46.48	48.66
Under 21	1,190	1,620	1,945	4.53	4.89	5.24	46.40	50.01	52.74
Senior	1,910	2,280	2,720	5.13	5.47	5.86	52.44	55.55	59.25

*Age range for players: minor group (17–19 years) and senior group (19–33 years).

Table 5. Yo-YoIR1 total distance rate of change relative to under 13 players (%).

	Sample size	Mean ± *SD* (%)	Minimum (%)	Maximum (%)	95% CI lower limit	95% CI upper limit
Under 13	63					
Under 14	41	149.81 ± 55.92	50.00	258.00	136.2	163.51
Under 15	62	166.19 ± 42.05	99.00	253.00	154.3	177.45
Under 16	53	180.21 ± 43.01	99.00	253.00	164.0	194.19
Minor	52	136.35 ± 36.98	68.00	208.00	124.8	148.14
Under 21	32	179.12 ± 50.32	90.00	280.00	160.9	196.67
Senior	52	267.25 ± 55.32	199.00	384.00	247.1	288.97

were used to report 25th, 50th, and 75th percentiles for Yo-YoIR1 metrics. One-way between-groups analysis of variance with Tukey post hoc was used to investigate mean differences using U13 performance as the dependent variable. Significance was set at $a\ p \leq 0.05$. Effect size (*ES*) was assessed according to Cohen. An *ES* of 0.02, 0.5, 0.8, or 1.3 was considered small, moderate, large, or very large, respectively. Significant pairwise differences between age groups are also reported.

Results

Total distance, maximum velocity (meter per second), and estimated $\dot{V}O_2$max obtained during the Yo-YoIR1 per age grade are presented in Tables 1–3, respectively. Quartiles are presented in Table 4. Rate of change (percent) relative to U13 players is presented in Table 5.

Total distance (meter) increased by 180.2% from 885.1 ± 347 m in U13 players to 1,595 ± 380 m in U16 players ($p < 0.001$, $ES = 3.49$). In comparison to U13, total distance at minor age group (1,206 ± 327 m) increased by 136.4% ($p = 0.002$, $ES = 0.95$). Subsequent increases were observed in U21 (1,585 ± 445 m) and senior players (2,365 ± 489 m) (Figure 1). Minimum (800–880 m) and maximum (2,240–2,280 m) total distances were comparable for U15, U16, and U21 players. Confidence intervals and quartiles reveal overlap for total distances between U14 and U21 players (Table 4). F1

Differences in total distance (meter) for all age grades were statistically significant when compared with U13 players ($p < 0.002$). Differences in maximum velocity (meter per second) for all age groups, except minor ($p = 0.948$), were statistically significant when compared with U13 players ($p < 0.001$). In comparison to U13 players, the magnitude of differences between age groups for total distance was deemed to be large ($ES > 0.8$). Maximum velocity was largely different ($ES > 0.8$) for all age groups when compared with U13 players; however, ES for the minor age group was deemed to be small ($ES < 0.5$).

Estimated $\dot{V}O_2$max progressed from 44.7 ± 2.6 $ml \cdot min^{-1} \cdot kg^{-1}$ in under 13 players to 56.3 ± 4.1 $ml \cdot min^{-1} \cdot kg^{-1}$ in senior players ($p < 0.001$, $ES = 3.4$). However, estimated $\dot{V}O_2$max seemed to decline in minor players when compared to under 14–16 players.

Pairwise comparisons for Yo-YoIR1 total distance reveal a statistically significant ($p \leq 0.05$) mean difference between (a) U13 compared with all age groups except minor, (b) U14 compared with U13 and senior, (c) U15 compared with U13, U21, and senior, (d) U16 compared with U13, U21, and senior, (e) minor compared with U15, U16, and senior, (f) U21 compared with U13 and senior, and (g) senior compared with all age groups.

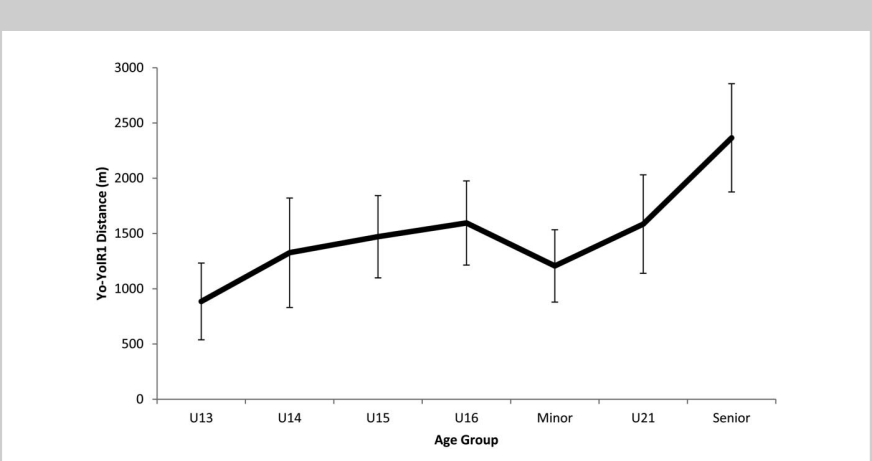

Figure 1. Yo-YoIR1 total distance (m) across age grades.

Pairwise comparisons for Yo-YoIR1 maximum velocity reveal a statistically significant ($p \leq 0.05$) mean difference between (a) U13 compared with all age groups except minor, (b) U14 compared with U13, minor, and senior, (c) U15 compared with U13, minor, and senior, (d) U16 compared with U13, minor, and senior, (e) minor compared with all age groups except U13, (f) U21 compared with U13, minor, and senior, and (g) senior compared with all age groups.

Pairwise comparisons for Yo-YoIR1 estimated $\dot{V}O_2$max reveal a statistically significant ($p \leq 0.05$) mean difference between (a) U13 compared with all age groups except minor, (b) U14 compared with U13 and senior, (c) U15 compared with U13, minor, and senior, (d) U16 compared with U13, minor, and senior, (e) minor compared with U15, U16, and senior, (f) U21 compared with U13 and senior, and (g) senior compared with all age groups.

Discussion

This is the first investigation on the evolution of Yo-YoIR1 performance in male Gaelic football players from adolescents to adulthood. Interestingly, several between-age group differences were observed. Yo-YoIR1 distance increased by 276 ± 55% between under 13 (885 ± 347) and senior players (2,365 ± 490) (Tables 1 and 5). However, subsequent decrements in total distance were observed in minor (1,207 ± 327) and U21 players (1,585 ± 445) (Figure 1) as evident by all descriptive statistics used (Tables 1 and 4). Cullen et al. (13) reported Yo-YoIR1 total distances of 1,446–1,503 m in 16- to 17-year-old elite Gaelic football players. Although greater scores were observed in this study for such age groups, differences may relate to decrements specific to seasonal cycles during these years. However, the cohort investigated by Cullen et al. (13) was participants in school competitions and not elite per se, given that they did not entirely consist of intercounty players. Furthermore, investigations on a single age group fail to challenge the current finding of Yo-YoIR1 decrements associated with various age groups. Variations in training load and maturation between age groups have yet to be described in Gaelic football. Thus, it is unclear whether such decrements reflect ineffective training interventions, overtraining by excessive exposure to training and match-play, or biological maturation.

Results of the current investigation differ from studies on adolescent soccer (11), rugby league (22), and Australian football (AFL) cohorts (8) in that aerobic performance during late-adolescent declined in this Gaelic football cohort. Although a novel finding, whether this impacts running performance during training and match-play remains to be investigated. The current results are at odds with longitudinal investigations of match-play locomotion profiles. For instance, high-intensity running has increased by 30% (890 ± 299 vs. 1 ,151 ± 337 m, $p < 0.001$, *ES*: 0.82) in English Premier League soccer match-play between 2006 and 2013. Similarly, meters per minute ($m \cdot min^{-1}$) during under 18 AFL match-play have increased by 5.2% (113.07 ± 17.1 vs. 118.94 ± 14.13 m, $p < 0.036$, *ES*: 0.37) from 2003 to 2009 (8). Greater increases in match-play demands were observed among senior AFL players (121.19 ± 14.74 vs. 134.02 ± 12.09 m, $p < 0.001$, *ES*: 0.95) during the same period (8). Studies have previously shown large correlations between Yo-Yo performance and match-play activity profiles (3) with improvements in Yo-Yo performance correlating to increased match-play running.

Studies have shown that junior AFL players with high aerobic capacity have greater countermovement jump scores and lower creatine kinase concentrations after match-play despite having experienced greater internal and external loads (16). Additionally, superior Yo-YoIR1 performance (>1,516 ± 182 m) was also shown to have a protective effect on under 19s rugby league players by reducing injury risk (10). Therefore, the impact of Yo-YoIR1 performance in altering injury risk in Gaelic football should be further investigated.

Similar to previous studies conducted in soccer (7), age was associated with superior aerobic capacity as marked by estimated $\dot{V}O_2$max between under U13 (44.70 ± 2.60 $ml \cdot min^{-1} \cdot kg^{-1}$) and senior level (56.30 ± 4.10 $ml \cdot min^{-1} \cdot kg^{-1}$) in Gaelic football players. The increase in this study across aerobic profiles was similar to previous studies (3,24). Interestingly, AFL players with greater estimated $\dot{V}O_2$max based on 20-m multistage fitness test performance were reportedly more likely to be selected for competitive match-play (*ES* = 0.2) (24). In addition, these players had more ball possessions during match-play (*ES* = 0.5) (24). Therefore, the link between aerobic capacity and match performance needs to be assessed in Gaelic football populations.

In this study, estimated $\dot{V}O_2$max increased linearly throughout adolescents with a noted decreased at minor and under 21 age grades. The data highlighted within this study may be used by coaches to analyze the development of aerobic capacity among Gaelic football cohorts. Indeed, among elite senior soccer players, a $\dot{V}O_2$max of 62–64 $ml \cdot min^{-1} \cdot kg^{-1}$ seems to suffice senior competition with no statistically significant differences between international, division one, or division 2 players (23). Such results suggest that this threshold of aerobic capacity is highly desirable in sports similar to Gaelic football, yet that pursuit of gains beyond this threshold may not advance performance.

This study is the first to report the rate of developmental change across Gaelic football players for Yo-YoIR1 shuttle performance (Table 5). The authors propose this as a methodology of highlighting potential performance improvements across developmental cycles. One of the interesting findings of this study relates to the age group decline in Yo-YoIR1 performance at the minor and under 21 age groups. To the best of our knowledge, this is the first article highlighting a decline in Yo-YoIR1 performance across certain age groups. Indeed, the current finding is a surprising one as 4 different team sports report consistent $\dot{V}O_2$max increases

with advancing pubertal development, suggesting increased metabolic capacity during adolescents (5). Therefore, future research should investigate influences of training loads during maturation on program responses. For instance, a change in the threshold or activities required to stimulate physiological responses, advantageous to Gaelic football performance, may differ across various stages of maturation.

Discussions into such decrements are limited as this is the first investigation highlighting this trend in Gaelic football. Future research should investigate whether such findings may impact the transition of players to senior ranks, affect tolerance to training and match-play demands, impair execution of technical and tactical skills, and thereby increase the risk of deselection. Furthermore, investigations into increased susceptibility to fatigue-induced performance decrements and injury are warranted. As a result, the authors advocate multiple testing periods for underage players across competitive seasons to fully understand the seasonal change in aerobic capacity. Gathered data may guide programme design as aerobic power development can be impaired by motor control and anthropometrical characteristics during maturation in adolescent soccer players (14).

Several limitations must be considered when reviewing this study. Participants were grouped by chronological age. Thus, the biological maturity of the players was not taken into account. Additionally, the impact of relative age is an important factor not taken into consideration in this study. Previous investigations have identified relative age as an important issue within Gaelic football (18); therefore, its impact on performance should be investigated in further studies. In addition, no identification of muscle mass differences among players impacts the value of this data set as muscle mass, not whole-body mass, impacts functional capacity of athletes (1).

Practical Applications

This study describes the cross-sectional evolution of Yo-YoIR1 performance in Gaelic football players throughout developmental age groups (U13 to senior). This study demonstrates that the Yo-YoIR1 is of value at identifying aerobic differences across age groups. Therefore, practitioners should appreciate the diverse range of abilities within each cohort as players transition between age groups. In light of the presented findings, coaches and strength and conditioning professionals should consider Yo-YoIR1 in testing batteries. This is because (a) the Yo-YoIR1 test is a valid, reliable, and easily available measurement tool of a player's aerobic capacity and (b) Yo-YoIR1 performance represents a very important fitness component in Gaelic football, which may be adversely affected during adolescents.

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