Central European Journal of Sport Sciences and Medicine | Vol. 46, No. 2/2024: 117–130
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2024.2-10

EVIDENCE FOR THE PSYCHOMETRIC PROPERTIES OF THE COMPONENT TEST ITEMS IN THE EUROFIT TEST BATTERY ADMINISTERED TO ELITE SCHOOLBOY RUGBY UNION PLAYERS: A TEST-RETEST RELIABILITY STUDY

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Abstract Rugby is a popular sport and requires participants to have commensurate physical attributes for effective participation. One physical fitness test battery which enjoys extensive use contextually is the European Test of Physical Fitness (Eurofit). However, the psychometric properties of the test battery have not been explored and documented in the local context. Therefore, this study was conducted to examine the test-retest reliability of the Eurofit test battery items among elite schoolboy rugby players in Harare, Zimbabwe. Thirty-two (32) players with the mean age of 17.2 (SD = 1.03) years completed all the tests during the in-season period. Anthropometric and Eurofit test measurements were obtained twice with seven days separating the assessments. The Intraclass Correlation Coefficient (ICC) estimated the reliability of the test items. The global ICCs for the Eurofit test items ranged from 0.59 to 0.98. The Sit-and-Reach test yielded the highest temporal reliability (ICC = 0.98). The Plate

Tapping test, Flamingo Balance test and 10 × 5m Shuttle Run test showed ICCs < 0.7. Cognisant of the study limitations, some component test items of Eurofit test battery can be recommended for reliably evaluating aspects of physical fitness in junior rugby players in Zimbabwe whilst others still need consideration and test modification.

Key words: test-retest reliability, rugby, adolescents, Junior, Eurofit test battery

Introduction

Rugby union (hereafter referred to as "rugby") is a popular sport played at different competitive levels in more than 100 countries worldwide (Abernethy & MacAuley, 2003; Brown et al., 2012; Spamer & De la Port, 2006; Duthie et al., 2006). Approximately, 171 000 adults and children play rugby at school and club level in Australia (Gabbett & Domrow, 2005). Reportedly, about 400 000-500 000 South African children, adolescents and adults play rugby (Brown et al., 2012). In addition, rugby is increasingly gaining popularity in many low-income countries previously not known for rugby on the international arena such as Zimbabwe (Nemadire, 2013).

Although little is known about Zimbabwean rugby worldwide, it is, arguably, one sporting discipline the country has a comparative advantage over most countries on the African continent. Much of the strength of Zimbabwean rugby at national level is grounded on a strong school-based male junior rugby system (Chiwaridzo et al., 2015). Central to this discussion, has been the establishment of the so called Super Eight Schools Rugby League (SESRL) which features the "elite" eight rugby-playing high schools in the country (Chiwaridzo et al., 2015). The schools in the SESRL variably expose talent-identified Under 13 (U13) to Under 19 (U19) rugby players to an optimal environment for learning and practising rugby under the auspices of reputable and well-acclaimed rugby coaches. This is done through the provision and availing of superior coaching services, excellent training facilities, adequate training resources, early specialisation services, selective scholarships, medical and physiotherapeutic services, and exposure to elite regional or international schoolboy rugby events. Annually, this league produces U19 players capable of joining professional and semi-professional senior clubs enhancing their chances for representing the country in the future. Hence, the SESRL forms the bedrock of Zimbabwe senior rugby as it continuously produces young players capable of embarking into professional rugby.

Since rugby is a physical sport, injuries are inevitable (Bleakley et al., 2011; Freitag et al., 2015; Kaux et al., 2015; Gabbett, 2003). Recent systematic reviews on rugby injuries for adolescents under the age of 21 years reported alarmingly high incidence rates between 27.5 and 129.8 per 1 000 match hours (Bleakley et al., 2011; Freitag et al., 2015). Unfortunately, there is limited information on the epidemiology of adolescent injuries in Zimbabwe. The little that is known about rugby-related injuries includes documented findings from a cross-sectional study profiling injuries sustained by 275 junior players in one competitive season of the SESRL (Chiwaridzo et al., 2015). The study reported injury rates, pattern and anatomical distribution of rugby injuries which were consistent with numerous regional and international studies on schoolboy players. These findings suggest that Zimbabwean schoolboy rugby players are vulnerable to injuries common in rugby as the rest of young rugby players from other countries.

The reported impact of rugby injuries, particularly among adolescents, should stimulate interest among coaches, sports scientists and physiotherapists. Against the background of recent findings on injuries and the level of competiveness exhibited in the SESRL (Chiwaridzo et al., 2015), research directed towards understanding the risk factors for rugby-related injuries in junior rugby players in Zimbabwe is paramount. Although there are many factors, impaired physical fitness levels have been linked to acute and recurrent rugby-related injuries (Gabbett & Domrow, 2005; Gabbett, 2000). In Zimbabwe, there is no study that has provided scientific evidence on the physical fitness levels of junior rugby players especially those participating in the competitive SESRL. Lack of such evidence is a significant shortcoming undermining credible preventative efforts in minimising injuries. However, as physical fitness is a multidimensional construct, it is essential, firstly, to establish the psychometric properties of physical test batteries commonly used in the Zimbabwean context to assess physical fitness of adolescent rugby players. Afterwards, it becomes logical to determine the normative values for physical fitness items for the Zimbabwe junior rugby population. Studies evaluating the relationship between physical fitness and injury risk could then be conducted based on test batteries which are psychometrically sound and contextually relevant.

Local rugby coaches and physical fitness trainers currently enjoy extensive use of the component test items of the European Test of Physical Fitness (Eurofit), evaluating the level of physical fitness among rugby players. This is particularly so for tests such as the Sit-and-Reach test and the 10 × 5 m Shuttle Run. Nonetheless, no information is available on the reliability of the Eurofit test battery in the Zimbabwean context. Although the reliability of the Eurofit test battery has been explored in various populations mainly from high income countries such as in Europe, less research has been conducted in this area particularly targeting young “elite” athletes living outside Europe. It is possible that differences in lifestyle, socio-economic status, playing standards, playing styles, training-related factors, and player recruitment strategies among other factors may affect direct extrapolation of results from other studies conducted in other countries. Evidence on the psychometric properties from other countries is thus unlikely to be transferrable and generalisable to inform the reliability of the Eurofit test items in a totally different context with a different organisation of the sporting activities. Therefore, an attempt to address this problem using Zimbabwean schoolboy rugby players seems scientifically interesting and offers great prospects, for example, for the development of standards or norms for this population of athletes in the future. This is particularly important given that competitive schoolboy rugby is still an emerging phenomenon gaining unparalleled attention and acceptance in Zimbabwe.

An understanding of the relative reliability of the Eurofit test items in an African context using a sample of elite adolescent rugby players is important for rugby coaches, rugby sport directors, sports scientists, medical rehabilitation professionals and the players. Urgently, such information would rationalise the use of constituent Eurofit test items in the cross-sectional and longitudinal monitoring of the level of physical fitness of adolescent rugby players and would further provide some justification for inclusion of some component Eurofit test items in test batteries used during talent identification (TID) programmes. Moreover, local rugby coaches, sports scientists and physiotherapists may reliably use the Eurofit test battery in injury surveillance and in evaluating the effectiveness of developed and implemented rehabilitation programmes. Against this background, this study was conducted with the broad aim of establishing test-retest reliability of the Eurofit test battery among junior male rugby players from schools participating in the elite SESRL based in Harare, Zimbabwe. Specifically, the study sought to determine the candidate items in the Eurofit test battery that would achieve a high Intraclass Correlation Coefficient (ICC) of greater than 0.7 between the test-retest assessments separated by seven days (7) when assessed during the in-season period of the elite schoolboy rugby league, the SESRL.

Methods

Study design, research setting and participants

Experimentally, a test-retest study design was conducted to establish reliability of the component test items of the Eurofit testing battery using a sample of junior male rugby players. A pragmatic approach for assessing the absolute and relative reliability of test items during the “in-season” period as previously used by Enright et al. (2018) was adopted for this study. The study targeted private and public schools playing rugby in the SESRL. This is the most competitive, exceptionally organised and well-sponsored junior rugby league in Zimbabwe (Chiwaridzo et al., 2021). All the SESRL schools have a local reputation for having a strong and long-standing culture of playing highly competitive rugby, hence the amalgamation and aggregation of these eight schools to form an “elite” junior league. In the selected schools, the study targeted schoolboy rugby players playing as U19s. Using tables derived from Walter et al. (1998) study, the estimated sample size was 18 based on the following parameters H0: p0 (minimally acceptable level of reliability) = 0.7, H1: p1 = 0.9 (maximum expected value of reliability), beta (β) = 0.2, alpha (α) = 0.05. However, due to multiple tests in the test battery and the study design involving two repeated measures, over-sampling was done. Firty-six (56) elite U19 players were available for participation.

Eligibility criteria

Only players willing to participate were included in the study. However, players had to have a signed informed consent form from their parents granting them permission to participate. Since data were collected when the SESRL was in its third (3rd) week of competition (*all the schools had played three competitive match games*), eligible schoolboy rugby players had to indicate having played at least two competitive matches, either for the first or second U19 team, to be included in the study. This was done to involve players in their peak physical condition. To further select appropriate players, an exclusion criteria adopted and modified from a study conducted by Green et al. (2011) was used. Players with reports of (un)diagnosed musculoskeletal injuries in the last eight weeks, verified by the players and the coaches, which could be aggravated by physical exertion were excluded. This means also that players not playing or training with the rest of the team because of covert or overt injuries or illnesses were also excluded. Additionally, players with any reports of neurovascular or cardiorespiratory symptoms such as numbness or tingling in the lower limbs or upper limbs, headaches, chest pains, episodic dyspnoea and fatigue were excluded. Furthermore, players had to be present in training on the day of testing for them to be included.

Instruments

Pre-measurement Demographic Questionnaire (PMQ): The PMQ was used to gather data on socio-demographic and rugby-related information of participants. Information elicited included age, place of residence, school, player position (forward vs. backline), specific player position (*for players that often changed positions, they had to state their regular position*), years playing school rugby and number of competitive games played in the season to the point of testing.

Physical Activity Readiness Questionnaire (PAR-Q): The PAR-Q was used as a pre-screening tool for the rugby players prior to partaking in Eurofit measurements to evaluate their general health and suitability to participate in the study. The PAR-Q has been used in similar studies involving rugby players as a screening tool for eligibility and its psychometric properties are well-established (Green et al., 2011).

Body weight scale: Body weight was measured using a SECA body weight scale. The weight was considered as an average of two best measurements that agreed within 0.1 kg. The participants were measured in light clothing (shorts and rugby jerseys) and shoes removed.

Stadiometer: Standing height was measured using a Stadiometer. The height was considered as an average of two best measurements that agreed within 0.1 cm. The participants were measured in light clothing (shorts and rugby jerseys) and shoes removed.

Eurofit testing battery

The Eurofit test battery was introduced in 1988 by the Committee for the Development of Sport of the Council of Europe for the evaluation of physical fitness in children and youth. Since introduction, the test battery has enjoyed wide application in research studies on different sample populations (Erikoglu et al., 2015; Vancompfort et al., 2015; Keane et al., 2010; Tsigilis et al., 2002; Vancompfort et al., 2012). In this study, we examined the reliability of the Sit-and-Reach test (flexibility), Bent Arm Hang test (muscular endurance or functional strength), Handgrip test (static arm strength), Standing Broad jump test (explosive leg power), Sit-Up test (trunk strength), Plate Tapping test (coordination or reaction speed), Flamingo Balance test (single leg balance test) and the 10×5m Shuttle Run (running speed and agility).

Outline of the school rugby activities

In Zimbabwe, schoolboy rugby is a winter sport played during the second term of the school calendar from May to September for 15 or 16 weeks. However, intense preparations begin during the pre-season period from February to April of every year. The pre-season period is characterised by player mobilisation, recruitment, health screening, pre-season training, early conditioning, friendly inter-scholastic rugby matches, international and regional tours, and participation in the annual rugby festival called the Dairiboard Zimbabwe Schools Rugby Festival (DZSRF). All these events are in preparation for the commencement of the SESRL league in May. In the second term of the school term, the SESRL begins with schools playing home and away games. This study was conducted during that in-season period.

U19 male rugby players had five (5) days of training sessions per week from Monday to Friday, emphasising various aspects of game technique, skills, tactics, physical training, speed training, aerobic conditioning, and simulated match games. Each training session lasted approximately three hours (14:00hrs–17:00hrs). The U19 schoolboy rugby players were allowed one day of (un)supervised training session per week emphasising resistance training in the gymnasium before commencement of regular field training. The gymnasium sessions were conducted every Wednesday between 12.00pm to 14.00pm at the selected schools. Inter-scholastic SESRL competitive matches were scheduled for every Saturday. Sundays were designated as recovery days, before resumption of light training next Monday. Training intensity heightens midweek (Tuesday, Wednesday, and Thursday) and lightens towards Saturday in preparation for the competitive match.

Data collection Procedure

Ethical approval and institutional permissions

Before data collection, the Joint Research Ethics Committee (JREC) of the University of Zimbabwe checked the aims, design, materials and procedures of the study and approved as it is ethically acceptable and follows the research code of the university. Additionally, ethical permission was also granted by the Medical Research Council of Zimbabwe (MRCZ) since the study involved adolescent participants found in the general public or private schools. Institutional approvals were granted by the Ministry of Primary and Secondary Education, Harare Provincial Education Directorate and the respective school principals. Written informed consent was obtained from parents/legal guardians of participating students. All students gave written assent as an expression of willingness to participate.

For ease of description, the procedure for data collection is discussed in three main stages: The Preparatory, Familiarisation, and Test-Retest stage.

Preparatory stage: During this stage, the research team visited participating schools to meet the school authorities and the coaches to explain the purpose, methodology of the study and to agree on dates for data collection. We also used this opportunity to address players explaining the rationale, procedure, risks and benefits of the study. Thereafter, students who verbally agreed to participate were given information letters and informed consent forms for parents. The students were given five days to return signed informed consent to the coaches. The researchers would remind the coaches using Short Messaging Services (SMSs) to collect returned documents. The researcher (TM) collected returned documents at the end of the week. Students with signed informed consent were then eligible to participate in the study.

Familiarisation stage: On agreed dates with the coaches, the research team visited the two participating schools to familiarise the eligible students to the candidate items of the Eurofit testing battery. This is in agreement with the recommendations made by Duthie et al., (2006) and Gabbett (2005). The familiarisation process entailed explaining the purpose of each test, the testing procedures involved and the outcomes to be recorded for each candidate item of the Eurofit test battery. Subsequently, the research assistants would demonstrate practically how the tests are conducted and allowed the players to practice. The familiarisation sessions were done until all the eligible players subjectively reported that they were satisfied and adequately knowledgeable on the procedure of each test in the Eurofit test battery.

Test-retest assessment: On agreed dates with the coaches, the research team visited the selected schools for test-retest measurements. This was conducted exactly two weeks after the familiarisation sessions. Eligible players completed pre-measurement demographic questionnaires and the PAR-Q. All the Eurofit measurements were conducted following standardised procedure. In both schools, data were collected after school hours (14.00–17.00hrs) in the rugby sports field during practice/training sessions. Owing to limited daily training time for the players and the extensive number of Eurofit tests to be performed by the research team, the coaches specified the days when the Eurofit measurements had to be conducted. Therefore, the tests had to be staggered for over three days as shown in Table 1. On the request from the coaches, the fitness testing took place 30–45 minutes before training on each testing day. The order of the tests was guided by the recommendations given by Turner et al. (2011). It involved performing simple and physically challenging tests together as opposed to conducting all physically challenging tests in one testing session. The re-test assessments for each specific test were conducted exactly seven days after by the same investigator following the same procedures.

Table 1. Summary of the test protocol for the Eurofit

Day	Tests (Abbreviation)	Physical fitness component measured
Monday	Height (H)	Height (m)
	Weight (W)	Weight (kgs)
	Sit and reach test (SAR)	Flexibility (cm)
	Handgrip test (HGR)	Static arm strength (kg)
Wednesday	Flamingo balance test (FBT)	Balance (n)
	Plate Tapping test (PLT)	Coordination or reaction speed (s)
	10±5m shuttle run (SHR)	Running speed and agility (s)
Friday	Sit up test (SUP)	Abdominal strength/endurance (n)
	Bent arm hang (BAH)	Upper body muscular endurance
	Standing broad jump (SBJ)	Explosive leg power (m)

Description of the tests

Sit-and-Reach (SAR) test: This test was used to measure hamstring and lower-body flexibility. Participants would warm-up for three minutes with general flexibility stretches. In sitting position, participants would extend their legs and spread their feet into the SAR box. The test involved the participants placing their feet against the wall of the SAR box and extending their arms slowly, one on top of the other, pushing a ruler placed on the top of the SAR box and held the final position for at least two seconds (Mayorga et al., 2012). The test was performed twice and the better of the two measures was recorded.

Standing broad jump (SBJ) test: Explosive lower-limb strength was measured using the SBJ test. The participants stood with feet parallel and shoulder width apart on the marked starting line. Participants were instructed to swing their arms, flex their knees and jump as far as possible trying to land with both feet together (Houwen et al., 2006; Ruiz et al., 2006). The participants would repeat the test if they fell backward or touched the floor with another part of the body. The distance jumped was recorded from the marked line to the farthest point backward of the participant recorded using a tape measure. The participants were allowed to practice two demonstration trials before they could perform the actual test. The SBJ score represented the best score of the two trials performed.

Handgrip strength test (HGR): Handgrip strength was assessed using the HGR test. After explaining the rationale of the test and demonstrating the procedure, participants were instructed to hold the dynamometer to the side of their body, arm fully extended, and palm facing inward (Houwen et al., 2006). The dynamometer would be compressed with maximal effort for 2–3 seconds (Donncha et al., 1999). Dominant handgrip measures were read to the nearest 0.1 kg. The participants were allowed to practice two demonstration trials before they could perform the actual test.

Sit-up test (SUP): The SUP test used to assess abdominal endurance. The participants would be instructed to lie in supine position on a mat (Keane et al., 2010). In preparation for the test, the participants would be instructed to bend their legs to 90 degrees, put their feet flat on the mat and the research assistant would stabilise them at the ankles (Skowronski et al., 2009). The participants would then place their hands at the back of the head with the fingers interlaced. A full sit-up was recorded when the participants touched their knees with the elbows and returned the shoulders to the ground. The SUP score was recorded as the maximum number of sit-ups achieved in 30 seconds.

10 ±5m shuttle run (SHR): Running speed was measured using a 5 × 10 m shuttle run. Each participant was required to sprint 10 times between two lines placed 5 m apart over a 1.3 m wide track. The sprint was followed by immediately turning and running back. The SHR test score was the time required to run 10 × 5 m measured in seconds (Fjørtoft et al., 2011; Duthie et al., 2006).

Flamingo balance test (FBT): Single leg standing balance was assessed using the flamingo balance test as the number of trials needed by individuals to achieve a total duration of 30 s in balance on their preferred foot on a flat firm surface. While balancing on the preferred foot (shoes removed), the free leg would be flexed at the knee and the foot of this leg held close to the buttocks (Tsigilis et al., 2008). The participants were allowed to place their arms on the researcher's shoulder for the initial balance. The test began the moment the participant released his supporting arm from the researcher's shoulder.

Plate tapping test (PLT): Plate tapping test was used to measure the speed of the arm (Monyeki et al., 2005). Two plastic discs measuring 20 cm in diameter were placed on a flat surface with their centers 60 cm apart (Telles et al., 2013). In between the two discs, a white rectangle paper was placed measuring 30 × 20 cm. The participants were instructed to place the non-preferred hand on the rectangle and move the preferred hand back and forth between the two discs over the rectangle. Two taps counted as one cycle and the participants were asked to complete 25 cycles as fast as possible. The item score was the time taken to complete 25 cycles.

Bent arm hang (BAH): This test evaluated the upper-limb endurance strength. The participant had to maintain a bent arm position while hanging from a bar with hands in a forward grip and at shoulder width position. The participant's chin had to be above the bar. The participant had to hold this position as long as possible without resting the chin on the bar. The test ended when the participant's eyes went the below the bar. The score was the total time taken recorded in seconds.

Statistical analysis

Statistical Package for Social Sciences (SPSS) was used for statistical analysis. Descriptive statistics described age, playing position and body mass index (BMI) for the sample participants. The independent t-test compared the mean ages and BMI of the participants by player position. One way analysis of variance (ANOVA) compared the mean age and BMI by specific position. The dependent t-test assessed the mean differences between test-retest results for the Eurofit items. The p-value for statistical significance was set at 0.05. Reliability was analysed using Intraclass correlation coefficient (ICC). The ICCs values expressed the absolute agreement between single measures on a two way mixed model (3, 1). Reliability coefficients were satisfactory for an ICC greater than 0.7 (Terwee et al., 2007; Turner et al., 2011). The standard error of measurement (SEM) was computed for each candidate item as the standard deviation (SD) multiplied by the square root of 1-ICC [SD x (square root of (1-ICC)] (de Vet et al., 2006).

Results

Sample characteristics

Of the 40 players given permission by their parents/legal guardians to participate, 38 volunteered to participate of which 32 completed all the Eurofit items in the test-retest study. The demographic and rugby-related information for the sample participants are shown in Table 2. The mean age of the participants was 17.2 (SD = 1.03) years. There was no significant difference in the mean ages between forward and backline players [t (30) = –1.26, p = 0.22]. There was no significant difference in the mean age by specific positions of the players [F (8, 23) = 0.86, P = 0.56]. There was a significant difference in the BMI by position [t (30) = 2.18, p = 0.04]. On average, backline players had a mean BMI of 22.7 kg/m^2 (SD = 1.76) compared to 25.1 kg/m^2 (SD = 3.70) for the forward players. There were no significant differences in the mean BMI by specific player position [F (8, 23) = 2.17, p = 0.07]. The mean years of experience playing schoolboy rugby was 4.81 (SD = 1.4) years. On average, participants played 2.2 (SD = 0.8) competitive games at the time of data collection.

Table 2. Sample demographic characteristics and rugby-related information (N = 32)

Variable	Response	n (%)
Age (years)	15	2 (6.3)
	16	6 (18.8)
	17	10 (31.3)
	18	12 (37.5)
	19	2 (6.3)
Playing positions	Forward	19 (59.4)
	Backline	13 (40.6)
Specific playing positions	Lock	7 (21.9)
	Centre	2 (6.3)
	Flank	6 (18.8)
	Fly-half	1 (3.1)
	Fullback	3 (9.4)
	Hooker	4 (12.5)
	Prop	2 (6.3)
	Scrum-half	4 (12.5)
	Winger	3 (9.4)
Body mass index (BMI)	Normal	25 (78.1)
	Overweight	5 (15.7)
	Obese	2 (6.3)

Test-retest reliability results

Table 3 shows descriptive statistics for the Eurofit items for the test-retest reliability study and the ICCs calculated at 95% confidence interval. The ICC values for the candidate items in the Eurofit test battery ranged from 0.51 to 0.98. The Sit-and-Reach test yielded the highest test-retest reliability values (ICC = 0.98). The only tests with ICCs values of less than 0.7 were the Flamingo Balance test, Plate Tapping test and the 10 ±5 m Shuttle Run test.

Table 3. Test-retest results (N = 32)

Test	Test Mean (SD)	Retest Mean (SD)	*t*-test	*p*-value	ICC	95% CI	SEM
FBT (n)	0.53 (0.91)	0.36 (0.71)	1.09	0.28	0.51	0.21–0.73	1.00
PLT(sec)	12.4 (1.42)	11.9 (1.31)	0.36	0.72	0.59	0.31–0.78	1.44
BAH (sec)	19.1 (11.1)	21.1 (11.0)	–2.43	0.02	0.90	0.78–0.95	6.83
SBJ (m)	2.07 (0.23)	2.04 (0.19)	1.18	0.25	0.82	0.67–0.91	0.17
HGR (kgs)	49.9 (7.09)	50.5 (7.74)	–1.08	0.29	0.89	0.79–0.95	4.79
SAR (cm)	14.3 (8.06)	13.7 (8.58)	1.40	0.17	0.98	0.95–0.99	2.55
SUP (n)	24.0 (4.45)	25.0 (4.89)	–1.90	0.07	0.73	0.51–0.88	4.56
SHR(sec)	16.3 (1.33)	16.1 (1.64)	0.86	0.40	0.60	0.32–0.78	1.69

SD = standard deviation, sec = seconds, kgs = kilograms, m = meters, n = number, cm = centimetres, ICC = Intraclass correlation coefficient, CI-confidence interval, SEM = standard error of measurement, FBT = flamingo balance test, HGR = handgrip test, PLT = plate tapping test, BAH = bent arm hang, SAR = sit and reach test, SBJ = standing broad jump test, SUP = sit up test, SHR = shuttle run test

Discussion

This study was conducted to provide baseline information on the test-retest reliability of the Eurofit test battery administered to elite Zimbabwean junior rugby players in high schools. Our findings showed that the majority of the Eurofit candidate items yielded high test-retest reliability with ICCs greater than 0.7. Exceptions were for the Plate Tapping (ICC = 0.59), Flamingo Balance (ICC = 0.51) and the 10 × 5 m Shuttle Run tests (ICC = 0.60). The studies specifically evaluating test-retest reliability of the Eurofit test battery among junior rugby players are limited in the literature. This renders comparisons of our present findings with other findings obtained from studies involving similar participants difficult. Nonetheless, there are innumerable studies conducted in different settings utilising different participants that have evaluated the test-retest reliability of the Eurofit test battery (Erikoglu et al., 2015; Vancompfort et al., 2015; Keane et al., 2010; Tsigilis et al., 2002). For example, Tsigilis et al. (2002) examined one-week test-retest reliability of the Eurofit test battery among 98 male and female physical education university undergraduate students (aged 19.45 ±2.7 years) in Greece. In that study, the Eurofit test battery yielded reproducible data for the majority of the tests with global ICCs values ranging from 0.57 to 0.94. Similarly, Houwen et al. (2006) reported ICC values between 0.63 and 0.91 using 21 Dutch school-children, aged 6–12 years, with visual impairments. In that study, the test-retest assessment sessions were separated by four (4) weeks. In Northern Ireland, Donncha et al. (1999) reported ICC values of 0.85 to 0.99 for the physical test items of the Eurofit for 22 healthy males aged 15.6 ±0.6 years in Ireland. Variability in the global reliability values could be explained largely by population and methodological (test-retest time interval) differences. In spite of these differences, our present study findings provide support for the reliability of Eurofit test battery in assessing physical fitness in the studied sample. These findings are important to coaches, sports directors and fitness coaches involved in local high school rugby since some of the candidate items of the Eurofit test battery are commonly used in training already.

The SAR test for hamstring and lower-back muscle flexibility yielded the highest temporal reliability with an ICC of 0.98. This reflected an almost perfect agreement in the test scores between the test and retest assessment. In concordance, Tsigilis et al. (2002) reported an ICC of 0.94 in physical education students who were slightly older than our sample participants. Similarly, Donncha et al. (1999) reported ICC values of 0.97 for participants with mild retardation and 0.91 for those without. Our present findings indicate that the SAR test can be proposed for the reliable evaluation of hamstring and lower-back muscle flexibility in junior rugby players in Zimbabwe.

Other candidate items of the Eurofit that achieved satisfactory reliability values included the BAH test for muscular strength and endurance (ICC = 0.90) and the HGR test for isometric muscle strength of the hand and forearm (ICC = 0.89). All these findings highlight the suitability and reliability of these tests to be used in examining static muscular strength and endurance of the upper limbs. There is incontrovertible evidence in the literature showing that the reliability of these tests is population specific (Monyeki et al., 2005). Fjørtoft et al. (2011) reported low reproducibility values for the BAH test in young children aged between the ages of five and seven years. In contrast, Tsigilis et al (2002) reported a high ICC of 0.89 for the BAH test in physical education students. The test also showed a relatively high coefficient of variation (CV) of 18.6% indicating huge variability in the scores in the test-retest reliability study. Of all the Eurofit tests investigated in the present study, the BAH showed a relatively high SEM (6.68) and the mean scores were significantly different ($p = 0.02$) between the test and retest assessments. To account for these results, it is possible that the BAH test was physical demanding for the junior rugby players resulting in variability of the scores (Tsigilis et al., 2002).

Of interest were Eurofit tests which yielded low relative reliability values in the sample studied. The three tests included the PLT (ICC = 0.59), FBT (ICC = 0.51) and the SHR (ICC = 0.60) tests. The wide CIs in the calculated ICCs values for these tests question the reliability and the usefulness of these tests in assessing corresponding aspects of physical fitness in Zimbabwean junior rugby players. However, these findings were consistent with reports from other studies (Fjørtoft, 2000; Tsigilis et al., 2002). Tsigilis et al (2002) reported ICC values of 0.57 for the PLT test. Fjørtoft (2000) reported low reliability values for the FBT with a correlation of 0.43 Fjørtoft et al. (2011) reported an ICC value of 0.69 for the SHR test in 5- to 12-year-old Norwegian children. In spite of the consistent results with other studies, replicate future studies with larger samples may be needed to establish the reliability of these tests in Zimbabwean junior rugby players. Although the importance of balance (measured by the FBT), running speed and agility (measured by the SHR) and upper-limb coordination and reaction speed (measured by the PLT) can never be argued for rugby players, it is possible that these tests need modifications when further use is required in junior rugby players.

Limitations of the study

The results of this study should be interpreted cognisant of a number of important limitations. Although we found high ICCs for the majority of the Eurofit test items, our results lack the strength of generalisability to all junior rugby players in Zimbabwe. This was mainly because of limited participation of schools in the study. Although all the junior rugby players in the selected schools were invited to participate, much of the attrition of the sample size was caused by lack of parental support for the players to participate in the study. In addition, the timing for data collection could have influenced the sample size. This study was conducted during the competitive rugby season. This marks the time when coaches are extremely busy with the first team players. Cognisant of these limitations, the results of this study should be interpreted cautiously for other junior rugby players either playing in the SESRL from the private schools or outside Zimbabwean context. It suffices to consider this study as a pilot study providing baseline information on the reliability of the Eurofit test battery in junior rugby players in Zimbabwe. There is need for future replicate studies with large sample sizes generated from a random selection of all 'elite' junior rugby players from the schools participating in the SESRL in Zimbabwe. However, future studies using 'elite' junior rugby players may need to be considerate of the time to collect data. It may be ideal to conduct related future studies during the pre-or post-season. In addition, future studies may consider reducing the training load, approximately by 50%, for 1–2 weeks before the measurements and plan a break in training for 1–2 days before the tests.

Conclusion

Numerous studies have been conducted validating the Eurofit test battery. However, few of these are in schoolboy rugby athletes from low-resource settings in Africa. Therefore, an attempt to address this problem through Zimbabwean rugby players seems scientifically interesting and offers great prospects, for example, the development of standards for this population of athletes in the future. Cognisant of the study limitations, this study pragmatically showed the possibility of evaluating the seven-day test-retest reliability of Eurofit test items during the in-season period among elite schoolboy rugby players from a low-resourced setting such as Zimbabwe. The following test items such as bent arm hang test, handgrip test, sit and reach test, standing broad jump test, and sit-up test can be recommended for reliably evaluating aspects of physical fitness in junior rugby players in Zimbabwe whilst others (Plate Tapping test, Flamingo Balance Test, and Shuttle Run test) still need consideration and test modification.

Acknowledgements The researchers wish to acknowledge all the high school rugby players who participated in the study as participants, and their parents for the informed consent. Also, we would like to acknowledge the Ministry of Education in Zimbabwe for the institutional approvals.

References

Abernethy, L., & MacAuley, D. (2003). Impact of school sports injury. *British Journal of Sports Medicine, 37*(4), 354–355. https://doi:org/10.1136/bjsm.37.4.354

Bleakley, C., Tully, M., & O'Connor, S. (2011). Epidemiology of adolescent rugby injuries: a systematic review. *Journal of Athletic Training, 46*(5), 555–565. https://doi:org/10.4085/1062-6050-46.5.555

Brown, J. C., Verhagen, E., Viljoen, W., Readhead, C., Van Mechelen, W., Hendricks, S., & Lambert, M. I. (2012). The incidence and severity of injuries at the 2011 South African Rugby Union (SARU) Youth Week tournaments. *South African Journal of Sports Medicine, 24*(2), 49–54. https://doi.org/10.17159/2078-516X/2012/v24i2a345

Chiwaridzo, M., Masunzambwa, Y., Naidoo, N., Kaseke, F., Dambi, J. M., & Matare, T. (2015) Profile of Rugby Injuries in High School Zimbabwean Adolescents. *International Journal of Sports and Exercise Medicine, 1*(5), 1–6. https://doi.org/10.23937/2469-5718/1510031

Chiwaridzo, M., Tadyanemhandu, C., Mkumbuzi, N. S., Dambi, J. M., Ferguson, G. D., & Smits-Engelsman, B. C. (2021). Absolute and relative reliability of SCRuM test battery component assembled for schoolboy rugby players playing competitive rugby in low-resource settings: A pragmatic in-season test-retest approach. *South African Journal of Sports Medicine, 33*(1), 1–7. https://doi.org/:10.17159/2078-516x/2021/v33i1a12220

de Vet, H. C. W., Terwee, C. B., & Knol, D. L., Bouter, L. M. (2006). When to use agreement versus reliability measures. *Journal of Clinical Epidemiology, 59*(10), 1033–1039. https://doi.org/10.1016/j.jclinepi.2005.10.015

Donncha, M. C., Watson, A. W., McSweeney, T., & O'Donovan, D. J. (1999). Reliability of Eurofit physical fitness items for adolescent males with and without Mental Retardation. *Adapted Physical Activity Quarterly, 16*(1), 86–95. https://doi.org/10.1123/apaq.16.1.86

Duthie, G. M., Pyne, D. B., Ross, A. A., Livingstone, S. G., & Hooper, S. L. (2006). The reliability of ten-meter sprint time using different starting techniques. *Journal of Strength and Conditioning Research, 20*(2), 246–251. https://doi.org/10.1519/R-17084.1

Duthie, G. M. (2006). A framework for the physical development of elite rugby union players. *International Journal of Sports Physiology and Performance, 1*(1), 2–13. https://doi.org/10.1123/ijspp.1.1.2

Enright, K., Morton, J., Iga, J., Lothian, D., Roberts, S., & Drust, B. (2018). Reliability of "in-season" fitness assessments in youth elite soccer players: a working model for practitioners and coaches. *Science and Medicine in Football, 2*(3), 177–183. https://doi.org/10.1080/24733938.2017.1411603

Erikoglu, O., Guzel, N. A., Pense, M., & Orer, G. E. (2015). Comparison of Physical Fitness parameters with Eurofit test battery of male adolescent soccer players and sedentary counterparts. *International Journal of Science Culture and Sport, 3*(3), 43–52. https://doi.org/10.14486/IntJSCS434

Fjørtoft, I., Pedersen, A. V., Sigmundsson, H., & Vereijken, B. (2011). Measuring physical fitness in children who are 5 to 12 years old with a test battery that is functional and easy to administer. *Physical Therapy, 91*(7), 1087–1095. https://doi.org/10.2522/ptj.20090350

Fjørtoft, I. (2000). Motor fitness in pre-primary school children: The EUROFIT motor fitness test explored on 5-7-year-old children. *Pediatric Exercise Science, 12*(4), 424–436. https://doi.org/10.1123/pes.12.4.424

Freitag, A., Kirkwood, G., Scharer, S., Ofori-Asenso, R., & Pollock, A. M. (2015). Systematic review of rugby injuries in children and adolescents under 21 years. *British Journal of Sports Medicine, 49*(8), 511–519. https://doi.org/10.1136/bjsports-2014-093684

Gabbett, T. J., & Domrow, N. (2005). Risk factors for injury in sub elite rugby league players. *The American Journal of Sports Medicine, 33*(3), 428–434. https://doi.org/10.1177/0363546504268407

Gabbett, T. J. (2005).Changes in physiological and anthropometric characteristics of rugby league players during a competitive season. *Journal of Strength and Conditioning Research, 19*(2), 400–408. https://doi.org/10.1519/14884.1

Gabbett, T. J. (2003). Incidence of injury in semi-professional rugby league players. *British Journal of Sports Medicine, 37*(1), 36–44. https://doi.org/10.1136/bjsm.37.1.36

Gabbett, T. J. (2000). Physiological and anthropometric characteristics of amateur rugby league players. *British Journal of Sports Medicine, 34*(4), 303–307. https://doi.org/10.1136/bjsm.34.4.303

Green, B. S., Blake, C., & Caulfield, B. M. (2011). A valid field test protocol of linear speed and agility in rugby union. *Journal of Strength and Conditioning Research, 25*(5), 1256–1262. https://doi.org/10.1519/JSC.0b013e3181d8598b

Houwen, S., Visscher, C., Hartman, E., & Lemmink, K. A. P. M. (2006).Test-retest reliability of Eurofit physical fitness items for children with visual impairments. *Pediatric Exercise Science, 18*(3), 300–313. https://doi.org/10.1123/pes.18.3.300

Kaplan, K. M., Goodwillie, A., Strauss, E. J., & Rosen, J. E. (2008). Rugby Injuries. A review of concepts and current literature *Bulletin of the NYU Hospital for Joint Diseases, 66*(2), 86–93.

Kaux, J. F., Julia, M., Delvaux, F., Crossier, J. L., Forthomme, B., Monnot, D., Chupin, M., Crielaard, J. M., Le Goff, C., Durez, P., Ernst, P., Guns, S., & Laly, A. (2015). Epidemiological review of injuries in rugby union. *Sports, 3*(1), 21–29. https://doi.org/10.3390/sports3010021

Keane, A., Scott, M. A., Dugdill, L., & Reily, T. (2010). Fitness test profiles as determined by the Eurofit Test Battery in elite female Gaelic Football players. *Journal of Strength and ConditioningResearch, 24*(6), 1502–1506. https://doi.org/10.1519/JSC.0b013e3181dc44a8

Mayorga, D., Viciana, J., & Cocca, A. (2012). Relationship between physical self-concept and health-related physical fitness in Spanish schoolchildren. *Procedia-Social and Behavioral Sciences, 69*(1), 659–668. https://doi.org/10.1016/j.sbspro.2012.11.458

Monyeki, M. A., Koppes, L. L. J., Kemper, H. C. G., Monyeki, K. D., Toriola, A. L., Pienaar, A. E., & Twisk J. W. R. (2005). Body composition and physical fitness of undernourished South African rural primary school children. *European Journal of Clinical Nutrition, 59*(7), 877–883. https://doi.org/:10.1038/sj.ejcn.1602153

Nemadire, Z. (2013). Super eight rugby league. *The Herald.* http://www.herald.co.zw/super-8-rugby-league/

Ruiz, J. R., Ortega, F. B., Gutierrez, A., Meusel, D., Sjöström, M., & Castillo, M. J. (2006). Health-related fitness assessment in childhood and adolescence: A European approach based on the AVENA, EYHS and HELENA studies. *Journal of Public Health, 14*(5), 269–277. https://doi.org/10.1007/s10389-006-0059-z

Skowronski, W., Horvat, M., Nocera, J., Roswal, G., & Croce, R. (2009). Eurofit special: European fitness battery score variation among individuals with intellectual disabilities. *Adapted Physical Activity Quarterly, 26*(1), 54–67. https://doi.org/10.1123/apaq.26.1.54

Spamer, E. J., & De la Port, Y. (2006). Anthropometric, physical, motor, and game-specific profiles of elite under 16 and under 18-year-old South African schoolboy rugby players. *Kinesiology, 38*(2), 176–184. https://hrack.srce.hr/10207

Telles, S., Singh, N., Bhardwaj, A. K., Kumar, A., & Balkrishna, A. (2013). Effect of yoga or physical exercise on physical, cognitive and emotional measures in children: a randomized controlled trial. *Child and Adolescent Psychiatry and Mental Health, 7*(37), 1–16. https://doi.org/10.1186/1753-2000-7-37

Terwee, C. B., Bot, S .D. M., de Boer, M. R., Van der Windt, D. A. W. M., Knol, D. L., Dekker, J., Bouter, L. M., & de Vet, H. C. W. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of Clinical Epidemiology, 60*(1), 34–42. https://doi.org/10.1016/j.jclinepi.2006.03.012

Tsigilis, N., Douda, H., & Tokmakidis, S. P. (2002). Test-retest reliability of the Eurofit test battery administered to university students. *Perceptual and Motor Skills, 95*(3 Pt 2), 1295–1300. https://doi.org/10.2466/PMS.95.7.1295-1300

Tsigilis, N., & Theodosiou, A. (2008). The influence of multiple administration of a psychomotor test on performance and learning. *Journal of Strength and Conditioning Research, 22*(6), 1964–1968. https://doi.org/10.1519/JSC.0b013e318821b75

Turner, A., Walker, S., Stembridge, M., Coneyworth, P., Reed, G., Birdsey, L., Barter, P., & Moody, J. (2011). A testing battery for the assessment of fitness in soccer players. *Strength and Conditioning Journal, 33*(5), 29–39. https://doi.org/10.1519/SSC.0b013e31822fc80a

Vancompfort, D., Sienaert, P., Wyckaert, S., de Hert, M., Stubbs, B., Rosebaum, S., Buys, R., & Probst, M. (2015). Test–retest reliability, feasibility and clinical correlates of the Eurofit test battery in people with bipolar disorder. *Psychiatric Research, 228*(3), 620–625. https://doi.org/10.1016/j.psychres.2015.05.042

Vancompfort, D., Probst, M., Sweers, K., Maurissen, K., Knapen, J., Willems, J. B., Heip, T., & De Hert, M. (2012). Eurofit test battery in patients with schizophrenia or schizoaffective disorder: Reliability and clinical correlates. *European Psychiatry: The Journal of the Association of European Psychiatrists, 27*(6), 416–421. https://doi.org/10.1016/j.eurpsy.2011.01.009

Walter, S. D., Eliasziw, M., Donner, A. (1998). Sample size and optimal designs for reliability studies. *Statistics in Medicine, 17*(1), 101–110. https://doi.org/10.1002/(sici)1097-0258(19980115)17:1<101::aid-sim727>3.0.co;2-e

Cite this article as: Mupondi, T., Shumba, T. W., von der Heiden, C., Kamba, F., Chiwaridzo, M. (2024). Evidence on psychometric properties of component test items of the Eurofit test battery administered to Zimbabwean schoolboy rugby players: A test-retest reliability study. *Central European Journal of Sport Sciences and Medicine*, *2*(46), 117–130. https://doi.org/10.18276/cej.2024.2-10