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Thesis abstract

Teacher-facilitated high-intensity interval-training intervention for older adolescents: evaluation of the Burn 2 Learn program

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Background: Engaging in physical activity is associated with a plethora of health benefits for young people, with evidence suggesting that vigorous physical activity is particularly beneficial. Despite this, physical inactivity is a serious public health concern and is the fourth leading cause of death worldwide. Physical activity begins to decline during childhood and continues to decline with age, with behaviours established during this time tracking into adulthood. It is commonly agreed that schools have a unique platform to address this issue; however, previous school-based physical activity interventions have been relatively ineffective. Further, curriculum time dedicated to physical activity (i.e., physical education and school sport), is redirected towards other academic subjects (i.e., mathematics, science, and English) for students in their final years of schooling. This presents a clear challenge for researchers designing interventions targeting this age group. It also highlights the scope for novel approaches such as high-intensity interval training (HIIT) to be examined. Research examining the utility of school-based HIIT programs has gained traction in recent years; however, studies have been predominately conducted on a small scale. Further, while the physiological effects of this type of training have been well studied, the effects on mental health and cognition are relatively unknown.

Objective: The overarching aim of this thesis is to evaluate a school-based HIIT intervention for older adolescents. To do so, this thesis-by-publication presents a series of seven research papers, organised into three complementary yet distinct phases of research (Chapters 3–9). Chapters 3–9 are presented in order to reflect the following research progression: *scoping*, *feasibility and preliminary efficacy*, *effectiveness* (Figure 1.1).

Phase 1 — Scoping. Chapter 3: To systematically review and synthesise the effects of HIIT on cognitive and mental health outcomes in children and adolescents (Research aim 1). The physiological benefits of HIIT for adolescents are well established. Preliminary evidence also suggests that HIIT can improve young people's cognition and mental health; however, there has been no quantitative synthesis of the evidence. Therefore, a systematic search of six academic databases was conducted for experimental studies that examined the effects of HIIT on measures of cognitive function or mental health outcomes in children and adolescents. A total of 22 studies were included in the

review, of which 19 were included in the meta-analyses. Separate effects were conducted for acute and chronic studies, and for cognitive function (basic information processing and executive function), and mental health (well-being [affect], and ill-being) outcomes. For acute studies, a moderate effect was observed for executive function (ES = 0.50), while a small-to-moderate effect was found for affect (ES = 0.33) following HIIT. For chronic studies, HIIT resulted in a small overall effect for well-being (ES = 0.22), and small-to-moderate effects for executive function and ill-being (ES = 0.31 and 0.35, respectively). Although promising, due to the small number of studies included, and high heterogeneity, study findings should be interpreted with caution.

Phase 2 — Feasibility and preliminary efficacy. Chapter 4: To examine the feasibility and preliminary efficacy of a teacher-facilitated HIIT intervention for older adolescents (Research aim 2). Prior to its implementation in a large-scale effectiveness trial, the B2L intervention was pilot tested in two secondary schools in NSW, Australia. Specifically, this study evaluated the feasibility and preliminary efficacy in sample of older adolescents. Following baseline assessments, schools were randomised to receive a 14-week HIIT intervention (2–3 sessions/week) or instructed to continue regular practice (wait list control). Four domains of feasibility (recruitment, attendance, retention, and satisfaction) were assessed via process evaluation methods. A range of physical and mental health outcomes were also assessed at baseline and post-test. The intervention achieved high levels of recruitment and retention; however, adherence was lower than initially prescribed (1.9/week). Overall program satisfaction was high among both students and teachers (4.0/5). Significant effects were observed for cardiorespiratory fitness (8.9 laps) and mental health (–2.1 units), while no effects were found for muscular fitness or autonomous motivation. This study provided evidence for the feasibility of a teacher-facilitated HIIT intervention for older adolescents.

Chapter 5: To describe the feasibility requirements of administering a group-based cognitive test battery and examine the preliminary efficacy of a HIIT intervention on executive function (Research aim 3). Traditional assessments of executive function have limited utility in school-based research. Therefore, the aim of this study was to describe the feasibility requirements of administering a cognitive testing battery for older adolescents in the school setting. Participants completed a group-based testing battery assessing inhibition (flanker) and working memory (n-back) at baseline and 14 weeks following baseline assessments. Preliminary efficacy of a HIIT intervention and the associations between changes in fitness and changes in executive function were also examined. The testing battery was able to be conducted with up to six participants simultaneously, taking approximately 30 minutes to administer. Intra-class coefficient values demonstrated acceptable reliability among cognitive outcomes (ICC = 0.5–0.81), with significant changes in incongruent accuracy (flanker) and non-target accuracy (2-back). Regarding intervention effects, small-to-moderate effects (d = 0.15–0.37) were found for accuracy measures in favour of the intervention group, while several small associations were observed between changes in fitness and cognitive performance. Findings indicate that a group-based cognitive testing battery

is feasible to administer in a school setting. A larger and more representative sample is needed to confirm preliminary efficacy findings.

Phase 3 — Effectiveness. Chapter 6: To describe the rationale and study design for the B2L effectiveness cluster RCT (Research aim 4). This chapter describes the rationale and study protocol for the B2L effectiveness cluster RCT, which was conducted in 20 secondary schools from NSW, Australia. B2L is a 16-week school-based HIIT intervention for older adolescents in Year 11. This research paper details the study methodology of a cluster RCT, and extensively describes the intervention components and implementation strategies involved. Study outcomes include CRF (primary outcome), physical activity, muscular fitness, body composition, cognitive control, stress, psychological difficulties, autonomous motivation, psychological needs satisfaction, well-being, perceived fitness, HIIT self-efficacy, brain structure and function (sub sample) and on-task behaviour (sub sample). This study also describes a process evaluation to determine intervention fidelity. The results of this trial are presented in Chapter 9.

Chapter 7: To examine the effect of the B2L program on older adolescents' on-task behaviour and subjective vitality (Research aim 5). Physical activity has been linked with improvements in cognition and scholastic performance. In Australia, physical activity (i.e., physical education and school sport) is no longer a mandatory component of the curriculum for senior school students. There is evidence to suggest that a single bout of activity can alter young people's cognition, creating favourable learning conditions. Therefore, this study examined the acute effects of the B2L intervention on senior school students' on-task behaviour and subjective vitality. This was a sub-study of the B2L effectiveness trial, which included participants (n = 221) from 10 secondary schools located in NSW, Australia. For five weeks, teachers allocated to the intervention group facilitated the delivery of two high-intensity activity breaks per week during academic lessons. On-task behaviour was assessed using a momentary time sampling procedure, during a 30-minute observation period at baseline and post-test. Subjective vitality was assessed at the start and the end of the observed lesson during post-test only using a validated questionnaire. There was a significant effect on students' on-task behaviour (ES = 0.43), and subjective vitality (ES = 0.36) in favour of the intervention group. The results from this study highlight the potential scholastic benefits of providing students with opportunities to engage in physical activity during the senior school years.

Chapter 8: To examine the effect of the B2L program on older adolescents' physical, mental, and cognitive health (Research aim 6). The overarching focus of this thesis was to examine the feasibility, efficacy, and effectiveness of a school-based HIIT intervention for older adolescents. Previous school-based HIIT interventions have relied on research personnel to deliver physical activity session. While this approach is likely to lead to greater effects, it lacks scalability. To support the ongoing delivery of HIIT in schools, alternative approaches are needed. Therefore, this study evaluated the effectiveness of a teacher facilitated HIIT intervention, using a cluster randomised controlled trial design. A total of 670 older adolescents (16.0 [0.43] years) from 20 secondary schools located in NSW, Australia,

were assessed at baseline then randomised to the B2L intervention (10 schools, 337 participants) or a wait-list control (10 schools, 333 participants) group. Participants were reassessed at 6 months (primary end point) and 12 months post baseline assessments for a range of physiological, psychological, and cognitive outcomes. Effects were estimated using linear mixed models accounting for clustering at the individual and class levels. Significant effects were found for CRF, muscular fitness, physical activity, and hair cortisol concentration at 6 months. Several moderator effects were also observed. This study provided evidence for the effectiveness of a HIIT intervention for older adolescents. Importantly, the current study utilised a more feasible and sustainable delivery model than previous HIIT interventions.

Chapter 9: To describe the implementation process of the B2L program (Research aim 7). Schools are ideal settings to promote physical activity and fitness to adolescents; however, few studies have specifically targeted older adolescents. Further, relatively few school-based interventions have included comprehensive process evaluation. Therefore, the purpose of this research paper was to describe and evaluate the implementation of the B2L program, using data collected from the B2L effectiveness cluster RCT. The B2L program was delivered over three phases (Phases 1 and 2 [primary endpoint], 6 months; Phase 3, 6 months) during a 12-month study period. Process evaluation data were collected from teachers (n = 22) and students (n = 333). Teachers reported facilitating the delivery of 2.0 (0.8) and 1.7 (0.6) sessions per week during Phase 1 and 2, respectively. Session delivery dropped to below one session per week during Phase 3. Researcher fidelity observations demonstrated that session quality was high; however, students' exercise intensity was lower than the prescribed target threshold of 85% age-predicted heart rate maximum. The B2L program was well accepted by both teachers and students, with over 80% of teachers reporting that they intended to deliver the program to a future student cohort, and approximately 70% of students intending to continue to participate in HIIT in the future. Findings from this study add to the scare process evaluation literature on the delivery of school-based physical activity programs.

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