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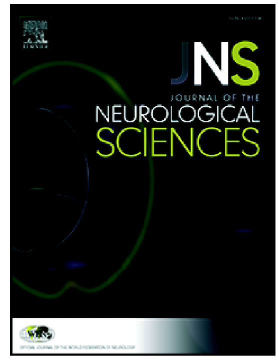

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Reported concussion incidence in youth community Rugby Union and parental assessment of post head injury cognitive recovery using the King-Devick test

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Abstract

Aim

To assess the frequency of reported head injuries in youth community Rugby Union and determine whether the King-Devick (K-D) test could be used by parents as a means to chart cognitive recovery following head injury.

Methods

A prospective cohort study of 489 junior players (U9-U18) conducted at a community level Rugby Union club over four seasons. All players undertook a baseline K-D test at the start of each season. Players identified with suspected concussion performed the K-D test post injury and results were compared to their most recent baseline assessment. Parent/Guardians of the player then oversaw repeated daily testing until baseline scores were surpassed.

Results

49 players were sent for assessment after suspected head injury. 46 parents oversaw daily repeated K-D testing (93.8% engagement). The median reduction in K-D test performance speed post-injury from baseline was 7.32 s (IQR 2.46 – 7.98). A median of 5.1 days/tests were taken for players to surpass baseline performance. No correlation was found between initial post-injury test and cognitive recovery time. 38 head injuries were reported from match play with an incidence rate of 12.7 per 1000 match hours (95% CI 9.2 – 17.5).

Conclusion

The K-D test is a practical tool for baseline, post injury and parentally supervised repeated testing within youth community Rugby Union. Incidence of reported head injuries following match play is higher than previously reported. Parental engagement was high. Post-Injury K-D test performance should not be used as a means to predict symptom recovery.

Keywords: King-Devick Test, Eye-movement, Occulo-motor, Sports-related concussion, Rugby Union

1. Introduction

Concussion threatens participation rates[1] and the long-term health of participants in contact sports.[2] In the United Kingdom (UK) the effects of concussion are most widely associated with Rugby Union. Head injury research has focused on professional players,[3] leaving a dearth of recent investigation at community and youth levels.[2] Several barriers to concussion understanding and management within Rugby Union remain, particularly at community levels.

The lack of practical, pitch-side diagnostic tools for concussion leaves its diagnosis shrouded in ambiguity and uncertainty.[4][5] Assessment therefore remains a primarily subjective process, reliant on symptom reporting. This places great pressure on those conducting assessments when asked to form a diagnosis. As a result, the term 'suspicion' of concussive symptoms has become the basis for removal from play.[6] With no objective pitch-side diagnostic tools, those responsible for the welfare of players at grass roots levels have little to substantiate decisions, and the judgments of those at elite levels open to criticism.[4] The difficulties of concussion assessment and reliance on player symptom reporting are reflected in the variability of incidence rates within the literature.

In research at adult community levels, concussion incidence rates range from 0.4/1000 match hours[7] to 46/1000 match hours more recently.[8] The 2017 Review of Community Level Concussion and Head Injuries, conducted by the RFU injury surveillance group represents the largest research into UK community Rugby to date. Despite reporting an incidence rate of 1.5 concussions per 1000 match play hours, it states that this figure represents a 'minimum estimate',[9] and alludes to the known under-reporting of symptoms and the range in ability of the players included, factors that have been demonstrated to influence injury frequency findings.[9]

It is acknowledged that at youth levels neither incidence nor severity of head injuries has been thoroughly identified or understood.[10] This can be attributed to the heterogeneity of studies, inconsistent injury definitions used and lack of wide scale injury surveillance systems.[11] However, evidence is growing and a systematic review by Kirkwood et al.[2] of concussion within youth Rugby Union and League reported incidence rates ranging widely from 0.2 to 6.9 per 1000 match hours.[2] More recently, an RFU supported schoolboy Rugby intervention study, designed to evaluate the impact of an exercise program on injury risk, found a concussion incidence rate of 8.0 per 1000 match hours in control cohorts.[12] Such figures have, however, been challenged by Pollock et al. who suggest, like the adult game,[9] the broad under-estimation of reported youth Rugby injury risks.[11]

The impact of the lack of youth concussion understanding is heightened by the acceptance that young people are more likely to sustain concussion,[13] experience symptoms for longer,[14] and can suffer 'Second Impact syndrome' with potentially fatal consequences.[15] Young players therefore represent the most vulnerable playing population in the UK and worldwide.

In an attempt to address these ongoing issues, the growing concussion research community has sought to establish the means to evaluate this complex pathology quantitatively, and validate suitable assessment tools for use in the field.[16] The King-Devick (K-D) Test has emerged as a tool proposed to add the critical dimension of vision to sports related concussion assessment[17] and be suitable for administration by non-medically trained persons.[18] Despite the growing body of evidence for its use,[17] the application of the K-D test within Rugby Union has been limited. The current elite level Head Injury Assessment (HIA) does not include a visual based testing domain.[19] This has prompted the RFU to conduct a trial of its use alongside the HIA for season 2016/17 and state that the K-D has the potential to impact beyond the professional game, if a validated assessment could be identified that could be performed by a non-medical practitioner.[19]

The challenges surrounding youth concussion do not end with its identification and assessment. Governing bodies advocate a mandatory stand down period following head injury, followed by a graduated return to play (GRTP) protocol.[20] This process is designed to allow suitable time for cognitive and motor skill recovery and progressively build towards contact activities. Young players have shown a lack of knowledge of the GRTP and adherence to it across sports including Rugby Union has proven poor.[21][22][23] In addition, non-medically trained people currently have no identified means of objectively assessing cognitive recovery. At community youth levels where medical support is sparse, parental engagement is required to oversee GRTP. Parents have however shown limited engagement within the management of concussion at community Rugby levels.[21] If these key individuals do not feel they have a responsibility to treat concussion it has been suggested that they will be unlikely to demonstrate any reasoned or planned action in the event of injury.[21] Whether actively involving parents in concussion recovery encourages greater parent/child engagement and in turn, adherence to the GRTP process, remains to be investigated.

The aim of this study was to assess the frequency of reported head injuries by pitch side first aiders within a youth community Rugby Union club. Secondly, the efficacy of the King-Devick concussion tool for baseline, post injury and parentally supervised recovery testing is then established.

2. Methodology

2.1 Participants

A prospective cohort study was conducted at a community level Rugby Union club. This encompassed all registered and active junior players between under nine and under 18 age grades (U9-U18) (n=489) over four seasons. First Aid Volunteers (FAV's), parents of players with a recognised first aid qualification assigned to each team/squad, were educated on the study through direct email and by direct communication with the researchers. The FAV's involved all completed a level three Qualsafe awards and HSE approved, Emergency First Aid at Work qualification.[24] The one-day (six hours of contact learning) course qualifies the individual as an emergency first aider for three years. Despite this qualification period, the Rugby club involved asks all FAV's to conduct the course that is held onsite, free of charge, annually. In addition to the basic first aid components specified by the course, rugby specific aspects have been added including head injury scenarios and concussion symptom recognition, as requested by the Club. All FAV's were required to pass the RFU HEADCASE online concussion module[20] prior to course conduction.

As the first responders pitch-side to any potential injury, The FAV's primary role was to 'recognise' and 'remove' those they suspected of sustaining a head injury as directed by the Consensus Statement for Concussion in Sport.[25] Parents and players where then to be directed to the onsite Duty First Aid Therapist (DFAT), in this case, a Health Care Professions Council (HCPC) registered physiotherapist for further evaluation. As advised by the RFU,[26] all DFAT's were sports trauma management qualified and had passed the coaches online RFU concussion module.

Parents and players were informed of the study through the online registration process, posters, website information and direct communication from the researchers with each age group. DFAT's were informed that the testing process would be no different from RFU head injury management guidance and that the K-D test would be an additional supplement.[20]

Parental consent to participate was gained during the Rugby club online registration process at the beginning of each season. Parents were asked to actively tick a box to consent to their child's baseline and post injury data to be recorded and used for research purposes. No parents declined consent for their child to participate. St. Mary's University Ethics Committee approved all procedures.

2.2 Procedure

2.2.1 King-Devick Test

The K-D test requires a player to read aloud a series of random single-digit numbers from left to right. The test pack includes one practice (demonstration) and three test cards varied in number format on a six by eight inch card. Players were asked to read the numbers aloud from left to right across the card as quickly as they could without making any errors using standardised instructions printed on the test cards. All test card packs had identical number and number placement formats. The time (s) was logged for each test card along with the number of errors made.

2.2.2 Baseline Testing

K-D baseline testing was conducted during the first four weekends of the 2013/14 season and repeated for the following three seasons. Two to four testers (First Aid volunteers and DFATs), conducted the baseline tests at a canopied pitch-side desk. Noise and environmental factors have been shown not to affect K-D Test performance.[27] Targeting one age group at a time, the lead researcher extracted players from Rugby training to conduct the test. Coaches were asked not to commence contact based activities until all players had conducted baseline testing. This cycle continued until all players from the age group had been tested. This method ensured baseline testing would mirror the physiological state of the player during post injury re-testing and include the positive effects of vigorous exercise observed on K-D Test scores.[17]

Players ≤ 13 years conducted the demonstration and test cards I & II whilst those > 13 years completed the demonstration and all three test cards. The recommended age divide for card number conduction changed to 10 years of age during the course of the study. The 13 years of age divide was maintained however to permit continuity of results. The K-D Test recommends two consecutive tests to negate any mild learning effect that has been observed.[17] Only one baseline test was used in this study as at no other time would the test be repeated twice in the same day, either directly after suspected injury or during the re-testing process. In support of this methodology, test-retest reliability has been shown to be very high between repeated baseline scores with minimal variability.[17] Marginal weighted mean combined improvements of 1.8 s have been observed when repeating the K-D test, considerably lower than the mean observed worsening in scores post head injury of 4.8 s.[17] Test scores were collated onto a database by the lead researcher. Players completing the test (n = 489) were logged against the registration database and those who missed baseline establishment were contacted to conduct a test after starting active participation.

2.2.3 Following suspected head injury

If a pitch-side FAV, coach or parent suspected a head injury on-site, the player was guided to the first aid room for assessment by the DFAT. The DFAT conducted the standardised concussion management process advocated by the RFU, followed by the K-D test. If present, the parent/guardian was educated on the on-going re-test process along with the GRTP. If not in attendance, the lead researcher would telephone the parent/guardian to inform them. The parent/guardian was provided with the players baseline score and was asked to oversee the repeating of the K-D Test. Every time the test was repeated, the discrepancy between baseline and current score was recorded. When the participant surpassed the baseline scores for all test cards, they had completed the K-D retest process. The number of days taken to return to baseline was recorded.

The DFAT was available to answer any questions regarding the player's symptoms and the GRTP process. Once the GRTP process was completed, parents were asked to feedback K-D scores to the DFAT and in turn, to the lead researcher, before their child returned to club representative contact based activities. Repeat home testing using the K-D was not influenced by baseline to post injury scores and as such the test was not considered a diagnostic tool from which to inform return to play decisions. In accordance with governing body guidance, suspicion of concussion remained the overriding trigger for removal from play and the GRTP followed regardless of K-D testing.

2.2.4 Data Analysis

All data were entered into a Microsoft Excel spreadsheet. For each age group, baseline median and interquartile ranges were calculated. Reported concussion rates were calculated per 1000 hours of match play with associated 95% confidence intervals. Differences between age group rates were assessed using rate ratios (RR). A Kruskal Wallis one-way ANOVA followed by post hoc Dunn's tests was used to determine any differences in K-D time between age groups. Some investigators have suggested that a three second worsening of K-D performance could be used as a marker to assist with the identification of a concussive injuries as part of a boarder medical evaluation.[28] As a result, baseline and post injury test discrepancies were split between < 3 seconds and $\geq$ 3 seconds, with a Spearman's correlation used to determine any association between baseline and post injury test discrepancy and days to recovery. Significance was set *a priori* at $P<0.05$.

3. Results

3.1 Baseline Data

Table one shows the median baseline K-D test times recorded for each age grade. The Kruskal-Wallis H Tests were used to determine differences in median times between the U9 to U13 age groups and U14 to U16 age groups. Each age groups baseline data distributions were similarly shaped. When examining the U9 to U13 groups, baseline performance significantly differed (χ^2 = 80.1, df = 4, p <0.0001). Dunn's test Post hoc analysis revealed that median baseline KD performance in the U9 age group (37.3 s) was significantly slower than the U10 (34.9 s), U11 (33.3 s) U12 (32.6 s) and U13 cohorts (31.7) ($p < 0.05$). Additionally, the U10 age group baseline performance (34.9 s) was significantly slower than the U12 (32.6 s) and U13 (31.7s) age groups (all p< 0.001). When examining the U14 to U17/18 groups, baseline performance also significantly differed (χ^2 = 22.2, df = 3, p <0.0001). Post hoc analysis revealed no significant differences in observed baseline performance with an age group and the cohort directly above in age, but just as with age groups U10 and above, significant differences where observed when skipping an age groups, U14 with U16 (χ^2 = 2.7, p = 0.077), U15 with U17/18 (χ^2 = 4.4, p = 0.002.)

Table 1. Median baseline K-D times (s) at age grade levels U9 to U17/18

Age Group	**U9**	**U10**	**U11**	**U12**	**U13**	**U14**	**U15**	**U16**	**U17/18**
Card 1. Median Time(IQR)	19.2 (15.3-20.9)	17.3 (15.1-19.7)	16.5 (14.8-18.9)	16.0 (14.3-18.5)	15.7 (14.0-17.7)	14.9 (13.3-16.5)	14.1 (12.8-15.8)	13.9 (12.7–15.6)	13.5 (12.3-15.2)
Card 2. Median Time(IQR)	18.2 (15.5-21.1)	17.6 (15.4-20.1)	16.8 (15.1-19.4)	16.5 (14.4-19.1)	16.0 (13.9-17.9)	14.2 (12.9-16.2)	14.1 (12.8-16.6)	14.1 (12.7 -16.3)	13.9 (12.3-15.7)
Card 3. Median Time(IQR)	-	-	-	-	-	15.6 (13.9-17.4)	15.2 (13.6-17.3)	15.0 (1376-17.2)	14.6 (13.0.-16.4)
Total median Time	37.3	34.9	33.3	32.6	31.7	44.7	43.4	43.0	42.0
N=	88	92	79	99	46	67	97	79	80

3.2 Head Injuries

Table 2. All reported head injuries (match and training) by season and age group.

Age Group	U12	U13	U14	U15	U16	U17/18	Total
Season 1	2	1	1	3	2	3	12
Season 2	1	1	3	2	4	2	13
Season 3	2	0	2	2	2	5	13
Season 4	0	3	1	1	3	3	11
total	5	5	7	8	11	13	49
Match injuries	5	4	5	6	7	11	38
Training injuries	0	1	2	2	4	2	11

Overall, 49 players reported to the onsite therapist following suspicion of concussion. Three players did not undergo parental re-testing, two of which were at boarding schools representing a 93.8% parental engagement rate. This rate rises to 98% if the mitigating circumstance of child boarding is accounted for. The number of players reported for further assessment remained consistent across the four-season period.(χ^2 =0.22 , P=0.9735)

Table 3. Incidence of on-site reported head injuries per 1000 match hours by age group.

Age group	U12	U13	U14	U15	U16	U17/18	Total
Total Matches played	27	30	32	36	42	54	221
Exposure (hr)	216	260	400	540	630	945	2991
Players assessed	5	4	5	6	7	11	38
Incidence per 1000 match hours (95% CI)	23.1	15.4	12.5	11.1	11.1	11.6	12.7
	(9.6 to 55.6)	(5.8 to 41.1)	(5.2 to 30.0)	(5.0 to 24.7)	(5.3 to 23.3)	(6.4 to 21.0)	(9.2 to 17.5)
RR	1.0	0.7	0.5	0.5	0.5	0.5	
95% CI		0.2 to 2.5	0.2 to 1.9	0.1 to 1.6	0.2 to 1.5	0.2 to 1.5	
P		0.4335	0.3198	0.2655	0.2575	0.2542	
X^2		(0.61)	(0.99)	(1.24)	(1.28)	(1.3)	

Thirty-eight injuries occurred during standardised competitive match play whilst eleven occurred during training. The U12 age group reported five head injuries from variable time, small-sided games and training. No injuries were reported in the U9 to U11 age groups. Combined reported match head injury incidence across all age groups was 12.7 (95% CI 9.2 – 17.5) per 1000 match hours (Table 2). The highest reported match head injury incidence rate was 23.1 (95% CI 9.6 to 55.6) per 1000 match hours in the U12 group, and the lowest observed in the U15 (11.1 [95% CI 5.0 to 24.7] per 1000 match hours), and U16 (11.1 [95% CI 5.3 to 23.3] per 1000 match hours) groups. Table 3. shows RR (Risk Ratios) for each age group compared through Chi-squared tests with the highest reported incidence cohort (U12) (1.0). Trends were apparent between age group incidences, although none were significant. Table three shows the median discrepancy in seconds between initial post-injury onsite test and last recorded baseline (7.3 s). Training incidence rates were not calculated due to the weekly variability in training time and player attendance.

Table 4. Number of reported head injuries, discrepancy time between first test and baseline and days/tests to recovery with median and inter-quartile ranges across four seasons.

	Head Injuries assessed by parents	Median discrepancy (s) first retest to BL (IQR)	Longest recovery (Days/tests)	Shortest recovery (Days/tests)	Median recovery (Days/tests)
Total	46	7.3 (2.5 – 8.0)	14	4	5.1
Season 1.	10	11.8 (2.8 – 19.3)	14	3	7.2
Season 2.	13	7.0 (2.8 – 7.5)	11	2	4.8
Season 3.	11	6.9 (4.2 – 7.3)	6	2	3.5
Season 4.	12	4.3 (2.0 – 6.1)	8	1	5

The days/tests taken to surpass baseline scores ranged from 1 to 14 days/tests, with a median recovery time of 5.1 days/tests (Table 3). A weak, insignificant correlation (r_s = 0.25, p =0.0861) was found between discrepancies and the days taken to surpass baseline scores. Of the initial post injury tests recorded, discrepancies of over three seconds from baseline were observed in 30 cases (median difference 4.9 sec (IQR -4.2-

4.7)). Discrepancies of less than three seconds from baseline were observed on 16 occasions (mean difference 1.67 sec (IQR-0.7-2.4)).

4. Discussion

The aim of this study was to assess the frequency of reported head injuries in youth community Rugby Union and the efficacy of the King-Devick concussion tool for baseline, post injury and parentally monitored recovery testing. Pre-season baseline scores were consistent with published studies.[17] U15 age group median baseline times (43.4 s) were similar to 15 year old Hockey players, (44.5 s),[29] as were median baseline times from U16/17 age group American Football players (43.0 s)[30] with counter parts in this study (43.4-43.0 s). Baseline comparisons with previous studies of under U13 children were prevented by the use of the two card testing protocol. Although not directly comparable, the baseline data supports meta-analyses observations that link improving K-D Test times with increasing age. [17] When using the two card testing protocol among the U9 to U13 age groups, notable improvements from U12 and U13 age groups were observed over the younger U9 and U10 age groups. No meaningful differences in baseline performance were noted between any age group over U10 and the next age group above. This pattern suggests that despite observable improvement with age, a one-year baseline span appears too brief to identify meaningful improvements when assessing mixed age cohorts.

Of the 49 post-injury K-D assessments conducted, none were equal to or less than previous baseline times, demonstrating a degree of impaired cognitive function in all injured players. The median discrepancy in baseline to initial post injury test of 7.3 (2.5 – 8.0) is higher than 4.8 s (95% CI: 3.7, 5.8; I2 = 0.0%; p = 0.58) reported within 2015 K-D meta-analysis.[17] The limited heterogeneity within the studies included, limited subject numbers and resulting high P values may, however, be responsible for the differences observed.

Some investigators have suggested that a three second worsening could be used as a marker to assist with the identification of a concussive injury as part of a boarder medical evaluation.[28] This study found 16 participants initial re-test times fell under the three-second marker, despite those players demonstrating assessment prompting symptoms. These findings suggest there is no evidence to support specific worsening of K-D test scores as a diagnostic tool for concussion, other than any degree of worsening in conjunction with other symptoms and tests. This is supported by meta-analysis finding of non-concussed control athletes who demonstrated improvements of 1.9 s (95% CI: -3.6 to -0.02; I2 = 0.0%; p = 0.99).[17] As a result, the K-D test can be considered a valid test when used within a multi-modal framework including symptom reporting.[31][32] This finding also substantiates the sensitivity of the single-test baseline method employed, as repeated test performance has been shown to only marginally improve speeds [33] and therefore not effect post injury test sensitivity.

As the K-D test has not been previously used to plot cognitive recovery on a daily basis after head injury, the median of 5.1 days to return baseline is a novel finding of this research. This sits below the accepted figure within Rugby that 80-90% of concussion symptoms resolve within 7-10 days.[20] It should be noted that the K-D test only assesses occulo-motor function and therefore further symptom resolution investigation is required to determine when all concussion-inducing impairments fully resolve.

The range in days to cognitive recovery (1-14 days) in the current study reveals a wide variety in recovery times. Recovery times also show only weak correlation with baseline to re-test discrepancies. It would therefore appear unwise to consider post injury K-D test performance as a marker for injury severity, but it can be a means to chart cognitive recovery after concussion. Coaches, medics and parents could therefore use the K-D test as an objective tool to measure cognitive recovery and substantiate when to implement active elements of the GRTP program or learning activities. This could negate current blanket stand-down periods that have proved both hard to enforce at community levels[9] and may act to hinder rather than promote clinician - player interactions.[4]

The combined reported head concussion incidence rate of 12.7/1000 match hours (95% CI 9.2 to 17.5) sits considerably higher the range of previously published youth Rugby concussion risk.[2][11][34] This figure fits the trend of increased reporting of Rugby head injuries over recent years.[2][9] The figure is however lower than the 15.8/1000hrs match concussions reported within English professional Rugby,[19] although it should be noted that this figure represents a formal diagnosis of concussion and not suspicion/assessment as was used to define incidence within this study. Within amateur men's Rugby Union players assessed using the K-D test, King et al. report similar witnessed incidences rates of 10.9/1000 match hours (95% CI 4.5 to 26.2).[35] Interestingly this study also assessed players not perceived to show concussive symptoms, increasing the incidence rate to 45.9/1000 match hours (30.3 to 69.8), when discrepancies of 3> seconds from K-D baseline were used as a marker within a broader medical evaluation. This supports the rationale that concussion assessment should be multimodal including[6] cognitive/neurological aspects [36] and that the King-Devick test is an efficient sideline assessment tool, but not a sole means to formally diagnose concussion.[37] Further research into the longer-term consequences of seemingly asymptomatic injuries is required.

The observed age distribution in reported match head injury incidence is contrary to the accepted norm of increased injury risk with age.[38] No head injuries were reported from the U9-U11 age groups. This may be a result of less contact exposure that incrementally increases with player age. The highest reporting of head injuries within U12-U14 age groups may be a result of several factors. First aiders and coaches may find identifying potential head injuries in younger age groups easier due to smaller pitch sizes and smaller player numbers, despite less contact incidents. They may also be more cautious when managing younger participants. As a result of the larger player numbers, pitch size, and the nature of the game, e.g. rucks and mauls, first aid observation may be more challenging within the older cohorts of the game. It should be noted that during the study period several amendments to age grade match rules occurred. Older players may also be more reluctant to seek assessment as has been shown with university age sports people.[39] A paucity of understanding of the knowledge and attitudes of both first aiders and players means the validity of these hypotheses remains unsubstantiated.

Only three participants failed to report repeated K-D test data, two of which were from children at boarding school away from close parental supervision. Parental engagement was therefore 93.8%. This figure is far higher than previous studies to report parental-child communication regarding concussion.[21][40] Through the assessment of 18 parents of Rugby playing children, Clacy et al. found only 27.8% felt they were responsible for ensuring their child's fitness to play, whilst only 22.2% felt they were responsible for concussion prevention including education.[21] This lack of perceived responsibility and engagement is concerning as parents play a primary role in shaping attitudes, behaviors and perceived norms of children regarding concussion,[40] Furthermore, concussion education is considered most effective when given in a family environment.[41]

Within this study the practical aspects of the home K-D test process clearly promoted greater parental engagement. Initially parents were introduced to medical professionals creating both communication channels and fostering parental responsibility. This link provided a vehicle to educate parents as to the risks of concussion. This is considered essential as parents who perceive a greater threat from concussion may be more likely to engage in safety related practices.[40] The use of the K-D test may also have helped overcome what has been described as 'behavioral paralysis' that can ensue when health outcomes are perceived as highly threatening, but no risk reduction strategies are available.[42] In addition, it has been suggested that the parents of previously injured players may also become more aware of the importance of future symptom reporting as a result of observing the time it took their child to recover.[40] The engagement provided by the K-D test would seem ideal in this capacity. Although it remains challenging to measure the impact of parental engagement on child concussion attitudes and behaviors, further studies could look to correlate parental-child concussion engagement with adherence to return to play protocols, player symptom reporting and wider school/club cultural norms.

Limitations

The primary limitation of this study, as with the majority of studies investigating concussion incidence, lies in the means of identification. This study does not purport to identify the incidence of concussion in youth Rugby Union, but does identify the incidence of reported concussion symptoms. Player, first aider and medical staff actions therefore influence the results heavily. As has been previously been described by Roberts et al. within UK men's community Rugby,[9] the results may represent a 'minimum estimate'. Further research of coaches, medical staff and players attitudes and behaviors regarding concussion is therefore paramount.

As with most un-supervised data collection, the accuracy of data collected through parental testing could be considered a limitation to this study. Despite evidence to suggest that the K-D Test can be effectively administered by non-medically trained persons,[18] the validity of data reported by parents could be brought into question. A means of increasing the validity of parentally supervised K-D test scores may be to enforce a supervised test before a return to contact based activities. Despite informing parents of the need to review their child before a full return, the addition of off-site, school and representative sport, and the limited contact between all supervisors, makes this process challenging to enforce. A child may sustain an injury at one site, either conduct a GRTP or not, and return to activity at another site without coaches, first aiders or medic awareness. If parentally garnered data is to be used as part of a concussion recovery process, clearance to play should include the validating of any such information. Until the means of recording and sharing head injury information across all representative bodies is established as part of the GRTP, the validating of home testing remains problematic and the efficacy of the GRTP process impaired.

The K-D test also has the potential to be purposefully under-performed or “sand-bagged” by participants adding to the challenges listed above.[43] Whether this occurs with young players and if so, at what age, remains to be established. Until objective measures are employed that cannot be participant influenced, symptom reporting will remain both the primary means to diagnose concussion and to establish incidence rates.

5. Conclusion

The results of this study demonstrate that the K-D test is applicable on a large scale within community level youth Rugby Union. This study supports the findings of youth and adult K-D meta-analysis within younger cohorts, that identify the K-D test as a rapid, reliable, sensitive and specific test for concussion.[17] The K-D test was not however used as a means to establish suitable removal from play or a diagnosis. Coaches and volunteer first aiders can be actively engaged in the testing process and parents are willing and capable of playing an active role in onward concussion management. Establishing the validity of any such parental involvement in concussion management does however require far higher levels of GRTP communication across sporting teams/schools than currently observed. Future investigation is needed to establish the drivers behind player, parent and FAV, attitudes and behaviours towards concussion and how tools such as the K-D test can support decision-making.

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Highlights

- Over four seasons, 46 players underwent parentally supervised repeated K-D testing following reported head injuries. (93.8% parental engagement)
- A match related head injury incidence of 12.7 per 1000 match hours. (95% CI 9.2 – 17.5) was observed.
- Median return to baseline K-D test performance was 5.1 days.
- No correlation between initial post injury test performance and recovery time was found.