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RESEARCH

The Feasibility of a Fitness Test Battery and Web-Based Platform for Monitoring Key Indicators of Adolescent Health in School Settings

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Aim: To examine the feasibility of a fitness test battery and web-based platform for monitoring key indicators of adolescent health in school settings.

Methods: A process evaluation framework for feasibility studies, developed by Orsmond and Cohn (2015), was used to conduct a systematic evaluation of a student centred approach to measure and monitor health-related fitness in schools. Adolescents (N = 1215, female = 609) aged 13.4 years (SD.41) from a randomised sample of 20 schools in the Republic of Ireland, stratified for sex, location and educational (dis)advantage, completed a series of field-based fitness tests. Five feasibility benchmarks were examined, including; recruitment capability, data collection, acceptability of study procedures, resources, and an evaluation of teacher participant experiences. Various sources were used to operationalise the feasibility framework including, student (n = 795) and teacher (n = 20) evaluation surveys, test-retest reliability indices, and health-related fitness data from the 20 school expansion phase.

Results: Overall, 95% of teachers (n = 19) and 79% of students (n = 618) surveyed agreed or strongly agreed that the Youth-Fit project was a worthwhile experience on a 5-point Likert scale. All feasibility benchmarks including recruitment capability, data collection procedures, resources and participant responses, were reached or exceeded. Further refinements including reducing the number of test items, increasing the time allocated for administering the test battery, and enhancing the efficiency of data input and quality of report output on the software platform are required.

Conclusions: Positive feasibility benchmarks indicated that the Youth-Fit test battery and software platform represented a feasible, pedagogically sound and scientifically rigorous approach for monitoring health-related fitness in secondary school settings.

Keywords: Schools; Physical fitness; Physical education; peer-facilitated

Introduction

Lack of physical activity and low levels of health-related fitness threaten both the current and future health of children (Strong et al., 2005). Schools are recognised as key settings for promoting healthy lifestyle behaviours (Ekelund et al., 2012), and physical education programmes are commonly acknowledged as the most powerful settings to systematically influence the health of children and adolescents (Pate et al., 2006). Fitness testing has been part of school based physical education programmes for over half a century (Morrow et al., 2009) and has been reported as one of the most common forms of assessment in physical education programmes (Hardman, 2004). The practice of monitoring health-related fitness in physical education programmes is widespread, however, its purpose in a physical education context remains a divisive topic (Lloyd et al., 2010). Advocates highlight the proposed educational and health benefits of monitoring students' health-related fitness (Cohen et al., 2015), while critics suggest that health-related fitness testing may well represent a misdirected effort at health promotion (Cale and Harris, 2009). Notwithstanding reservations regarding current implementation practices, Cale et al (2014) indicated that, if integrated appropriately as one element of broader fitness education unit, there was no reason why fitness testing could not play a role in supporting healthy lifestyles and in educating young people about physical activity and fitness.

The surge in research identifying physical fitness as a powerful marker of health among adolescents has led to many countries developing fitness test batteries and software platforms to facilitate monitoring health-related fitness in schools (O'Keeffe et al., 2020c; Bianco et al., 2015). However, despite World Health Organisation recommendations for the establishment of comprehensive health monitoring programmes in youth (Hallal et al., 2012), and unlike many countries internationally, including United States, Canada, Russia, China, Hungary, Finland and Slovenia, the Republic of Ireland lacks are clearly specified strategy for monitoring health-related fitness in school settings (O'Keeffe et al., 2020d). In addition, a recent review of health-related fitness monitoring practices among a nationally representative sample of secondary school physical education teachers in the Republic of Ireland reported that over 95% of teachers used fitness tests in their PE programmes, however, less than 12% tracked students' results across year groups (O'Keeffe et al., 2020c).

A plethora of research articles have been published identifying best practice approaches to fitness monitoring in schools. Recommendations included moving away from command style test administration to a more reciprocal, small group and peer facilitated approach (Graser et al., 2011); using criterion rather than norm-referenced health standards to promote a self-referenced comparison with attainable health standards (Mahar and Rowe, 2008); and allowing students an opportunity to familiarize themselves with the tests prior to testing (Martin et al., 2010). However, and rather surprisingly, very few empirical studies have been conducted to provide evidence for the purported positive impact of such methodologies with both students and teachers. Therefore, the Youth-Fit project was initiated with the aim of developing a pedagogically sound and scientifically rigorous fitness test battery for monitoring physical fitness in Irish secondary school settings.

A significant amount of funding resources, including participants' and researchers' time, may be wasted if feasibility has not been carefully examined and assured prior to conducting a pilot study or a randomised control trial (Orsmond and Cohn, 2015). The Youth-fit test battery was established through a systematic plan that included eight steps (**Figure 1**). The aim of the current study was to evaluate both teachers and

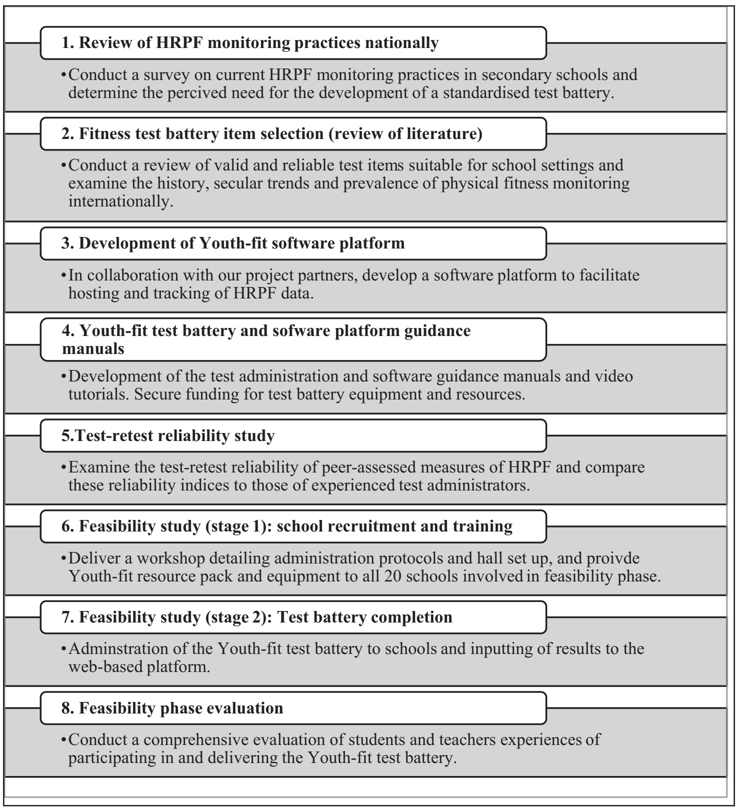

Figure 1: Schematic overview of the steps involved in the development and evaluation of the Youth-fit test battery and software platform.

participants experiences of the two key project outputs, namely; a peer-facilitated health-related fitness test battery; and a software platform designed for teachers to facilitate monitoring students test scores at a school level. A comprehensive evaluation of the Youth-Fit project, guided by the five overarching objectives of a feasibility study (Orsmond and Cohn, 2015), is provided in the following sections.

Methods

The methodology related to feasibility and acceptability outcomes is detailed below.

Youth-Fit test battery and software platform development

An eight step plan was created to inform the development and implementation of the Youth-Fit test battery and software platform in a systematic manner, culminating in an evaluation of the initiative which is the focus of the current manuscript (**Figure 1**). A rationale for the development of the Youth-fit test battery and software platform (O'Keeffe et al., 2020c), the selection of test items and reliability of administration protocols (O'Keeffe et al., 2019), and a comprehensive evaluation of student experiences of the test battery (O'Keeffe et al., 2020a) have been reported elsewhere.

Recruitment

Research ethics approval for all phases of the Youth-Fit study was granted by the Research Ethics Committee of the Faculty of Education and Health Sciences, University of Limerick (EHS_2017_02_12), and performed in accordance with the Declaration of Helsinki. A randomised sample of 20 schools, stratified for sex (single-sex boys, single-sex girls and mixed-sex), location (urban and rural, categorised by population density), and educational (dis)advantage (Department of Education and Skills, 2017), agreed to participate subsequent to an initial recruitment email and telephone conversation with each school principal and cooperating physical education teacher. The procedure for generating a randomised sample was conducted by an experienced statistician using a special computerized code system in which all secondary schools in the mid-west and south-west region of Ireland were assigned a code and categorised according to pre-defined strata. Due to the geographical spread of schools, and the need to visit each school individually, 20 schools was considered to be the maximum sample size achievable from a logistical viewpoint, and the minimum required to obtain a sufficient number of schools in each of the chosen strata. Following school approval, written informed consent was obtained from the parents of the students, and the students themselves. Test battery administration took place over a three-month period between November 2018 and January 2019.

Induction and administration

The cooperating physical education teacher in each school selected eight senior student facilitators (final two years of second level education) to assist in the administration of the test battery. Student or peer facilitated learning can be defined as a learning process whereby students learn from and with others; this can be with students of the same-age or from those who are older (cross-age) (Jenkinson et al., 2012). Tests, with the exception of the 20 metre-shuttle run test (20 m SRT) which was administered to groups of ≤15, were delivered in a station format to small groups of five students or less, and each student facilitator was responsible for one test item on the test battery. Tests included; 20 m SRT, body mass index (BMI), hand-grip strength, standing broad jump (SBJ), isometric plank-hold, 90° push-up, 4 × 10 m shuttle-run, back-saver sit and reach (BSR), and blood pressure. A detailed standard operating procedure for each test item was designed for and read by all cooperating teachers and student facilitators one week in advance of data collection. Subsequently, cooperating physical education teachers and student facilitators participated in a three hour training workshop delivered by the lead author. During this workshop, the cooperating teacher and student assistants were trained on the administration protocols for each test item. The test battery was administered during three timetabled physical education class periods lasting ≥80 minutes over three consecutive weeks. The focus of week one was test protocol familiarisation and background information. The purpose and protocols for each test item were explained during this session. Week two focused on the administration of the 20 m shuttle-run test (20 m SRT), and the remaining test battery items were delivered in week three. Cooperating physical education teachers were responsible for uploading test results to the Youth-Fit web-based application, hosted on a secured internally facing server at the University of Limerick.

Software application development

Two software applications, developed by project partner's *iMosphere*®, were used to gather students health-related fitness data, and transfer data to a centrally hosted anonymised database. Results were inputted through the *Carepartner*® application, which was hosted on an internally facing server at the lead author's institution. This user-friendly application enabled data from all participating schools to be captured through an easily navigable interface (**Figure 2**), and stored on a secured database. Individual log-in accounts for cooperating physical education teachers were created by a member of the research team. Only participating school principals, physical education teachers, the three members of the research team and a designated *iMosphere* software support administrator had access to the Carepartner application. School profiles (name), cooperating teacher profiles (name) and consented student profiles (name, gender, month of birth, school, and class group) were created by the system administrator using a bulk import function on the Carepartner application. An anonymized alphanumeric coding system was used to associate each school, cooperating teacher, and their students. The Carepartner application also enabled teachers to download summary reports of an individual's health-related fitness test results. A comprehensive guide on the Carepartner application to assist cooperating teachers inputting results is available at the following link (available here).

Following input to the Carepartner® application, data automatically transferred in anonymised form to the Atmolytics® application (**Figure 3**). The Atmolytics platform enabled more detailed statistical analysis at a school or regional level, but not at an individual level. All identifiable information from the Carepartner

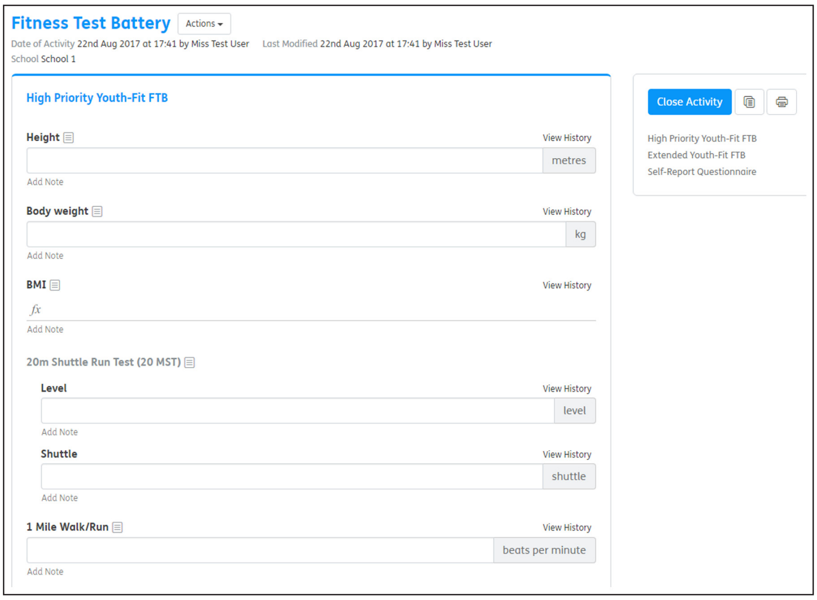

Figure 2: The Youth-fit software platform results input interface.

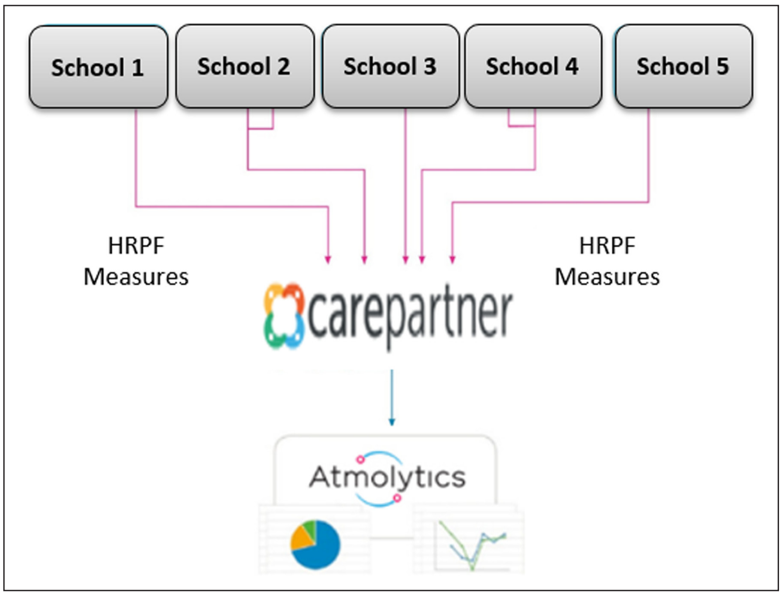

Figure 3: Overview of information flows on the Youth-fit software platform.

system was redacted when transferred to the Atmolytics application. The Atmolytics application included a variety of functions that facilitated the generation of school-level reports, enabling school principals or cooperating teachers to compare their schools results with established criterion or normative values (**Figure 4**). A comprehensive step-by-step guide detailing the procedure for generating reports on the Atmolytics platform is available at the following link (available here).

Feasibility benchmarks

A framework for the evaluation of feasibility studies, developed by Orsmond and Cohn (2015), was used to appraise the core components of the Youth-Fit project. Drawing on the emerging methodological literature, Orsmond and Cohn conceptualized feasibility and pilot studies along a continuum. Feasibility studies focus on the process of developing and implementing an intervention and result in preliminary examination of participant responses to the intervention (Dobkin, 2009), while pilot studies more clearly focus on outcomes, rather than process, often administered in the form of a randomised control trial. Feasibility studies are conducted in advance of pilot studies to assess the research and delivery process. Orsmond and Cohn (2015) identified five overarching objectives of feasibility studies including; recruitment capability; data collection procedures and outcome measures; acceptability of study procedures; resources; and preliminary evaluation of participant responses. An overview of Orsmond and Cohn's feasibility study evaluation framework dimensions and guiding questions within each objective is provided in **Figure 5**. The results of the feasibility and acceptability analysis are presented for each of the five outcomes in the following section.

Analysis

Following completion of test battery a sample of student participants (n = 795, 65% of total student sample) and the lead cooperating physical education teacher in each school (n = 20) completed a purposefully designed program evaluation survey. Although students in each of the 20 schools involved in the study were represented, response rates within schools varied between 60 and 100 percent, which could have resulted in some response bias. Four follow up reminder emails containing links to the student evaluation surveys were sent to all schools in an effort to minimise non-response bias and maximise the overall response rate. The student survey comprised of two sections; section one included an 18 item scale, validated for measuring attitude towards fitness tests (Mercier et al 2014). Section two focused on a process evaluation of each key component of the Youth-Fit test battery and report outputs. A comprehensive evaluation of student experiences of the Youth-Fit test battery was detailed by O'Keeffe et al (2020a).

The teacher evaluation survey comprised of four sections, namely; induction and resources; test battery administration and protocols; teacher perceptions of student experience; and user experience of the Youth-Fit software package, guided by the technology acceptance model (Venkatesh and Davis, 2000). For convenience and wide distribution, teacher and student surveys were administered via SurveyMonkey

Figure 4: The Youth-fit software platform sample school level report output.

Objective	Details
Objective 1: Evaluation of Recruitment Capability and Resulting Sample Characteristics	The focus of objective one is on the recruitment rates, eligibility criteria and the relevance of the intervention to the target population.
Objective 2: Evaluation and Refinement of Data Collection Procedures and Outcome Measures	The focus of this objective is the appropriateness of data collection procedures. Follow up questions include participants ability to complete the test measures, suitability of study protocols, delivery time, value of each test item, and reliability of data gathered.
Objective 3: Evaluation of Acceptability and Suitability of Study Procedures	Are the study procedures suitable for and acceptable to participants?" Follow up questions address retention, time, capacity, acceptability and satisfaction of the study to participants, and safety.
Objective 4: Evaluation of Resources and Ability to Manage and Implement the Study and Intervention	The key focus for this objective is whether or not the research team have the resources and ability to manage the study. Factors including space, administrative capacity, expertise, budgetary considerations, equipment needs and technology should be addressed.
Objective 5: Preliminary Evaluation of Participant Responses to Intervention	This objective deals primarily with prospect of the proposed intervention or study being successful based on the experience of participants.

Figure 5: The five overarching objectives of a feasibility study (Orsmond and Cohn 2015).

(SurveyMonkey, Palo Alto, CA) cloud-based software. Complete responses were transferred to SPSS (Statistical Package for Social Sciences, version 24; IBM Corp., Chicago, IL) for analysis. Responses to closed-ended questions were analysed descriptively. Responses to open-ended questions were reviewed and organized thematically (Taylor-Powell and Renner, 2003).

Results

Feasibility benchmarks

Objective 1: Evaluation of Recruitment Capability and Resulting Sample Characteristics

All secondary schools with access to an indoor hall space of ≥25 metres and students in year one of second level education with no inhibiting health conditions were eligible to participate. Inhibiting health conditions were listed as a prior heart condition, pains in chest or joints when exercising, or if a physician was currently prescribing medication. A total of 1215 adolescents (female = 609) aged 13.4 years (SD.41) from a randomised sample of 20 schools, stratified for sex (single-sex boys, single-sex girls and mixed-sex), location (urban and rural, categorised by population density), and educational (dis)advantage as defined by the Department of Education and Skills (2017), were recruited for this study. Of the initial sample of 20 schools, four schools declined to participate, in which case the next school on a randomised reserve list was recruited. Contrasting reasons were provided by the principal and (or) cooperating physical education teacher in the four schools that declined to participate, including; time constrains (two schools), unsuitable indoor facilities, and the aim of the project not aligning with the school's ethos.

A total of 27 students were deemed ineligible to participate due to underlying health conditions recorded on a physical activity readiness questionnaire (Warburton et al., 2011). A minimum participation rate threshold of 70%, as used in other similar studies (Moreno et al., 2008), was set for a school to be considered eligible. Participation rates in the final sample were ≥75% in all schools, and reached 100% in many schools, with one teacher noting, "*We had maximum participation which is a great endorsement of their willingness to be involved*" (female teacher, boys school). Reasons for non-participation among student participants were recorded on a non-participant form. The most commonly cited reasons were absenteeism, injury/sickness, and parents or students not providing consent. The time consuming process involved in gathering participant and parent consent forms was noted as a significant barrier by five of the 20 cooperating teachers surveyed, for example, one teacher stated that "*the greatest challenge we faced was collecting consent forms from students*" (male teacher, mixed sex school).

Objective 2: Evaluation and Refinement of Data Collection Procedures and Outcome Measures

The training workshop and equipment provided by the lead investigator at the induction session in each school was cited by six of the 20 teachers surveyed as the most beneficial aspect of the project, one teacher stated, "*Receiving the equipment, guidance manuals and training during the induction session on the protocols for delivering each test item was great CPD for our physical education department*" (Male teacher, boys school). All lead cooperating teachers (n = 20) agreed that the sequence of testing was appropriate, and 19 of the 20 teachers agreed or strongly agreed that the student facilitators improved the delivery of test battery. Similarly, the vast majority of student participants (86.8%, n = 690) who completed the evaluation survey agreed or strongly agreed that the senior student facilitators made it easier for them to perform each test item. A mean coefficient of variation of 6.5% across all tests was found in an examination of the intra-rater reliability of the peer-centred format of delivery found. A more detailed summary of these reliability findings can be found in O'Keeffe et al. 2020b.

All teachers agreed or strongly agreed that each test item was suitable for administration in a physical education context, with the exception of blood pressure, which five teachers questioned the necessity of its inclusion. A male teacher in a mixed sex school stated, *"I don't think the students really understood the relevance of the blood pressure (test)....I thought all the tests had their place with the exception of blood pressure."* The research team defined an incomplete case as missing the body mass index (BMI) recording, or two or more fitness test items. Less than five percent (n = 66) of participant health-related fitness profiles inputted to the Youth-Fit software platform were deemed incomplete and were excluded from all analyses. Following feedback from teachers in the initial four school pre-feasibility trial, the software platform was updated to include biologically plausible value limits for each test item at the point of data entry, and this was a key factor in limiting the number of unusable responses.

Objective 3: Evaluation of Acceptability and Suitability of Study Procedures

A key objective of the Youth-Fit study was to develop a test battery that would be feasible to administer during timetabled physical education lessons. The majority (95%) of teachers surveyed agreed that the test administration procedures were suitable, however, almost two thirds (65%) of teachers indicated that it would not be feasible to deliver the test battery using the small group format without the assistance of the senior student facilitators. Furthermore, half of the teachers surveyed indicated that it was not feasible to deliver the full test battery within the recommended time allocation of two 80 minute class periods. Four teachers noted the blood pressure test to be a particularly time consuming component of the test battery. For example, a female teacher in a girls' school stated, "*Some tests were quicker than others to complete, so those students were waiting quite a bit at this station*." As detailed in the evaluation of student experiences of the Youth-Fit test battery, participating with friends in small groups of ≤6 and having fun was the most commonly cited enjoyable aspect of the test battery (n = 196). For example, one student stated, (I enjoyed) "*doing it with a small group of my closest friends and motivating each other to get a good score*" (male, boys school).

When asked to provide recommendations to enhance the overall Youth-Fit initiative, three teachers commented on the length of time taken to input results on the Youth-fit software platform. For example, a male teacher in single sex girls' school noted, *"I think the concept of online tracking is great but the process of inputting could be made a bit more efficient. For example, not having to input the school code and year group for each student."* Issues around teachers' interaction with the software platform are explained in more detail in the following paragraph. In terms of safety, no unexpected adverse events were recorded from any of the participating schools, however, one school teacher (female, mixed sex school) did note that two students felt light headed following the 20 m shuttle-run test and asked to go home from school. Teachers were encouraged to follow their physical education department's adverse event response protocol, however, a response protocol specific to the Youth-Fit test battery should be developed in advance of an upscaling of the project.

Objective 4: Evaluation of Resources and Ability to Manage and Implement the Study and Intervention

As mentioned in a previous section, the induction training and resources provided to participating schools was frequently cited as one of the biggest strengths of the project. While the current study was conducted within the allocated budget, significant investment at governmental level in testing equipment would be required, as noted by one teacher, "*The provision of the testing equipment was super and made the testing possible. However, if I was to administer this test battery again, I would not have access to the required equipment*" (female teacher, girls' school). In addition, the individual school level induction sessions delivered by the lead investigator would not be feasible for a scale up of the project, therefore, in-service

CPD through regional cluster sessions could represent a viable solution. The study obtained ethical approval from an institutional review board, and test administration protocols were followed, aided by the inclusion of the senior student facilitators and poster displays at each testing station that provided a detailed step-by-step protocol with visual image cues for all test items.

A primary aim of the Youth-Fit project was to develop a low-cost, user-friendly and efficient web-based solution to facilitate monitoring the measures of health-related fitness generated from the test battery. One section of the teacher evaluation survey focused on evaluating their experience of the Youth-Fit software package, guided by relevant elements of the technology acceptance model (Venkatesh and Davis, 2000). In total, 80% of the teachers surveyed indicated that the Youth-Fit software application had relevance to their work, and the same number of teachers indicated that their interaction with the software application was clear and understandable. Although 85% of teachers agreed or strongly agreed that the software platform was easy to use, 50% of respondents were undecided or disagreed that the quality of the student report output generated was high. In addition, as mentioned in the previous section, some teachers raised concerns over the amount of time taken to upload results to the web based platform. For example, when asked to provide recommendations to improve the overall quality of the project, one teacher stated they were "*not sure about the whole reporting infrastructure….I think the input process could have been made more efficient and the student reports could be better*" (female teacher, boys' school). Despite the issues highlighted, 85% of teachers surveyed stated that they would continue to use the software package as part of their fitness education unit if made permanently available.

Objective 5: Preliminary Evaluation of Participant Responses to Initiative

The vast majority of teachers (95%, n = 19) and 79% (n = 618) of student participants surveyed agreed or strongly agreed that the Youth-Fit project was a worthwhile experience. Furthermore, 95% of teachers indicated they would like to incorporate the Youth-Fit test battery as a regular component of their fitness education units in the future. Teachers (80%, n = 16) and students (79%, n = 618) agreed or strongly agreed that the project made them more aware of the importance of health-related fitness, one teacher stated that "*the youth fit fitness test battery is a much needed resource that can assist teachers to frame the importance of health-related fitness and make clear links with future health that is understandable for all young people*" (male, mixed sex school). The inclusion of senior student facilitators and the small group design for administering the test battery were two notable strengths of the initiative commonly cited by both teachers and students. It was encouraging that student attitudes toward participating in the Youth-Fit project, measured using a validated scale developed by Mercier and colleagues (2014), did not vary significantly based on the socio-demographic profile of the school. A more comprehensive overview of students attitudes towards and experiences of the Youth-Fit test battery is available in O'Keeffe et al. 2020a.

Discussion

The aim of the current study was to examine the feasibility of a fitness test battery and web-based platform for monitoring key indicators of adolescent health in school settings. This study, to the best of the authors' knowledge, represents the first evaluation of a student-centred fitness test battery, from the perspective of a stratified sample of students and their physical education teachers. Based on the success of the recruitment capability (≥75% of students in all schools), data collection procedures (combined mean coefficient of variation of 6.5% across all tests (O'Keeffe et al., 2020b)), and overall participant responses (95%, of teachers and 79% of students agreed or strongly agreed that the it was a worthwhile experience), the Youth-Fit test battery and software platform represents a feasible, pedagogically sound and scientifically rigorous approach to measure and monitor health-related fitness in secondary school settings. Teachers should consider moving away from command style test administration to a more reciprocal, small group and peer-facilitated approach. Teachers should implement test batteries as part of a broader fitness education unit framed within the physical education curriculum with an emphasis on learning, not performance, and allow students an opportunity to familiarize themselves with the tests prior to testing. Finally, although the Youth-Fit software infrastructure confirmed the capacity for large-scale collection of objective measures of health-related fitness, enhancing the efficiency of data input and quality of report output should be considered prior to a future expansion.

Benchmarks in relation to recruitment and acceptability were reached or exceeded, evidenced by both the high acceptance rate of schools in the original randomly generated sample agreeing to participate in the study, and the student participation rates of greater than 75% in all schools. This suggests that interventions aimed at promoting healthy lifestyle behaviours are a high priority for school management personnel, underlining the potential for further school-university partnerships for the delivery of evidence based interventions. However, as detailed in the results section, five teachers cited the time consuming process involved in gathering parent and student consent forms as a barrier to recruitment. Similar projects, including NFL Play 60, have been deemed exempt from gathering participant consent due to the participatory nature of the project and the use of de-identified data as part of normal school assessments (Welk et al., 2016). This unique participatory design offers schools the opportunity to voluntarily opt in and directly coordinate their own local programming with training and support provided by the institution coordinating the intervention (Welk et al., 2016). Encouragingly, the accuracy of values for test variables including BMI and estimated cardiovascular endurance were comparable to recently published population level studies involving the same age groups (Woods et al., 2019). For example, similar levels of overweight and obesity amongst the same age cohort, classified according to age and sex specific cut points (Cole et al., 2000), were reported in a recent national longitudinal study.

One of the most frequently cited strengths to emerge from the feasibility analysis was the positive role of the peer facilitators in the delivery of test battery. This was evidenced by 95% of teachers and 87% of students indicating that the peer facilitators made it easier to perform the test battery. It has been suggested that peer facilitated learning in a physical education context may overcome some aspects that impede student learning, enjoyment and participation by providing opportunities for increased levels of individualised feedback, social learning and less direct instruction from the teacher (Ward and Lee, 2005). In addition, given that most teachers indicated that it would not be feasible for one teacher to administer the test battery within the specified time, incorporating peer facilitators to assist with the set up and delivery could reduce the burden on teachers, as indicated in other school based interventions (Lubans et al., 2011). A conceptual model for targeted health behaviour interventions promoting physical activity by Morgan et al. (2016) noted the important but often under-recognized impact facilitators can have on the effectiveness of interventions. Although the experiences of student facilitators was not formally evaluated as part of the current feasibility trial, other studies that utilised a senior student facilitated approach reported very positive impact on the facilitators themselves (Jenkinson et al., 2012). However, Jenkinson and colleagues also cautioned that older student facilitators were reluctant to give up too much of their timetabled class time (Jenkinson et al., 2012), which could be a potential barrier for a future expansion of the Youth-Fit test battery as facilitators are selected from students in the final three years' of second level education, when pressures associated with state examinations are greatest (Banks and Smyth, 2015).

The induction workshop and resources provided to deliver the test battery were cited by teachers as another significant strength of the study design. Remington and Brownson (2011) caution that evidence based interventions aimed at promoting health lifestyle behaviours rarely get implemented in a sustainable manner in real-world settings. Furthermore, the integrity of pre-intervention induction workshops for facilitators has been reported as one of the factors limiting the impact of many multi-site interventions (Galbraith and Winterbottom, 2011). The importance of providing sufficient training and resources outlining testing protocols, equipment, organisation and timing has been highlighted in similar school based studies involving a peer senior student facilitator approach (Jenkinson et al., 2012; Morgan et al., 2016; Galbraith and Winterbottom, 2011; Stock et al., 2007). Morgan et al. (2016) also emphasised the importance of facilitators responsible for the delivery of an intervention being perceived as credible, likable and motivated, which may lead to increased participant engagement. This study involved a three hour test battery induction workshop, delivered to physical education teachers and peer facilitators in all schools, during which test battery equipment and a comprehensive manual detailing a rationale and protocol for each test item was provided. In a review of large-scale fitness testing, Martin and colleagues (2010) stated that fitness testing that documents and leads to improved physical fitness and health will not occur unless those involved receive proper knowledge, preparation, motivation, and support. Therefore, the provision of in-service professional development workshops, in addition to investment in resources and testing equipment, would be necessary prerequisites for a potential future national expansion of the Youth-Fit test battery.

A key benchmark which did not appear to be acceptable was the recommended time allocation to deliver the test battery. Half of the teachers surveyed indicating that it was not feasible to deliver the full test battery within the recommended time of two 80 minutes periods of physical education. Jenkinson and colleagues (2012) stated that the compulsory context of curriculum-based sessions are important in enabling greater opportunities for intervention success. Therefore, the research team were keen to ensure that the Youth-Fit test battery could be administered during timetabled physical education class periods. In order to sustain this approach, steps need to be taken to ensure that the recommended time allocated to complete the test battery is feasible. The higher number of test items in the Youth-Fit test battery in comparison to other test batteries internationally, including Fitnessgram, Netfit and SLOfit, and the contrasting time taken to administer different test items, are potentially key factors contributing to this barrier. The inclusion of blood pressure as a test item in a health-related fitness test battery and the time taken to administer this test specifically was noted by a number of teachers. Although test items were delivered in small groups of no more than six students per station at any one time, a future roll out of the test battery could potentially include high priority and optional test items, as is the case in other similar health-related fitness test batteries, such as the ALPHA test battery (Espana-Romero et al., 2010). In addition, given the high coefficient of variation values reported in an analysis of the test-retest reliability of the Youth-Fit test battery (O'Keeffe et al., 2019), the 90° push-up and isometric plank hold tests of muscular strength and endurance could also be included as optional items that could be conducted on a separate day to the high priority tests.

A key component of the Youth-Fit battery was the development of a software platform to enable teachers to store and track student scores, while simultaneously transferring this data to an unidentifiable open access database, showing trends in real time and enabling school level comparisons with regional and national norms. Web-based tracking technology to aid teachers in monitoring students' health-related fitness is common in many test batteries internationally, including Fitnessgram in the United States (Welk and Meredith, 2013), SLOfit in Slovenia (Jurak et al., 2019) and Netfit in Hungary (Csányi et al., 2015). Researchers have highlighted the need for the development of efficient systems for large scale collection of health-related fitness data, and the transfer of this data to centrally located databases (Ruiz et al., 2006). Although the vast majority of teachers in the current study agreed or strongly agreed that their interaction with the software application was clear and understandable, there were issues in relation to both the time taken to input student results, and the quality of report outputs generated. A future update to the software platform should include the option to input multiple students test scores at once, significantly reducing the amount of time taken to input results. Furthermore, the individual student and teacher report outputs generated need to be improved, perhaps including more comparison charts to graphically depict a student or schools score against international age-matched norms or criterion referenced values, as used in similar software platforms (Welk and Meredith, 2013).

Limitations

This evaluation has identified a range of different outcomes and limitations that should be considered prior to further implementation and dissemination of the Youth-fit test battery. Firstly, although a randomised sample of schools were recruited, stratified for sex, location and socioeconomic status, participants were generated from only one year group, with no control group. The non-experimental nature of the design limits the ability to make causal conclusions about the program efficacy. A future expansion of the test battery should be implemented across a range of grades. All lead cooperating teachers in each of the 20 schools completed the process evaluation survey, however, student evaluation survey response rates varied between 60 and 100 percent, potentially leading to some response bias. A future evaluation should also analyse the experiences of senior student facilitators, given that they were not formally evaluated as part of the present feasibility study. Finally, this survey was based on a single data source, with no follow up. Although not a primary objective of the current evaluation, the three week timeframe did not enable the measurement of behavioural change in student participants, facilitators or teachers. Furthermore, a longitudinal investigation of the implementation of the test battery over two or more occasions, with the addition of qualitative forms of evaluation such as focus groups, would provide a more comprehensive overview of the fidelity of the Youth-fit test battery.

Conclusion

This study demonstrated that the Youth-Fit test battery and software platform represents a feasible, pedagogically sound and scientifically rigorous approach to monitoring health-related fitness in schools. It adds an important contribution to the current literature as one of the first studies to empirically evaluate both students' and teachers' experiences of recommended best practice approaches to fitness testing in a physical education context. Physical education teachers should consider using a similar approach to that outlined in the current study when assessing students' health-related fitness, including, using senior student facilitators, allowing student participants the opportunity to familiarise and practice tests prior to testing day, and utilising a small group design. Furthermore, the Youth-fit software infrastructure confirmed the capacity for large-scale collection of objective measures of health and physical fitness from population-based samples. Refinements to the number of test items, the time allocated for administering the test battery, and enhancing the reporting infrastructure on the software platform should be addressed in advance of a future expansion of the test battery.

Competing Interests

The authors have no competing interests to declare.

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