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Word Count: 5077

Implementing a school-based physical activity program: process evaluation and impact on teachers' confidence, perceived barriers and self-perceptions

Introduction: Secondary schools have the potential to promote health-related fitness (HRF) and physical activity within and outside school hours. As such, schools are often chosen as the setting to implement child and adolescent physical activity programs. School-based programs often utilise teachers as delivery agents, but few studies examine effects on teacher-level outcomes.

Purpose: The primary aim of this study was to determine the impact of teacher training embedded within a physical activity intervention on teacher-level outcomes. The secondary aim of this study was to evaluate process data, including implementation, satisfaction and fidelity.

Methods: *Resistance Training for Teens* (*RT for Teens*) was evaluated using a cluster randomised controlled trial in 16 secondary schools. Teachers (N=44; 48% female/52% male; mean±SD years teaching experience=10.6±8.0) from 16 secondary schools were assessed at baseline. Intervention group teachers (i.e., from eight schools) delivered a structured school-based physical activity program over 10-weeks. Teacher outcomes included confidence to teach health-related fitness (HRF) activities, perceived barriers to teaching HRF activities, and perceived fitness. Detailed process evaluation data were also collected. Assessments were conducted at baseline and 6-months (post-program), and outcomes were assessed using repeated measures analysis of variance.

Results: There was a positive group-by-time effect for the confidence composite score (p = .010, partial eta squared = 0.29), but no effects for the two (contextual, interpersonal) barrier composite scores. Also, there was a significant effect for perceived 'general fitness' (p = 0.044, partial eta squared = 0.13), but not for specific fitness subdomains. Teachers were highly satisfied with both the training and the program, believing it was beneficial for students. Resource usage and adherence to the SAAFE (Supportive, Active, Autonomous, Fair, Enjoyable) delivery principles was high.

Conclusion: *RT for Teens* improved teachers' confidence and perceived fitness. These findings highlight the potential for high-quality teacher training and program delivery to positively influence teacher-level outcomes. This may provide support for the use of teacher professional development to improve HRF-related pedagogy.

Keywords: resistance training; intervention; muscular fitness; professional learning; process evaluation

Summary

Resistance Training for Teens (*RT for Teens*) is a 10-week school-based physical activity program, which focuses on improving the health-related fitness (HRF) of secondary school students. The intervention was delivered by teachers following a one-day accredited professional development workshop, addressing all aspects of program content and delivery. Teachers were also provided with resources and an equipment pack. *RT for Teens* includes: i) an interactive student seminar; ii) a structured physical activity program, focusing on RT; iii) lunchtime fitness sessions; and iv) a purpose-built smartphone app. Participation in *RT for Teens* had a significant impact on teachers' overall confidence to teach HRF activities and perceptions of their own fitness. These findings highlight the potential for a teacher-led physical activity program, incorporating professional development, to positively impact teachers' knowledge, skills and confidence, as well as their own self-perceptions.

Introduction

Regular physical activity during childhood and adolescence provides numerous physical (Janssen and LeBlanc 2010) and mental (Lubans, Richards, et al. 2016) health benefits. Despite these wide-ranging benefits, 80% of adolescents worldwide are not acquiring the minimum amount of physical activity needed to enhance health (Hallal et al. 2012). Although the importance of cardiorespiratory fitness for health is well established (Blair et al. 1989), recent evidence demonstrates the unique health benefits of achieving and maintaining adequate muscular fitness (Smith, Eather, et al. 2014). For example, muscular fitness may be an independent protective factor in the development of cardiovascular disease risk (Steene-Johannessen et al. 2009), as adolescents with a high level of muscular fitness have a healthier lipid-metabolic profile independent of cardiorespiratory fitness (Artero et al. 2011; García-Artero et al. 2007). For this reason, it is important children and adolescents are provided with opportunities to engage in both cardiorespiratory and muscle-strengthening (hereafter referred to as resistance training [RT]) activities on a regular basis.

Secondary schools (i.e., grades 7-12, students aged ~12-18 years) have the potential to promote physical activity and improve health-related fitness (HRF) by providing opportunities within (e.g., PE) and outside (e.g., before and after school) school hours (Centers for Disease Control and Prevention 2013; International Union for Health Promotion and Education 2009). Specifically, schools have the expertise and resources to implement school-based programs that help students' develop knowledge, skills and confidence to be physically active now and into the future (Hills, Dengel, and Lubans 2015). Of note, the majority of school-based physical activity programs utilise teachers as the primary delivery agents (Sharma 2007). Consequently, the long-term sustainability of such programs depends on the likelihood that teachers will continue

implementation after research-oriented resources are withdrawn (Hung et al. 2014; Langford et al. 2015). A number of teacher-level factors may contribute to the sustainability of school physical activity programs. For example, low teaching confidence, lack of expertise/qualification, and other institutional barriers have been shown to impact both the time spent delivering PE, and the quality of PE lessons (Morgan and Hansen 2008; Nathan et al. 2017). Presumably, these factors would be equally (or even more) relevant for the delivery of physical activity programs that are not part of the usual school curriculum. In light of this, it is important to target teacher-level competencies within school-based physical activity interventions, and to evaluate the impact of intervention strategies targeting these factors.

Finally, it is necessary to evaluate the intervention process, to assist in determining fidelity and implementation rigor and how this may have impacted outcomes (Craig et al. 2008). Despite these recommendations, few school-based physical activity interventions include comprehensive process evaluations (Brown and Summerbell 2009; Dobbins et al. 2013), and analysis of intervention effects on teacher-level outcomes are rarely conducted. This is a major shortfall when evaluating intervention effectiveness, as individuals (i.e., the teachers) and the implementation process (i.e., process evaluation) are two of the major domains presented in the Consolidated Framework for Implementation Research (Damschroder et al. 2009). Teachers have a major influence over the adoption and implementation of physical activity interventions in schools, therefore it is essential to determine the impact of interventions on teacher-level outcomes. Likewise, the process of intervention uptake and delivery require evaluation to determine best practice and to continually improve the intervention (Carroll et al. 2007). Therefore, the primary aim of the current study was to determine the impact of the school-based Resistance Training for Teens (RT for

Teens) intervention on teachers' confidence, perceptions of barriers, and perceived fitness. The secondary aim of this study was to evaluate process data, including implementation, program satisfaction and fidelity, to assert what program components were being delivered and teacher's perceptions of program effectiveness.

Methods

Study design and participants

The design and methods (Lubans, Smith, et al. 2016), and student outcomes (Kennedy et al. 2017) have been reported in detail previously. Briefly, *RT for Teens* was evaluated using a cluster randomised controlled trial (RCT), which adhered to the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) (Chan et al. 2013) and Consolidated Standards of Reporting Trials (CONSORT) (Moher et al. 2010) guidelines. Students involved in the *RT for Teens* intervention significantly improved their muscular fitness, resistance training skill competency and resistance training self-efficacy at 6-months (Kennedy et al. 2017). Ethical approval for this study was obtained from the Human Research Ethics Committees of the University of Newcastle and New South Wales (NSW) Department of Education, Australia. School principals, teachers, parents, and students all provided informed written consent/assent. Government-funded secondary schools located within the Hunter, Central Coast and Sydney regions of NSW, Australia were eligible for inclusion, with 16 co-educational secondary schools recruited (81 invited, 54 did not respond, 11 declined). Following baseline assessments, schools were match-paired based on core demographics and randomized to either the intervention group (n=8) or the wait-list control group (n=8) by an independent researcher using a computer-based random number producing algorithm. In NSW, the academic year is divided into four school terms (~10 weeks). The intervention was delivered over one school term (July – September, 2015 [Term 3]), with pre- (April –

June, 2015) and post-test (October – December, 2015) data collection occurring in the preceding and subsequent terms, respectively. This resulted in a period of approximately 6-months between pre- and post-test measurements. Participants for the present study were teachers of Grade 9 students, enrolled in the *RT for Teens* cluster RCT.

Intervention

The intervention was guided by Social Cognitive Theory (SCT) (Bandura 2004) and Self-Determination Theory (SDT) (Deci and Ryan 1985), and included the following gender-targeted components: i) an interactive student seminar; ii) a structured physical activity program, focused on RT; iii) lunchtime fitness sessions; and iv) a purpose-built smartphone app. The structured physical activity program followed a specified session format, including: i) movement-based games and dynamic stretching warm-up; ii) RT skill development using bodyweight and resistance band exercises; iii) 7-minute high intensity RT (HIRT) workout; iv) modified game involving fitness infusion, boxing, or core strength activity; v) static stretching cool down including discussion of key behavioural messages (regarding physical activity, screen-time, and healthy eating). These sessions were intended to be delivered for approximately 90 minutes per week, during co-curricular school sport, PE, or an elective subject known as 'Physical Activity and Sports Studies' (PASS). All students within the sport group/class participated in the sessions (regardless of whether or not they consented to participate in the research evaluation), unless unable due to injury or illness. Where intervention students completed the sessions via PE, the program replaced PE for the intervention period, and these students also participated in regularly scheduled co-curricular school sport and PASS (if selected as an elective subject) as per the usual curriculum. The following implementation strategies were also utilised: i) recruitment of school champions (i.e.,

teachers); ii) professional development workshop for teachers; iii) teacher instruction handbook; iv) session resources; v) fitness equipment; and vi) physical activity session observation and feedback (i.e., a member of the research team observing and providing feedback to the teacher).

The full day professional development workshop for teachers was delivered by members of the research team, all of whom held a tertiary qualification in Physical Education. During the workshop, the 'SAAFE' (Supportive, Active, Autonomous, Fair, and Enjoyable) teaching principles (Lubans et al. 2017) were introduced. The SAAFE principles reflect an attempt to operationalise the basic psychological needs posited by SDT (Lubans, Morgan, Weaver, et al. 2012), and served as the framework for the design and delivery of the physical activity sessions, as well as the session observations. Teachers were given a rationale and description of the SAAFE principles and provided with strategies for integrating the principles within their lessons. They were also given opportunities to practice implementing these strategies during the workshop, to develop confidence and skills in their delivery. The SAAFE principles, and the associated practical strategies, were also reinforced during session observations. Consistent with SDT (Deci and Ryan 1985), the SAAFE principles encouraged teachers to satisfy students' basic psychological needs (for autonomy, competence, and relatedness), to promote autonomous motivation. Regarding SCT (Bandura 2004), the professional development workshop also introduced teachers to strategies for enhancing students' resistance training self-efficacy. These strategies included providing feedback related to effort and involvement, demonstrating correct technique, and encouraging participation. Additionally, teachers were advised to participate with students during the physical activity program when possible, as a potential means to improve their own self-efficacy, physical activity behaviour and personal fitness levels. More detail regarding the

intervention components and implementation strategies are provided in Table 1. The control group participated in usual practice (regularly scheduled PE, PASS or co-curricular school sport) for the duration of the intervention and received the intervention after 12-month follow-up assessments.

(insert Table 1 about here)

Outcomes

Teachers completed a questionnaire to obtain demographic information, including gender, age, years of teaching experience, area of specialisation, and attainment of other HRF-related qualifications.

Confidence to teach HRF activities

Assessed using an adapted version of an existing scale (Morgan and Bourke 2008). The original items applied to a variety of learning activities, which are typically taught as part of the PE curriculum. For this study, seven questions were included, answered on a six-point scale (i.e., 1 = *Strongly Disagree* to 6 = S*trongly Agree*). The common stem *"I feel confident teaching…"* was employed, with items adapted to apply only to the teaching of HRF activities. Items included: i) body weight RT, ii) elastic tubing and resistance band RT, iii) boxing, iv) Pilates, v) yoga, vi) skipping, and vii) CrossFit style activities. A composite score was calculated for "overall" confidence to teach HRF, by determining the mean of the seven individual components, with Cronbach's alpha calculated at baseline ($\alpha = .82$) and 6-months ($\alpha = .84$).

Barriers to teaching HRF activities

Evaluated using items adapted from an existing scale, originally applied to delivering the health and PE curriculum (Morgan and Hansen 2008). The adapted scale included

many of the same barriers as the original, but focused on barriers to the delivery of HRF activities specifically, with additional barriers relevant to HRF activities added to the scale. A total of 10 barriers were included, with teachers responding using a six-point scale (i.e., 1 = *No barrier or does not inhibit* to 6 = *Major barrier or strongly inhibits*). Two composite scores for the barriers were calculated, adapted from a previous framework (Cane, O'Connor, and Michie 2012). A *contextual* barrier was calculated by determining the mean of six individual barriers: i) inadequate facilities/space; ii) class size too big; iii) lack of time; iv) inadequate equipment; v) litigation concerns; and vi) lack of money budgeted to programs. An *interpersonal* barrier was calculated by determining the mean of four individual barriers: i) negative executive attitudes; ii) lack of departmental assistance; iii) negative student attitudes; and iv) poor level of staff support. Cronbach's alpha was calculated at baseline and 6-months, for the *contextual* (α = .72, .77) and the *interpersonal* (α = .81, .80) barrier composite scores, respectively.

Perceived fitness

Self-reported using the International Fitness Scale (IFIS), which has previously shown validity and reliability in adults (Álvarez-Gallardo et al. 2016). The IFIS is a five-item instrument in which participants report perceptions of their 'general fitness' and four other specific fitness components using a five-point scale (i.e., 1 = *Very poor* to 5 = *Very good*).

Process evaluation

A detailed process evaluation was conducted and included: i) intervention implementation (e.g., total number of sessions delivered); ii) teacher satisfaction with the professional development workshop; iii) overall program satisfaction; iv) fidelity (e.g., compliance with the proposed session structure [see Table 2]); and v) adherence to

SAAFE delivery principles. Fidelity and SAAFE adherence was determined using two session observations (per class) during the intervention period, one scheduled during weeks 3-5 of the school term, and the second during weeks 7-9. Session observations were conducted by members of the research team, all of whom held a tertiary PE teaching qualification. Sessions were given an overall score (possible range = 0 to 8), calculated as the sum total of eight suggested lesson components (see Table 2). Adherence to the SAAFE principles was determined using a 16-item checklist, with items recorded on a 5-point scale (i.e., 1 = Not at all true to 5 = Very true), with a value assigned to each of the 16 specific strategies covered during the teacher training (see supplementary Figure 1). Based on these scores, a percentage was calculated by summing the mean for each of the strategies and dividing by the maximum possible score, for each of the SAAFE principles. Teachers were asked to record any injuries or adverse events that occurred during any of the sessions.

(insert Table 2 about here)

Statistical analyses

A repeated measures analysis of variance was used to assess the impact of the *RT for Teens* intervention on teacher outcomes from baseline to 6-months. IBM SPSS Statistics for Windows, Version 20.0 (2010 SPSS Inc., IBM Company Armonk, NY) was used for the analysis, with significance set at $p < 0.05$. The analyses assessed the significance of the treatment-by-time interaction. Time was used as the within-subject factor, and treatment the between-subject factor. Verification of homogeneity of inter-correlations and variance was met by all outcomes when assessed using the Levene's test. Differences between those who completed the 6-month questionnaire, and those who did not, were examined using independent samples t-tests. Descriptive statistics are provided for process measures (i.e., implementation, satisfaction, and fidelity).

Results

Sixteen schools were recruited, with 44 teachers (27 intervention, 17 control) assessed at baseline (48% female, 52% male, mean±SD years teaching experience=10.6±8.0). Baseline characteristics of the study sample can be seen in Table 3. The most highly represented age group were those aged 26-30 years (27%), and the majority (64%) of teachers were 'Health and PE' trained. Other teaching specialties included: Dance (2%), English (2%), Human Society and Its Environment (16%), Mathematics (2%), Science (2%), and Technology and Applied Studies (9%). Almost half of all teachers (48%) had at least one additional qualification relating to teaching/coaching HRF. Post-intervention (6-month) questionnaires were completed by 34 (77%) teachers. Teachers who were unable to complete the questionnaire on the day (i.e., those absent, working in a different position, or who had moved schools) were sent an electronic copy via email, however few of these were returned. Participants who did not complete 6-month questionnaires reported higher confidence to teach HRF at baseline (p = 0.012). Within- and between-group changes in confidence to teach HRF, barriers to teaching HRF, and perceived fitness are presented in Table 4.

(Insert Table 3 about here)

Intervention effects for teachers' confidence, perceived barriers, and self-perceptions

A statistically significant group-by-time effect was found for confidence to teach HRF activities, F (2, 31) = 7.52, p = .010, partial eta squared = 0.19. This medium-to-large effect suggests teachers in the intervention group experienced greater improvements in their confidence to teach HRF compared to the control group. Regarding barriers to teaching HRF activities, there were no group-by-time effects for contextual barriers, F (2, 30) = 0.78, p = .384, partial eta squared = 0.03, or interpersonal barriers, F (2, 30) =

0.04, p = .849, partial eta squared = 0.00. Finally, there was a significant group-by-time interaction for teachers' perceived general fitness, F (2, 30) = 4.41, p = .044, partial eta squared = 0.13, indicating a medium-to-large effect in favour of teachers in the intervention group. However, there were no group-by-time effects for any of the specific subdomains of perceived fitness (*p's* > .05).

(Insert Table 4 about here)

Process evaluation

Implementation and program satisfaction

Implementation and program satisfaction data are presented in Table 5. Teachers delivered over 80% of intended *RT for Teens* sessions during the 10-week intervention period, but incomplete data precluded an evaluation of lunch-time session delivery. Regarding the professional development workshop, teachers were highly satisfied and believed that it provided them with useful information and skills to improve their teaching. Teachers rated the *RT for Teens* program as *'excellent'*, with consistent belief that it was enjoyed by, and beneficial for their students. Teachers '*strongly agreed'* that delivering the program was enjoyable, and indicated students were sufficiently active during practical sessions. Data show lunch-time sessions were not as successful as those delivered during class time, with teachers reporting '*neutral*' success, and perceived student enjoyment of these sessions. However, teachers '*agreed'* that delivering the lunch-time sessions was enjoyable. On average, teachers *'agreed'* that adequate program support was provided, and contact from the research team was helpful. Teachers *'strongly agreed'* that program resources were sufficient for delivery of the *RT for*

Teens program and that the teacher handbook was practical. However, evaluation of the smartphone app indicated that teachers did not believe it was very useful.

(Insert Table 5 about here)

Intervention fidelity

Intervention fidelity, based on research team observations of physical activity sessions, is presented in Table 6. Overall, resource usage was high, with over 90% of observed lessons including either, or a combination of, the circuit cards (see Figure 2 for example), teacher handbook, resistance band devices (i.e., Gymstick), or smartphone app. During the second half of the intervention period however, there was a slight decrease in resource usage (i.e., from 94% to 88%). An average of six suggested session components were included by teachers during observed sessions, which remained consistent throughout the intervention period. Including *movement-based games within the warm-up* and including a *HIRT workout* were the most commonly included components (i.e., almost 90% of lessons). When looking at the two lesson observations separately, a number of differences emerged were evident. During observation one, over 90% of lessons included the session components *movement-based games within the warm-up* and *RT skill development*. During the second observation, inclusion of these components decreased (from 94% to 81%, and 94% to 75%, respectively), and there was a notable increase in the inclusion of *Pilates/yoga style activities* and *fitness infused games* (from 47% to 56%, and 29% to 63%, respectively). Of note, including a *HIRT workout* remained consistent across both observation points (remaining at 88%).

(Insert Table 6 and Figure 2 about here)

SAAFE adherence

SAAFE adherence, also based on research team observations of physical activity

sessions, is presented in Table 7. Adherence to the SAAFE teaching principles was high amongst teachers, with all elements evident in 80% of lessons. During the first lesson observation, the most commonly observed strategies for each of the SAAFE elements were: i) *providing skill specific feedback* (Supportive); ii) *plentiful equipment* (Active); iii) *students involved in set-up and running of activities* (Autonomous); iv) *students are evenly matched in activities* (Fair); and v) *session starts with an enjoyable activity,* and *included a wide variety of activities* (Enjoyable). During the second observation, adherence to the SAAFE principles increased slightly, with all elements apparent in 85% of lessons observed. During this observation period, the most common strategies utilised for each of the principles changed, with the following becoming most prevalent: i) *feedback on student effort and enjoyment* (Supportive); ii) *monitoring of student activity levels* (Active); iii) *students involved in set-up and running of activities,* and *choice regarding activities* (Autonomous); iv) s*tudents evenly matched in activities,* and *teacher rewarding good sportsmanship* (Fair); and v) *session finishes with an enjoyable activity* (Enjoyable). No injuries or adverse events were recorded by any of the teachers involved in the study.

(Insert Table 7 about here)

Discussion

The primary aim of this study was to evaluate the effect of the *RT for Teens* intervention on teacher-level outcomes. The secondary aim of this study was to evaluate process data, including implementation, program satisfaction and intervention fidelity. Our findings indicate the *RT for Teens* intervention resulted in significant improvements in teachers' overall confidence to teach HRF activities and their perceived general fitness. However, there were no effects on teachers' perceived barriers to teaching HRF activities. To the authors' knowledge, this is one of very few studies examining the

effects of a school-based physical activity program on teacher-level outcomes.

Delivering HRF activities in the school setting has been identified as an effective method of promoting physical activity, but low teacher confidence is likely to influence the delivery of such activities in schools (Alfrey, Cale, and A. Webb 2012). Thus, the improvement in teachers' overall confidence to teach HRF activities was a promising finding. There are a number of potential explanations for this finding, which may have operated independently or in conjunction. First, teachers' content knowledge and fitness-related pedagogy likely improved following the professional development workshop. As recommended by Morgan et al. (2016) the professional development workshops were delivered by credible (tertiary educated) and relatable (former teachers) presenters. These characteristics are important drivers of teacher engagement and their subsequent learning during the workshop. The workshop also followed recommendations provided by Su and Reeve (2011) to support autonomy and task engagement, through both knowledge and skill-based training practices. Process data collected following the workshop supported the usage of presenters with these dispositions, and this training style, as teachers indicated they had gained useful information and skills (4.9±0.3 out of 5).

The provision of quality training appears to be a prominent contributor to the effective implementation of school physical activity programs (Naylor et al. 2015). It was therefore encouraging to find teachers in the present study reported high levels of satisfaction with the professional learning workshop (5.0±0.0 out of 5). Teachers who are satisfied with program content are more likely to adopt and implement programs as intended (Lander et al. 2017). The theoretical and practical aspects of the workshop, and the relevance of the content to the teachers interests likely elicited greater engagement (Lander et al. 2017).

Teachers in the current study were provided with a suite of purpose-designed resources, which included circuit cards, a teacher handbook (with information on session structure, warm-up examples, and workout templates), fitness equipment and access to a smartphone app (see Table 1). The provision of these resources may have contributed to improvements in teachers' confidence, as the resources were designed to reduce the organisational and instructional burden on teachers, making sessions easier to deliver. For example, the circuit cards provided a scaffold for teachers to give skill-specific feedback to students rather than having to recall this information from memory. Our process data support this, showing teachers found session delivery easy (4.3±0.8 out of 5), and felt the resources provided were sufficient for delivering the program (4.7±0.4 out of 5). Of note, findings from a recent qualitative study with teachers participating in RT for Teens found the circuit cards were the most widely utilised and highly rated resource (Kennedy et al., 2018). The circuit cards were included within RT for Teens as a means to promote student's RT skill development (Fleck and Kraemer 2014), enabling student self-direction during the HRF sessions. As each card included an image and description of the exercise (with key technique points), it is understandable that teachers liked this resource, as it would have substantially reduced their instructional burden, and allowed them to focus their attention on students most in need of additional support. Taken together, these findings provide important insights for future intervention design. In particular, our process findings reinforce the importance of practical resources for enhancing program adoption and implementation (Naylor et al. 2015).

The feedback offered by the research team during the two lesson observations provided teachers with confirmation from a 'trusted source'. Supplemental follow-up, such as session observation feedback, has been identified as an important characteristic

of effective training programs (Su and Reeve 2011). Again, our process data provides some support for this claim, with teachers reporting high levels of satisfaction with the support they received from research staff (4.8±0.4 out of 5), and indicating that the session observations were helpful (4.7±0.5 out of 5). This is a promising finding, as a recent review identified a lack of follow-up support throughout the intervention as a concern when evaluating teacher professional development (Lander et al. 2017).

A recent systematic review cited 'environmental context and resources' and 'social influences' (analogous with 'contextual' and 'interpersonal' barriers, respectively) as commonly identified barriers to the implementation of physical activity programs in schools (Nathan et al. 2017). In light of this, it was surprising that baseline values for perceived barriers were low in both study groups. The characteristics of the teachers volunteering to participate in the intervention may also help in explaining this finding. It is likely these teachers had existing interest in exercise and health, and fewer perceived barriers to HRF delivery (perhaps due to prior experience in schools or elsewhere). As previously noted, most teachers enrolled in the RCT had a tertiary PE qualification, and close to half had additional qualifications in fitness instruction. However, these null findings could also be interpreted positively. As teachers in the intervention group were actively facilitating HRF activities during the trial period, they were differentially 'exposed' to potential barriers to delivery (compared with their control group counterparts). There was the potential for intervention group teachers to report an 'increase' in perceived barriers relative to the control group, as they may have underestimated the impact of specific barriers prior to having to face them within the intervention. Fortunately, this did not happen, as teacher-reported barriers remained low at post-test.

To the authors' knowledge, this is the first evaluation of a school-based physical activity intervention to report findings for teachers' perceived fitness. During the training day, teachers were informed of the motivational benefits of teacher co-participation in program activities, and were encouraged to participate alongside students. This could explain the finding for perceived fitness, as regular co-participation in the RT for Teens sessions may have improved teachers' fitness (as it did for students) (Kennedy et al., 2017). Even if teacher co-participation was not common, it is possible their involvement in the intervention led to a heightened awareness of their own health and fitness. As such, teachers may have altered their physical activity behaviours outside of school hours. Prior evidence has indicated physically active teachers are more likely to deliver school-based physical activity programs (Dowda et al. 2005). Our findings imply this association could be bidirectional, with involvement in school programs also reinforcing teachers' physical activity behaviour. While this would need to be confirmed, this finding extends upon evidence of the benefits of exercise programs for students' self-perceptions (Liu, Wu, and Ming 2015), by showing such programs may also result in self-evaluative benefits for teachers.

Lesson observation data indicated that teachers utilised diverse lesson formats and varied session components (i.e., GymFit, BoxFit, CoreFit etc.), supported by program resources. However, a number of changes were evident in the way teachers delivered the HRF sessions as the intervention progressed. Of note, there was a meaningful decline in the use of the RT skill development component (i.e., GymFit), and an increase in the use of Pilates/yoga style activities (i.e., CoreFit) and fitness infused games (i.e., GameFit) components, during the second observation. This finding could be attributed to improvements in students' movement skill competency (Kennedy et al. 2017), perhaps achieved through a focus on developing these skills early on in the

intervention. Once these skills were developed, teachers may then have focused on offering students alternative activities to promote variety and prevent boredom.

Interestingly, the delivery of the 7-minute HIRT workout remained consistently high at both observation points (i.e., 88% and 88%), which may be due to students' enjoyment and engagement with this session component (Kennedy et al. 2018). Some researchers insist 'high-intensity' physical activities are inherently unenjoyable due to predictable declines in positive affect as exercise intensity extends beyond the 'moderate' band (Ekkekakis, Parfitt, and Petruzzello 2011). However, teacher and student satisfaction with the HIRT workouts, further supported by the consistent presence of this component in the observed sessions, implies that perhaps qualitative aspects of the exercise experience can influence students' affective evaluations. This has implications for future interventions that aim to deliver vigorous physical activities in a way that is palatable for students and teachers.

A worthwhile finding from the process evaluation was the lower than desired ratings for the lunch-time physical activity sessions, compared to those delivered during class time. This finding is consistent with previous trials conducted in secondary schools (Smith, Morgan, et al. 2014; Lubans, Morgan, Okely, et al. 2012; Peralta, Jones, and Okely 2009). Teachers' indicated this was due in part to a lack of student interest in 'giving up' their break time to participate in HRF sessions. For example, one teacher indicated these periods were only successful for a minority of (presumably more motivated) students, commenting that *"Most (students) were not willing to give up their lunch time, the ones that did really enjoyed it"*. Break periods are an attractive opportunity to increase the 'dose' of physical activity delivered within school-based programs (Smith, Lubans, and Lyn 2017), particularly for those offered via PE or co-curricular school sport which are usually not scheduled as frequently. However, the

utilisation of these periods must be considered in tandem with students' and teachers' willingness to use them for this purpose. Although teacher-reported satisfaction of the lunch-time sessions (both for themselves and students) was generally neutral, they was clearly less popular than the sessions offered during other periods (i.e., 4.3±0.9 versus 3.4±1.3 for perceived student enjoyment of 'regular' versus 'lunch-time' sessions, respectively).

Strengths and limitations

Strengths of this study include the cluster RCT design, novel teacher outcome measures, relatively high participant retention, and comprehensive process evaluation. However, there are some limitations that should be noted. First, the self-report nature of the outcome measurements opens up the possibility for social desirability bias. Second, only two observations were completed per class within the 10-week intervention period, and it is possible the observed sessions were delivered to a higher standard due to the presence of an observer (i.e., Hawthorne effects). Finally, incomplete process evaluation data (i.e., teacher records) limited our ability to evaluate the frequency of lunch-time session delivery. Therefore, it is unclear whether this component was delivered as intended.

Conclusions and implications for teacher practice

The *RT for Teens* intervention was successful in improving teachers' confidence to deliver HRF activities and their perceived fitness, but not in improving perceived barriers to teaching HRF activities. Our findings add to the literature showing the potential for a multi-component intervention, incorporating teacher professional learning, resource provision, and support and feedback mechanisms to positively impact teacher-level outcomes, such as confidence to teach and perceived fitness. More

research is needed to determine the impact of improving teacher confidence on outcomes for students. Indeed, if such changes were shown to moderate or mediate the effectiveness of interventions on student health and wellbeing, this would be of significant value for future intervention design.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research project was supported by the Australian Research Council (Grant number: FT140100399), the Department of Education School Sport Unit, and an Australian Government Research Training Program Scholarship.

Acknowledgements

The authors would like to thank the Australian Research Council and the Department of Education School Sport Unit (with special thanks to Ross Morrison and Sue Meade). The authors would like to thank the participating schools, students and teachers for their support and cooperation throughout the project.

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Table 1. Description of intervention components and implementation strategies

Table 2. Proposed physical activity session structure

Table 3. Baseline characteristics of the study sample

Table 4. Confidence to teach HRF, barriers to teaching HRF and perceived fitness for intervention and control group teachers at two time-periods

Table 5. Implementation and program satisfaction

Table 6. *RT for Teens* physical activity session fidelity

Table 7. Adherence to SAAFE delivery principles during session observations

Figure 1: Circuit card example

Supplemental Figure 1: Lesson observation checklist

Table 1. Intervention and implementation description

Component/strategy	Description
Intervention components	
1. Interactive student seminar	*Teacher delivered* – Provided key information regarding the program components (i.e., RT) and behavioral messages (i.e., move whenever you can, get some vigorous physical activity, limit screen-time, sometimes foods and sugar-sweetened beverages). It also provided an overview of the purpose-built smartphone app and its functions. The student seminar was designed to engage the students, integrating videos and websites, student quizzes and opportunities for student input and discussion.
2. Structured physical activity program	*Teacher delivered* – A uniform structure was followed for these sessions, which included activities such as: bodyweight and elastic tubing RT, HIRT fitness challenges, strength-, flexibility- and aerobic-based activities, and modified game involving fitness infusion. Behavioral messages were also reinforced throughout the sessions.
3. Lunch-time fitness sessions	*Student directed* – Teachers were asked to facilitate a minimum of five lunchtime sessions over the 10-week intervention period, as an opportunity for students to demonstrate leadership skills by organizing and running these sessions under teacher supervision.
4. Purpose-built smartphone app	The app included: 1) an exercise library (of predominantly RT exercises) with GIF animated images and descriptions of exercises; 2) a list of 7 min HIRT workouts of varying intensities with built-in count-down timer and results entry option; 3) the RTSB checklist for evaluating and improving RT movement skill competency; 4) tailored motivational messaging reinforcing the five behavioral messages; 5) self-monitoring function for recording and reviewing physical activity; and 6) goal setting to promote participation in MVPA. Incorporating smartphone technology allows for timely and increased accessibility to resources to promote physical activity and health, also offering innovative and engaging ways to teach the students important behavioral skills of self-monitoring and goal setting.
Implementation strategies	
1. Recruitment of school champions	Two champions were recruited from each school, acting as the study organizers. Duties included: liaising with research team, recruiting students, program delivery, facilitation of lunchtime sessions and organizing study assessments.
2. Professional learning workshop for teachers	Two male and two female teachers from each intervention school were invited to attend the one day professional development workshop which addressed all aspects of the *RT for Teens* intervention. This included: 1) teacher roles and expectations; 2) intervention components; 3) introduction to RT and safety implications; and 4) philosophy of the programs, including an explanation and examples of the 'SAAFE' teaching principles. This workshop was certified with BOSTES, the professional body responsible for teacher certification and professional learning accreditation within the NSW Government schooling system as an incentive for participation.
3. Provision of resources and equipment pack	Schools were provided with two facilitator handbooks and two sets of circuit cards (one NEAT and one ATLAS of each), and two fitness equipment packs which included: 15 Gymstick resistance band devices, 5× skipping ropes, 5× sets of boxing gloves and focus pads, 2× agility ladders, and 1× suspension strap.

4. Physical activity session observation and feedback	Two *RT for Teens* sessions at each intervention school were observed by members of the research team using a structured SAAFE observation checklist. The checklist was used to assess intervention fidelity and provide feedback to teachers. Fidelity was assessed as compliance with the proposed session structure (provided in Table 2).

Abbreviations: RT, resistance training; HIRT, high-intensity resistance training; NEAT, Nutrition and Enjoyable Activity for Teens; ATLAS, Active Teen Leaders Avoiding Screen-time; RTSB, resistance training skills battery; MVPA, moderate-to-vigorous physical activity; SAAFE, Supportive, Active, Autonomous, Fair, and Enjoyable; NSW, New South Wales; BOSTES, Board of Studies, Teaching and Educational Standards.

Table 2. Proposed Resistance Training for Teens physical activity session structure

Activity	Purpose	Explanation	Timing
1. Warm-up	• Safety	• General warm-up involving movement based games and dynamic stretching	3-5 mins
2. GymFit	• Develop RT movement skills	• Circuit or workout consisting of Gymstick and body weight exercises • Opportunities for student choice • Moderate intensity exercise • Emphasis on skill development and improving technique	20-30 mins
3. HIRT workout	• Improve CRF and muscular fitness	• Short, high intensity workout • Pre-designed workout completed without rest for 7 minutes • Performed in pairs. Partner counts reps, monitors technique and provides encouragement. Partners swap after 7 minutes. • Result recorded as number of 'rounds' within 7 minute period	14 mins
4. Select from: i) GameFit ii) BoxFit/CardioFit iii) CoreFit	• Enjoyment • Student choice	• Students may decide to participate in a boxing/aerobic circuit (i.e., BoxFit/CardioFit), a Yoga/Pilates session (i.e., CoreFit), or play a modified game with fitness infusion (i.e., GameFit). • Teachers may facilitate multiple activities during this period	20-30 mins
5. Cool down	• Reinforce messages • Consolidate learning	• Static stretching and light activity • Discuss *RT for Teens* behavioral messages • Reinforce key skill components or concepts	5 mins

Abbreviations: RT, resistance training; HIRT, high-intensity resistance training; CRF, cardiorespiratory fitness

Table 3. Baseline characteristics of the study sample

Characteristics	Control (n=17)	Resistance Training for Teens Intervention (n=27)	Total (n=44)
Age range (y), %			
21-25	23.5	7.4	13.6
26-30	23.5	29.6	27.3
31-35	29.4	14.8	20.5
36-40	0.0	29.6	18.2
41-45	11.8	7.4	9.1
46-50	0.0	7.4	4.5
51+	11.8	3.7	6.8
Female participants, %	52.9	44.4	47.7
Years of teaching experience, mean (SD)	9.2 (9.2)	11.5 (7.2)	10.6 (8.0)
Area of teaching specialty, %			
PDHPE	58.8	66.7	63.6
Other[a, b]	35.4	33.3	34.1
Dance	0.0	3.7	2.3
English	0.0	3.7	2.3
Human Society and Its Environment	23.6	11.1	15.9
Mathematics	0.0	3.7	2.3
Science	5.9	0.0	2.3
Technology and Applied Studies	5.9	11.1	9.0
Other qualifications related to teaching/coaching health-related fitness, %[c]			
Yes	58.8	40.7	47.7
No	35.3	59.3	50.0

[a] One participant in the control group did not report their teaching specialty
[b] Some teachers nominated multiple 'Other' teaching specialties. In these cases, the first specialty was included in the calculation of percentages.
[c] One participant in the control group did not report whether or not they had other qualifications related to teaching/coaching health-related fitness.

Table 4. Confidence to teach HRF, barriers to teaching HRF and perceived fitness for intervention and control group teachers at two time-periods

	Group	Baseline			6-months			Wilks' Lambda	*F*	6M group-by-time	Effect size[a]
		n[b]	M (95% CI)	SD	n[b]	M (95% CI)	SD			***p***	
Confidence to teach HRF activities											
Overall composite score	INT	22	4.1 (3.8 to 4.5)	0.9	22	4.9 (4.6 to 5.3)	0.7	0.81	7.52	0.010	0.19
	CON	12	4.3 (3.8 to 4.9)	0.9	12	4.5 (4.0 to 4.9)	0.8				
Barriers to teaching HRF activities											
Contextual composite	INT	21	2.9 (2.5 to 3.3)	0.9	21	2.6 (2.2 to 3.0)	0.9	0.98	0.78	0.384	0.03
	CON	12	2.8 (2.2 to 3.3)	0.8	12	2.7 (2.2 to 3.2)	0.9				
Interpersonal composite	INT	21	2.5 (2.0 to 3.0)	1.2	21	2.5 (2.1 to 3.0)	1.1	1.00	0.04	0.849	0.00
	CON	12	2.5 (1.9 to 3.2)	1.0	12	2.6 (2.0 to 3.3)	1.0				
Perceived HRF											
Perceived general fitness	INT	21	3.6 (3.2 to 4.0)	1.0	21	4.0 (3.7 to 4.4)	0.8	0.88	4.41	0.044	0.13
	CON	12	4.3 (3.7 to 4.8)	0.6	12	4.2 (3.7 to 4.6)	0.6				
Perceived CRF	INT	21	3.5 (3.1 to 3.9)	0.9	21	3.9 (3.5 to 4.2)	1.0	0.92	2.65	0.114	0.08
	CON	12	4.0 (3.5 to 4.5)	0.7	12	4.1 (3.6 to 4.6)	0.7				
Perceived MF	INT	21	3.4 (2.9 to 3.8)	1.0	21	3.8 (3.4 to 4.3)	0.9	0.93	2.34	0.136	0.07
	CON	12	4.0 (3.4 to 4.6)	1.0	12	4.1 (3.5 to 4.7)	1.2				
Perceived speed/agility	INT	21	3.0 (2.6 to 3.4)	1.1	21	3.4 (3.0 to 3.8)	1.0	0.98	0.56	0.458	0.02
	CON	12	4.0 (3.4 to 4.5)	0.7	12	4.3 (3.7 to 4.8)	0.6				
Perceived flexibility	INT	21	3.2 (2.7 to 3.7)	1.2	21	3.5 (2.9 to 4.0)	1.3	0.99	0.34	0.566	0.01
	CON	12	3.1 (2.4 to 3.8)	1.0	12	3.3 (2.5 to 4.0)	1.2				

Abbreviations: BA, Baseline; 6M, 6-month; 12M, INT, intervention; CON, control; BMI, body mass index

Confidence scale: Participants self-report their confidence to deliver health-related fitness activities on a six-point scale ranging from *Strongly Disagree* (1) to S*trongly Agree* (6).

Barriers scale: Participants self-report their perceived barriers on a six-point scale, ranging from *No barrier or does not inhibit* (1) to *Major barrier or strongly inhibits* (6).

Perceived fitness scale: Participants report perceptions of their 'general fitness' and four other specific fitness components on a five-point scale, ranging from *Very poor* (1) to *Very good* (5).

[a] Effect size determined using Partial eta squared. Partial eta results = 0.01 (small), 0.06 (medium), 0.14 (large).

[b] One teacher in the intervention group completed only the first page of the post-intervention survey, resulting in a sample of 34 for the confidence to teach outcomes and 33 for the remaineder of the outcomes.

Table 5. RT for Teens implementation and program satisfaction

Intervention implementation	
Intended RT for Teens physical activity sessions delivered, %[a]	84 (11)
Satisfaction	
Teacher evaluation rating (professional learning workshop)	
Overall workshop satisfaction[b]	5.0 (0.0)
Useful information and skills[b]	4.9 (0.3)
Teacher evaluation rating (*RT for Teens* program)	
Overall program rating [c]	4.8 (0.4)
Delivery enjoyment[b]	4.8 (0.4)
Ease of delivery[b]	4.3 (0.8)
Student enjoyment[b]	4.3 (0.9)
Student benefit[b]	4.7 (0.5)
Program satisfaction[b]	4.6 (0.7)
Practical session enjoyment – teacher[b]	4.6 (0.5)
Practical session enjoyment – student (teacher's perception)[b]	4.2 (0.8)
Students sufficiently active[b]	4.5 (0.5)
Lunch time session enjoyment[b]	3.8 (0.7)
Success of lunch time sessions[b]	3.0 (1.4)
Enjoyment of lunch time sessions – student (teacher's perception)[b]	3.4 (1.3)
Student organisation/running of lunch time sessions[b]	3.0 (1.4)
SAAFE intention[b]	4.6 (0.5)
Program support[b]	4.8 (0.4)
Helpfulness of weekly email[b]	4.5 (0.5)
Helpfulness of observation[b]	4.7 (0.5)
Usefulness of App for teacher[b]	2.8 (1.3)
Usefulness of App for student (rated by teacher)[b]	2.5 (1.0)
Sufficient resources/equipment[b]	4.7 (0.5)
Practicality of Teacher handbook[b]	4.8 (0.4)

Note: All values reported are the mean (SD)

[a] of total sessions offered

[b] on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5)

[c] on a 5-point Likert scale ranging from poor (1) to excellent (5)

Table 6. RT for Teens physical activity session fidelity

	Observation 1	Observation 2	Mean
Intervention fidelity			
Use of resources, %[a]	94	88	91
Warm-up			
Includes movement-based game, %[b]	94	81	88
Includes dynamic stretching, %[b]	88	69	79
GymFit, %[b]	94	75	85
HIRT workout, %[b]	88	88	88
BoxFit, %[b]	35	19	27
CoreFit, %[b]	47	56	52
GameFit, %[b]	29	63	46
Cool down			
Includes static stretching, %[b]	77	75	76
Behavioral messages discussed, %[b]	71	63	67
Skill components reinforced, %[b]	65	63	64
Overall session score, /8[c]	6 (2)	6 (2)	6 (2)

[a]of observed lessons including resources
[b]of observed lessons including this specific lesson component
[c]mean (SD)

Table 7. RT for Teens physical activity session SAAFE adherence

	Observation 1	Observation 2	Mean
Adherence to SAAFE teaching principles			
Supportive, %[a]	89 (12)	90 (11)	89 (12)
Teacher provides individual skill specific feedback [b]	4.6 (0.6)	4.3 (0.8)	4.4 (0.7)
Teacher provides feedback on student effort and involvement [b]	4.3 (0.8)	4.7 (0.6)	4.5 (0.7)
Teacher promotes positive interactions between students [b]	4.4 (0.8)	4.5 (0.7)	4.5 (0.8)
Active, %[a]	89 (10)	87 (12)	89 (11)
Activities involve small-sided games and circuits [b]	4.6 (0.6)	4.2 (1.1)	4.4 (0.9)
Teacher monitors students' activity levels (visually or using pedometers) [b]	4.4 (0.9)	4.5 (0.7)	4.4 (0.8)
Equipment is plentiful [b]	4.9 (0.3)	4.3 (1.2)	4.6 (0.9)
Efficient transitions between activities [b]	4.2 (0.9)	4.3 (0.7)	4.3 (0.8)
Autonomous, % [a]	80 (12)	85 (20)	82 (16)
Teacher reinforces the relevance of the activities [b]	3.8 (0.8)	3.9 (1.4)	3.9 (1.1)
Students are given choices about the tasks and activities [b]	3.9 (0.9)	4.4 (0.8)	4.1 (0.9)
Students are involved in the set-up and running of activities [b]	4.3 (0.8)	4.4 (1.0)	4.3 (0.9)
Fair, % [a]	80 (14)	89 (14)	85 (15)
Teacher ensures that students are evenly matched in activities [b]	4.3 (0.8)	4.6 (0.9)	4.4 (0.9)
Teacher acknowledges and rewards good sportsmanship [b]	3.9 (0.9)	4.6 (0.6)	4.2 (0.8)
If necessary, teacher modifies activities to maximise opportunities for success [b]	4.1 (1.0)	4.2 (0.9)	4.1 (0.9)
Enjoyable, % [a]	86 (12)	93 (9)	89 (11)
Session starts with an enjoyable activity [b]	4.6 (0.7)	4.7 (0.7)	4.6 (0.7)
Session finishes with an enjoyable activity [b]	3.8 (1.1)	4.7 (0.6)	4.2 (1.0)
Session involves a wide variety of activities [b]	4.6 (0.7)	4.6 (0.8)	4.6 (0.8)

Note: All values reported are the mean (SD)

[a]calculated using the sum of all scores for that SAAFE element, divided by the highest possible score (i.e., 15 for supportive, autonomous, fair, and enjoyable; 20 for active)

[b] on a 5-point scale ranging from not at all true (1) to very true (5)

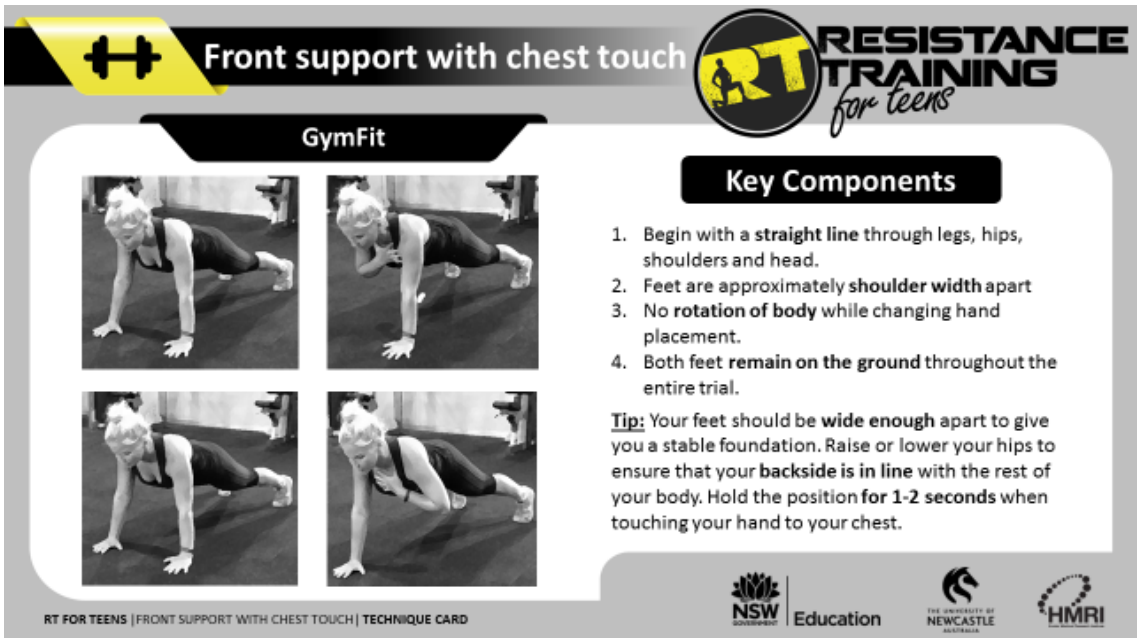

Figure 1: Circuit card example