LITERATURE REVIEW

Physical Activity and Wellbeing in Childhood and Adolescence

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in association with

The International Baccalaureate Organization

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This literature review serves as a companion to the summary report, Physical Activity and Wellbeing in Childhood and Adolescence. This report can be found in full at wellbeing.hmc.ox.ac.uk/schools

Further information can be found on the International Baccalaureate website at ibo.org/research

Executive Summary

Physical activity can be defined as bodily movements which significantly increase energy expenditure, which can vary in intensity. Current World Health Organization (WHO) guidelines recommend 60 minutes of daily moderate to vigorous physical activity for children and young people, though evidence finds that not enough children are achieving this.

The Current Evidence

The literature consistently finds that physical activity has a positive effect on wellbeing, as well as having a positive influence on drivers of wellbeing, such as: self-esteem; social skills; cognitive development; and academic performance. Such benefits of physical activity are not only confined to childhood and adolescence, but also help to set up each child to have a healthier lifestyle in adulthood. Thus, it is of considerable importance that we understand how physical activity can be encouraged in order for us to be able to improve the wellbeing of our students.

Physical Activity Interventions

Though the evidence points to physical activity interventions as being effective in increasing physical activity and improving wellbeing in children and young people, further robust research is to be encouraged in order for empirically-supported intervention recommendations to be made. There is no overarching finding that a specific type of physical activity intervention will lead to the best outcomes, though the research does recommend that physical activity should be integrated within the wider school curriculum and environment, rather than just during Physical Exercise classes. For example, physical activity could be incorporated into academic classes, or for there to be physical activity resources available to students at break/recess/recreation times.

Implementation and Design of Physical Activity Interventions

The literature recommends that to encourage student engagement with the physical activity intervention, students should be involved in the decision-making process of choosing and designing a physical activity intervention. Furthermore, the inclusion of student role models such as teachers or parents should also be included in the implementation and design of any intervention in order to help motivate the students.

It is vital that schools ensure that any intervention is appropriate for the needs of their students and the wider school community. This requires understanding the context of the students, including but not limited to: age; motor abilities/functioning; gender; school resource availability; community influences; and physical environment of the school.

Further Research

The current state of the literature does not point towards a singular physical activity intervention. Further research into the efficacy of different interventions within different school and student contexts needs to be conducted. In addition, a greater understanding of how to: scale up physical activity interventions; implement such interventions in a resource-efficient way; and motivate all those within the school community to engage with the intervention, is required.

The field of physical activity intervention is continually growing, and with it, our understanding of physical activity interventions for children and young people grows too.

Introduction

The IBO and the Wellbeing Research Centre at the University of Oxford have worked together on a series of reports focused on wellbeing in schools. Two foundational reports, 'Wellbeing in Education in Childhood and Adolescence' and 'Wellbeing for Schoolteachers', have been published and give detailed information about the IBO's approach to wellbeing. We suggest that readers first explore these foundational reports to gain a detailed understanding of wellbeing in schools before reading this series of brief reports on the drivers of wellbeing.

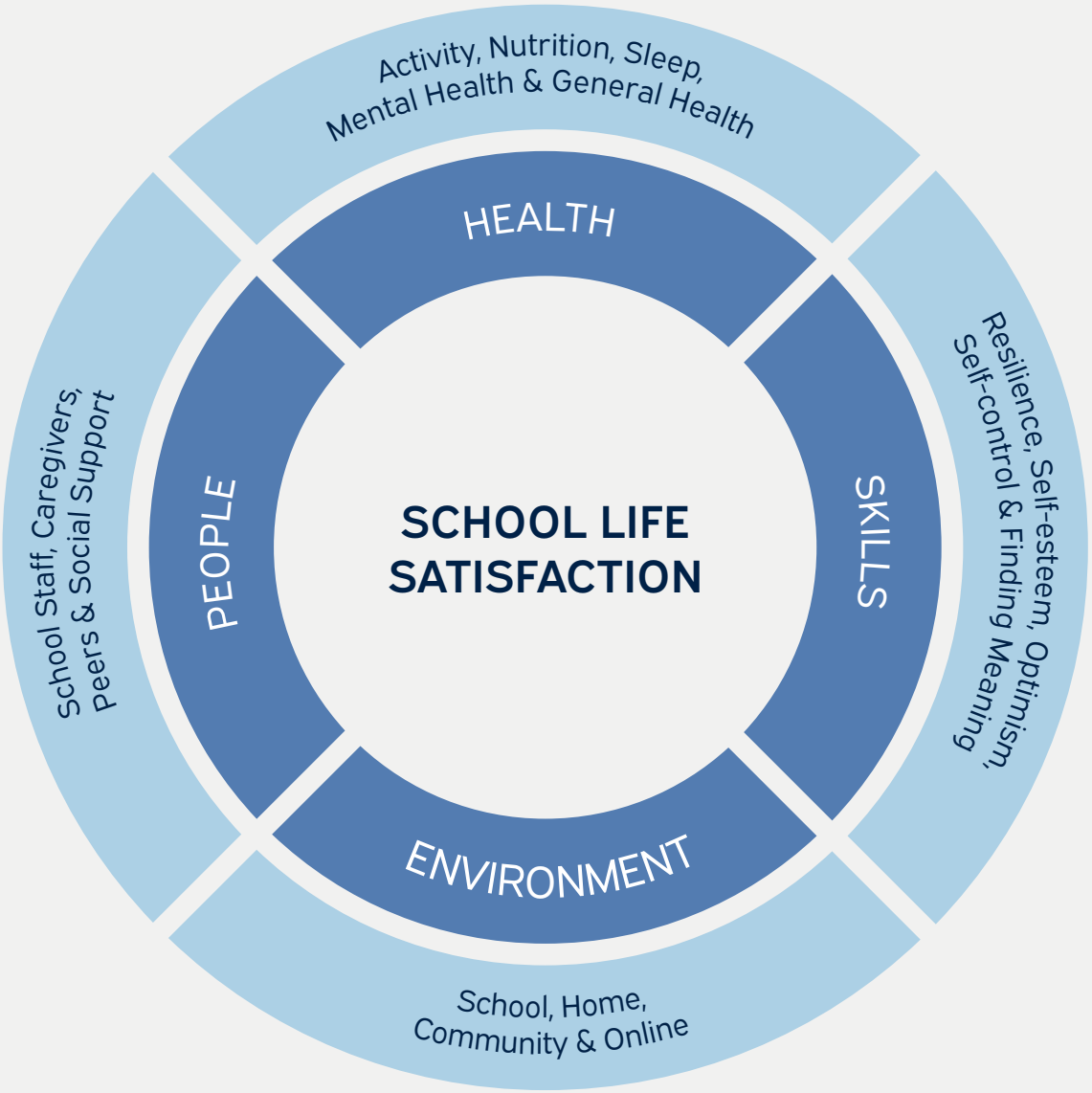
For this report, it is important to highlight what we mean by wellbeing. In our published reports (exploring the wellbeing of young people and schoolteachers), we focus on subjective wellbeing, which refers to the individual's perception of their own wellbeing. In schools, wellbeing is often used as a catch-all term for anything that sits outside academic attainment. This makes it difficult for schools to measure and implement changes, because the parameters are so broad and intangible. Wellbeing science is an established area of academic research, and we employ insights from the empirical science of wellbeing to inform these reports.

In school settings, wellbeing is often misunderstood as simply the opposite of mental ill health or happiness. However, in the 'Wellbeing in Education in Childhood and Adolescence' report, we clarify the differences between these concepts and how schools can use these definitions to decide which aspects of wellbeing to measure and impact. The definitions we recommend in the report remove the drivers of wellbeing (like resilience, mental health, family, peers, teachers, etc.) from the definition and focus on the three key areas of subjective wellbeing: life satisfaction; affect; and eudaimonia.

FIGURE 1: COMPONENTS OF WELLBEING

LIFE SATISFACTION	This element captures young people's satisfaction with their lives, their perception, and experience.
AFFECT	The feelings, emotions, and states of a young person at a particular timepoint, including both positive affect (e.g., joy, happiness, pride) and negative affect (e.g., sadness, depression, anxiety).
EUDAIMONIA	Whether young people feel their life is worthwhile or has purpose and meaning (this can include autonomy, capabilities, competencies, and other areas of psychological functioning).

FIGURE 2: THE SCHOOL LIFE SATISFACTION FRAMEWORK



The core outcome of the wellbeing framework for young people for this project is satisfaction with school life. We focus on the life satisfaction area of subjective wellbeing as the key outcome for the frameworks for practical reasons, but we also emphasise the importance of affect and eudaimonia. These outcomes were selected as they represent the areas that schools can most influence. The framework is presented in Figure 2. The framework has the key performance indicator (KPI) or outcome variable in the centre, and all the drivers that research evidence has suggested influence this outcome surrounding it. It is important to note that this framework only focuses on the evidence for wellbeing and, as such, there may be other research that schools may wish to consider, beyond the scope of these reports, which focus on other positive outcomes for young people.

Each driver has varying degrees of influence on the wellbeing of individuals depending on factors such as the age of the individual and their environment. For example, we know that peers are very important to the wellbeing of adolescents, but to a lesser extent for younger children. This framework gives ultimate flexibility and can be adapted over time to incorporate new insights.

In the 'Wellbeing in Education in Childhood and Adolescence' report we give examples of definitions that schools can use. For young people, we suggest that a school-specific definition, including all three areas, is most appropriate:

> *"This school promotes the wellbeing of all pupils. We define wellbeing as our pupils being satisfied with their school lives, having positive experiences at, and feelings about, school, and believing that what they do at school gives them some purpose and meaning."*
>
> [Edited extract from the 'Wellbeing in Schools in Childhood and Adolescence' Report; Taylor et al., 2022]

Purpose and Scope of the Focused Report

This series of intervention reports is intended to give the IBO and schools a more nuanced understanding of the drivers of wellbeing for young people. Each report contains scientific research, interventions, measurement, and discussion around a specific driver of wellbeing. Each of the topics within these reports has differing levels of scientific evidence, and one of the main aims of these reports is to summarise what we know now about a topic and what further work needs to be done. Ultimately, we aim for these reports to become part of a digital, evidence-based repository which schools can use to measure, monitor, and support, the wellbeing of young people.

The Importance of Wellbeing Interventions for Children

An in-depth discussion of this topic can be found in the report 'Wellbeing in Education in Childhood and Adolescence'. The report discusses three important reasons why schools should seek to improve the wellbeing of their pupils: firstly, childhood and adolescence are important periods in their own right, and every young person has the right to have a positive experience in this critical formative period; secondly, higher wellbeing in childhood and adolescence is associated with other benefits for young people, such as higher attainment, better mental health, and positive pro-social behaviour. Finally, it is important to maximise wellbeing in childhood and adolescence because of the long-lasting impact this has on their future, including their adult levels of wellbeing and job prospects.

The report emphasises that there is value in using school time, money, and resources to improve pupil wellbeing. These improvements will likely not only have immediate benefits for students but will have a driving effect on other positive outcomes (individually, socially, and academically) and have a positive impact on the future lives of the young people as they mature into adulthood. Importantly, there is seemingly no trade-off to make between wellbeing and academic performance. Put simply; happier children make better learners. Schools can feel confident to use time and resources to improve pupil wellbeing in the knowledge that it will likely also lead to improvements in their core business of academic attainment.

[Edited extract from the 'Wellbeing in Schools in Childhood and Adolescence' Report; Taylor et al., 2022]

Physical Activity in Childhood and Adolescence

Physical Activity Definition

Physical Activity (PA) is defined consistently across the literature as any bodily movement that involves skeletal muscle contraction and significantly increases energy expenditure (Physical Activity Guidelines Advisory Committee, 2018; Sneck et al., 2019; Vaquero-Solis et al., 2020). This concept is distinct from "Exercise", which is understood as a more structured and repetitive PA aiming to improve health (Alvarez-Bueno et al., 2017). In this report, we refer to relative levels of PA in reference to the World Health Organization's recommendation that children and adolescents spend (at least) 60 minutes per day doing some form of moderate to vigorous PA (WHO, 2022). Sport England (2022) defines an active individual as someone who engages in at least 60 minutes of PA per day on average, while a fairly active person performs 30-59 minutes of PA per day on average, and a less active person struggles to sustain more than 30 minutes of PA per day. The difference between moderate and vigorous PA is determined by the intensity level, with moderate activities raising heart rate and causing sweating, and vigorous activities causing difficult and fast breathing and rapid heart rate (OECD, 2017).

The Current State of Physical Activity Globally

The literature consistently suggests **insufficient levels of PA for children and young people (CYP): beginning in early childhood and worsening in teenage years and adulthood**. Reported PA levels are nearly always compared against the WHO's recommended 60 minutes of moderate to vigorous PA per day. According to one study which examined global trends in PA based on population-based surveys employing a total of 1.6 million participants, 85% of CYP globally are classified as inactive because they fail to meet the World Health Organisation (WHO) recommendations for PA (Guthold et al., 2020). Other studies corroborate these findings. For instance, a Health Behaviour in School-aged Children (HBSC) survey from 2015 indicated that only around 14 % of children and adolescents across 32 countries from Europe and North America met the WHO recommendation for PA (Kalman et al., 2015). The findings are consistent with accelerometer data from 20 research studies conducted in ten countries, involving over 27,000 children and adolescents aged 3 to 18. According to the report, only 9% of boys and 2% of girls met the WHO's PA standards (Cooper et al., 2015). Belton et al. (2014) further note a high level of inactivity among CYP in their study, with 99% of them failing to achieve fundamental movement skills proficiency expected for this age group.

These trends of insufficient PA begin at a very early age. One systematic review of PA in 2-6-year-old preschool children across seven countries (United States, Scotland, Finland, Australia, Chile, Estonia, Belgium) found that only 54% were sufficiently physically active (Tucker, 2008). Moreover, there is a declining trend over time; records from both self-report and objective measurements show there is an incline in sedentary behaviour and low levels of PA, meaning CYP are more inactive now than they have been historically (e.g., Cliff et al., 2016; Luan et al., 2022). Children have been less active in recent decades partially as a result of technological advancement and socio-economic issues (Landry & Driscoll, 2012; Szabo et al. 2021). The European Heart Health Initiative (2001) further highlights that the provision of physical education in schools has declined in many countries in tandem with decreasing opportunities to be physically active outside of school. They suggest that this decline in opportunity is due to a combination of factors, including low availability of safe and accessible places for activity; lack of adult support, supervision, and guidance; increasing popularity of the car as a mode of transport; and the computer or television screen as a mode of recreation. The recent impact of the COVID-19 pandemic has also been explored and has been shown to have an effect on lowering levels of PA in young people (e.g., Do et al. 2022; Hawke et al., 2020; Young Lives, 2022). **Such reported trends in low and decreasing PA have implications not only on CYP physical health, but potentially also their overall wellbeing.**

Core Drivers of Physical Activity for Young People

Research evidence, presented below, shows that there are several core drivers of PA for young people. Two of the drivers with the strongest evidence are motivation and social environment.

Motivation

There is strong focus in the literature on motivation as a driver and/or mediator of PA in children and young people (e.g., Cairney et al., 2012; Hagberg et al., 2009; Vaquero-Solis et al., 2020; Wankel, 1993). Motivation is affected by elements like enjoyment, support from peers, parents, teachers, coaches; and feelings of competence and goal achievement. Self-Determination Theory (SDT) has been widely used for the development of intervention strategies to improve student motivation during PA practice (Vaquero-Solis et al., 2020). Constructed by Edward Deci and Richard Ryan, SDT argues that human motivation is essentially based on three innate psychological needs: competence, autonomy, and relatedness (Smedegaard et al., 2016). Enjoyment has also often been found to be related to the SDT needs of competence, autonomy, and relatedness, and as a significant determinant of children's and adolescent's PA behaviours. Meta-analyses have indicated that **children and adolescents are more likely to participate in PA when they perceive it to be enjoyable and that PA enjoyment is linked with sustained PA participation** (Burns et al., 2017; Cairney et al., 2012; Gao et al., 2012, 2013; Wankel, 1993). More specifically, teachers exhibit a more significant influence on students' perceptions of autonomy and competence, while peers appear to have a greater impact on feelings of relatedness (Vasconcellos et al., 2020). School leaders and teachers should consider SDT and the drivers of motivation when encouraging their students to engage in PA. For example, teachers might involve their students in activities which are at an appropriate skill level to their students (competence), provide students with options of the PA they would prefer to engage in (autonomy), and inclusive activities involving all students using equipment which is accessible (relatedness).

Social Environment

Research has indicated that the **social environment in which PA occurs, particularly in terms of social relationships with peers, teachers, coaches, and parents, is strongly linked to the wellbeing benefits of PA** (Bailey et al., 2013). The positive influence that PA can have on student wellbeing is dependent on the social context in which students interact with their teachers, parents and peers. Research indicates that feeeling connected with/ having a sense of belonging with teachers, teammates and coaches can influence self-esteem and wellbeing (Belton et al., 2014; Christiansen et al., 2018; Smith, 2003). However,several factors can limit or even inhibit CYP's motivation and participation in PA, such as insufficient opportunities for teacher professional development, low teacher confidence, and difficulty in obtaining curriculum resources. Class teachers, who aren't necessarily trained in delivering exercise classes, are also often the main deliverers of physical education (PE), thus indicating that teachers delivering PE might require additional support (Goodyear et al., 2023; Mcveagh et al., 2020; Randall, 2020; Smedegaard et al., 2016;). As noted in one randomized controlled trial, increasing teacher modelling could be an important mediator of PA in children (Donnelly et al., 2009). Thus, in order to support CYP involvement in PA, there is a need to provide teachers with support, such as instructional PA curriculum support, the allocation of PA-related resources to schools, so that an environment to support connections between teachers and students as well as amongst students themselves can be fostered (Bailey et al., 2013).

Physical Activity and Wellbeing

Existing literature draws a **clear link between PA and wellbeing, both in terms of physical health and socio-emotional components of wellbeing in childhood and adolescence**. Aside from the recognised benefits of PA for physical health as a crucial component of overall health (OECD, 2017), it also improves wellbeing. As Smedegaard et al. (2016) note, "The benefits of PA for the mental health and wellbeing of children and youths are well-established" (p.2). Systematic reviews have found that PA has an overall positive effect on mental health and wellbeing, with effectiveness being more evident for wellbeing (Biddle et al., 2019; Hale et al., 2021; Hinkley et al., 2014). Results from PISA 2015 also showed that, on average, across OECD countries, students who engaged in some moderate or vigorous PA were less likely to report that they felt very anxious about schoolwork and that they do not feel part of school (OECD, 2017). Moreover, regular PA can help build social skills and self-esteem (Kelly et al., 2012; Luan et al., 2022; OECD, 2017; Smedegaard et al., 2016; Sport England, 2022; Vaquero-Solis et al., 2020); reduce loneliness and mitigate mental health concerns such as stress, depression, and anxiety (OECD, 2017; Sport England, 2022; Vaquero-Solis et al., 2020); improve cognitive abilities (Bidzan-Bluma & Lipowska, 2018; Carson et al., 2016; Martínez-Gómez et al., 2011); as well as improving memory, perseverance, and self-regulation (Kelly et al., 2012; OECD, 2017; Vaquero-Solis et al., 2020).

Therefore, it is clear that **PA is not only beneficial for**

wellbeing directly, but it also has recognised impact on other drivers of wellbeing and broader positive outcomes, including physical health, self-esteem, social skills, and cognition. Below we discuss the links between PA and other drivers of wellbeing for young people.

PA and Physical Health

There is a **significant body of literature that addresses the link between PA and physical health**. One WHO report noted that insufficient PA is responsible for around one million deaths per year and has become the fourth risk factor for global mortality in high-income countries, posing a significant public health problem (Kelly et al., 2012). While the direct relationship between PA and cardiovascular disease remains inconclusive in research, it does contribute to a slight variance in cardiovascular disease risk factors during childhood and adolescence, with a more pronounced effect observed in extreme cases (Eisenmann, 2004; Tolfrey et al., 2000). Physical health is a key determinant of wellbeing in childhood and adolescence (Almond et al., 2018; Conti & Heckman, 2013; Currie, 2020; Mallo & Wolfe, 2020), and therefore should be considered when addressing the role of PA in wellbeing. A systematic review of school-based PA interventions noted that there is strong evidence of the importance of PA in children's and adolescents' physical and psychological development, with the benefits of PA on health including: improvement of basic physical skills, physiology, morphology, body mass index (BMI), and reducing the percentage of fat (which is closely related to cardiovascular diseases; Vaquero-Solis et al., 2020). The importance of PA in CYP, as indicated by these findings, is further emphasized in literature that draws a link between PA in childhood and physical health in adulthood (also see 'Benefits of PA tracking into adulthood' below).

PA and Self-Esteem

Regular PA can help build self-esteem, which is commonly viewed as a key indicator of wellbeing (e.g., OECD, 2017). Some emphasis in the literature is placed on the effect of PA on improving self-esteem, often through reduced BMI and improved body image (Gaspar et al., 2011; Tremblay et al., 2000), and experience of growing physical capability (Christiansen et al., 2018). However, a review of reviews by Biddle et al. (2019) showed that although PA was associated with some mental health outcomes in young people (including a causal association with cognitive functioning, a partial association for depression, and less powerfully with anxiety), there was no significant correlation found with self-esteem. This study, among others (see for example Andermo et al. 2020) suggest that, while school-related physical activity interventions may reduce anxiety, improve well-being and mental health, the relationship between PA and drivers of wellbeing, such as self-esteem, is complex and difficult to assess. It is clear that there needs to be further exploration into the relationship between PA and self-esteem, and any positive benefits that are reported may as a result of other related outcomes. Therefore, if schools want to focus on increasing self-esteem, PA alone may not be the best course of action, but could be one component of a broader approach.

PA and Social Skills

The link between PA and social relationships, which drive wellbeing, had also been explored in the PA literature. **Studies indicated that PA could contribute to an individual's social integration, social support, and sense of belonging**, leading to positive outcomes such as self-acceptance, improved relationships, personal growth, environmental mastery, and a sense of purpose in life (Chen et al., 2021; Luan et al., 2022). As illustrated above, with reference to the core drivers of CYP PA, a sense of belonging and connecting with others could be an important motivating factor for CYP to engage in PA (Bailey et al., 2013). The importance of not underestimating the effect of PA in relational settings is articulated by the European Heart Health Initiative (2001): "It should be remembered that PA – whether through sport, games, play, dance, structured exercise, or walking and cycling – can give young people valuable experiences that help in learning basic motor skills as well as in social integration, moral and social development and the joy of movement and exploration" (p. 8). Active participation in physical education classes has been linked to enhanced social and emotional skills. These classes not only offer opportunities for the development of diverse interpersonal, social, and ethical abilities, but they also equip children and adolescents with the capacity to navigate effectively through a range of social situations (Bailey, 2005; Bailey et al., 2009).

PA, Cognitive Development, and Academic Performance

There is a substantial and growing body of literature on the relationship between PA and cognitive development, cognition, and (to a lesser extent) memory (Alvarez-Bueno et al., 2017; Esteban-Cornejo, 2014; Guthold et al., 2020; Kelly et al., 2012; Luan et al., 2022; OECD, 2017). **These attributes are often linked with improved performance in school (including attainment) and executive functioning** (Buck et al., 2008; Castelli et al., 2007; Donnelly et al., 2009; Marques et al., 2017; Van der Niet et al, 2014). For instance, a PISA report using data collected in 2015 indicated that there is a positive relationship between an additional day of PA outside of school and students' science performance, after accounting for gender and socio-economic status (OECD, 2017). A comprehensive systematic review of PA and cognition in adolescents also highlighted the increasing amount of literature which suggest that PA has a clear impact on cognitive measures (e.g., concentration, working memory,

inhibition, and classroom behaviour), which are all factors that contribute to academic success. (Esteban-Cornejo, 2014). The findings of the systemic review also supported the positive association between PA and both cognitive and academic performance (Rees & Sabia, 2010; Fox et al., 2010). Further, it suggests that cognitive performance is linked with vigorous PA, while general PA is related to academic achievement, mainly for girls (Esteban-Cornejo et al., 2014). Two previous reviews in school children aged 5–18 years also collectively reported the positive effect of PA on cognition (Centers for Disease Control and Prevention, 2010; Singh et al., 2012). **This body of literature supports the notion that school time allocation shouldn't be thought of as one or the other: academic achievement vs. PA. Instead, time in school attributed to PA can also contribute to higher academic performance.**

Benefits of PA Tracking into Adulthood

One important aspect of the research into PA for CYP, which is noted by many researchers through both prospective and retrospective studies, is that **PA benefits are thought to track into adulthood** (e.g., Guthold et al., 2020; Hallal et al., 2006; Iannotti et al., 2009; McMurray, 2020; McMurray et al., 2008; Sibley & Etnier, 2003). These benefits in adulthood are discussed mainly in relation to mitigating physical health risks (e.g., diabetes, cardiovascular problems, etc.), but some studies also explore the development of behaviours and habits that can shape PA in adulthood (Cragg & Cameron, 2006; European Heart Health Initiative, 2001; Stolley et al., 2003; Tucker, 2008; Vaquero-Solis et al., 2020). Such literature highlights that PA levels in youth (and associated physical health factors, such as obesity; Bar-Or & Baranowski, 1994; Telama et al., 2005) tend to persist into adulthood (Belton et al., 2014), and therefore making an up-stream intervention and **establishing strong habits for engaging regularly in PA during childhood and adolescence is one way to prevent the development of later health risks**, such as obesity and chronic diseases, like diabetes and heart disease (Demetriou et al, 2017). Esteban-Cornejo et al. (2014) highlighted in their systematic review on PA and cognition in adolescents that PA plays a crucial role in predicting adult health. Poor cognition during adolescence is linked to higher morbidity and mortality, psychological problems such as anxiety and depression, and chronic illnesses like coronary heart disease and certain types of cancers in adulthood. Some admission is made, however, that tracking behaviour and lifestyle into adulthood can be difficult and the evidence for tracking PA behaviours is tenuous (e.g., Birkeland, 2009; European Heart Health Initiative, 2001; Kohl et al., 2000).

Differences Across Populations

Population differences are also found in PA, especially regarding gender, age, and though less studied, socio-economic status (SES) and ethnicity. One set of guidelines published by the WHO in 2020 on PA and sedentary behaviour noted that there has been "no overall improvement in global levels of participation in PA over the last two decades and substantial gender differences. Furthermore, national data consistently show inequalities in participation by age, gender, disability, pregnancy, SES and geography" (Bull et al., 2020, p. 1451). Below we discuss the differences in the association between PA and wellbeing across populations.

By Age Group

Significant differences are found across age groups. Research which looked at PA and wellbeing across the lifespan, found that while PA significantly enhances wellbeing at any age (Physical Activity Guidelines Advisory Committee, 2018), **affect, behaviour, and cognition are subject to change across the lifespan, and these developmental changes may result in differences in PA, wellbeing, and in the link between them across life stages** (Hyde et al., 2013). This non-uniformity across ages requires more detailed analyses and which types of PA might be more beneficial and appropriate at different age levels merits further research.

Early Childhood

Early childhood is characterised by higher levels of PA than other times in the lifespan. Cross-sectional research using accelerometers suggests children were over five times more likely to participate in 60 minutes of PA per day than adolescents or adults (Troiano et al., 2008), though young children also require more PA given that they are at early stages of development (Hyde et al., 2013; WHO, 2022). According to a Sport England report (2022), PA, such as walking, dancing, and swimming, are more popular among infant age children (ages 5-7), while team sports are less common at this age (but gradually become more important as they grow older). In terms of early childhood wellbeing and PA, it has been shown that PA can acutely enhance affect (labelled as "mood") in young children (Williamson et al., 2001). However, less is known about the effects of PA on satisfaction with life or the long-term affective consequences of PA in young children (Hyde et al., 2013), despite some ability to meaningfully measure life satisfaction in children as young as age seven (Huebner, 2004).

Adolescence

Throughout adolescence, there is a significant decline in PA (e.g., Hyde et al., 2013). In pre-adolescence, active play reduces in favour of running, athletics, or

multi-sports which are most prevalent among junior age children (ages 7-11). Similarly, the prevalence of participating in gym and fitness courses also increases over time (Sport England, 2022). PA levels fall significantly between the ages of 11 and 15 years (Kelly et al., 2012). In tandem with this decline in PA, wellbeing levels in adolescence also seem to decline. One study showed that adolescents who are less physically active have lower levels of life satisfaction compared to their more physically active peers (Valois et al., 2004). Although little is known about the long-term affective implications of PA, some research has found a higher PA level relating to more positive affect in research with adolescents (Hyde et al., 2013; Schneider et al., 2009; Schneider & Graham, 2009). Data from the Millennium Cohort study in the UK show a positive association between PA and wellbeing in early adolescence (Brylka et al., 2021), which is supported by the findings of some recent systematic reviews and meta-analyses (e.g., Andermo et al., 2020; Bermejo-Cantarero et al., 2021; Poitras et al., 2016) which confirm a significant relationship between PA and wellbeing. Emerging adulthood is correlated with even further reductions in PA and wellbeing, which has motivated thinking and research around boosting physical literacy at the adolescent stage to establish habits in school which can become embedded before emerging adulthood (Cragg & Cameron, 2006; European Heart Health Initiative, 2001; Stolley et al., 2003; Tucker, 2008; Vaquero-Solis et al., 2020).

By Gender

Differences in gender are the most frequently studied and clearly identified difference in PA across populations. **Girls and women across the board are less likely to engage in PA than boys and men, a trend which starts early and continues throughout the lifespan** (Caspersen et al., 2000; Hyde et al., 2013; Sallis et al., 2000; Trost, et al., 2002). Starting from early years, one systemic review of PA in preschool-aged children found that boys are consistently more active than girls (Tucker, 2008). Objective assessment data from England also shows only 34% of girls aged 4 to 10 meeting the recommended levels, and none of the girls aged 11 to 15 exercising to this level (Townsend et al., 2012). Furthermore, a study of trends in insufficient PA among adolescents found that globally, girls were less physically active than boys across various income groups and regions, and in almost all countries studied. Importantly, the prevalence of insufficient PA among girls has not improved since 2001 (Guthold et al., 2020). The European Heart Health Initiative (2001) also highlighted that in nearly all surveys, girls are less active than boys, with activity levels declining steeply in adolescence. This decline in PA during early adolescence is greater among girls than boys, and the decline in girls begins earlier than that in boys (Biddle et al, 2014; Dumith et al., 2011; McMurray, 2020). Furthermore, research from the Youth Sport Trust and Women in Sport in 2016 found that despite both boys and girls understood the importance of being physically active, girls had a considerable gap between their beliefs and their actual engagement in PA (McMurray, 2020). This significant difference in levels of PA between genders has led to increased interest in interventions that target engagement in PA among girls. An under-researched area is PA and wellbeing for children who do not identify as cisgender, this will need to be considered when exploring interventions and measurement for PA in schools.

By Socio-Economic Status

An HBSC report based on 2005/2006 survey data, found that though the literature might appear to present satisfactory health and wellbeing for many young people, there are considerable numbers of young people who are experiencing problems related to overweight and obesity, self-esteem, life satisfaction, substance misuse, and bullying (Currie et al., 2008).. Yet the relationship between SES and PA has not been studied in as much depth as age and gender. Some literature suggests that, on the whole, lower socio-economic-status typically correlates with lower PA. Findings from the PISA data collection in 2015 suggest that SES is related to adolescents' level of PA with advantaged students being more likely to engage in moderate or vigorous PA outside of school than disadvantaged students (OECD, 2017), potentially due to a wider range of resources and opportunities at home and in their environment. Relatedly, one review which examined evidence of the association between the neighbourhood-built environment, green spaces and outdoor home area, and early (0-7 years) child health and development found that the presence of child relevant neighbourhood destinations and services often were positively associated with early child development domains of physical health and wellbeing and social competence (Christian et al., 2015). Guthold and colleagues (2020) also highlight that previous research on the effect of SES on PA participation among adolescents indicated that higher SES relates to higher levels of PA among adolescents. Though they note that findings on this social patterning across studies are not uniform (Stalsberg et al., 2010) and more research is needed (Guthold et al., 2020).

Limitations and Confounders

Several challenges and confounders emerge in the study of PA and wellbeing, especially amongst research conducted with CYP. These relate to challenges that exist with defining and measuring wellbeing. **While interventions often measure impact on physical health factors, it has been challenging historically for researchers to measure the impact on wellbeing.** Wellbeing science is advancing rapidly but there are still

a wide range of questionnaires used internationally to measure wellbeing, and some researchers have struggled to define and quantify wellbeing. Lotan and colleagues (2005) listed several challenges with establishing a clear link between PA and wellbeing including: a) the construct of wellbeing has been found to differ among researchers; b) the measurement of wellbeing is extremely dissimilar among researchers; c) researchers have attempted to disclose the link between PA and wellbeing using different methodological paths, thus leaving little room for linking the results into a unified construct; and d) populations in different studies have been too small or too divergent to enable comparison between them.

While there is literature supporting the positive relationship between PA and wellbeing in childhood, the evidence is not as strong or well-documented as it is for adults (Bell et al., 2019; Hagell, 2016; McMurray, 2020). This is in part due to measurement challenges related to studying younger populations (see details in the 'Measurement' section). High variance has also been found across studies and individuals, which make comparing and consolidating findings, and designing appropriate interventions, challenging. As Hyde et al. (2013) note, though PA may be a viable tool for enhancing wellbeing, the magnitude of the effects varies widely across studies and individuals. Other limitations or challenges in the study of PA and wellbeing include: a) the majority of data, studies, and interventions, on PA and wellbeing have been produced in the Global North (Europe, North America, Australia, etc.), and usually among predominantly white populations, making generalisation of findings to other populations difficult; b) the close association between PA with other wellbeing drivers, such as nutrition, sleep, and SES can make it difficult to extricate the impact of PA alone and study its impact in isolation (Guthold et al., 2020: Ávila-García et al., 2020).

Physical Activity Interventions

This report highlights a selection of interventions presented in detail which have been chosen based on their high levels of evidence, including the use of randomized controlled trials (RCTs) and relatively large and diverse samples. These interventions are presented in Table 1 below, while the remaining published interventions are included in Appendix 1 for readers to explore. It is recommended that readers also examine the interventions presented in the appendix to determine whether they may be of use for their own school settings. It should be noted that some of these interventions may be particularly promising when targeted towards at-risk populations or when using advanced technology. It should also be noted that this report focusses on general PA interventions in schools because there is very little scientific evidence on specific PA interventions for wellbeing. **Schools should use their own judgement and protocols to deem whether any intervention is appropriate for their setting and individuals.** Key findings pertaining to the implementation of wellbeing interventions within schools in the 'Wellbeing in Schools in Childhood and Adolescence' report are listed here (Taylor et al., 2022; more information about the science of implementation can be found in this report):

- Community consultation and ownership is recommended for wellbeing strategies to be adopted and promoted by the school community (parents and caregivers, pupils, staff, wider community, and other school stakeholders such as school governors). This should crucially include pupil voice and a child- focused approach.
- Wellbeing policies and strategies should be formalised, any program implemented should have clear guidelines (or be manualised), and staff should know which areas they are individually responsible for.
- Interventions should have a sound theoretical base and when interventions are delivered, school stakeholders should ensure that these essential theoretical elements are taught during the intervention and not lost through adaptation. These interventions should also aim to be direct and specific for the desired outcome.
- External experts can be useful for the initial set up of an intervention, but for the intervention to thrive, in-house staff must take over to ensure that the intervention becomes embedded and is successful in the longer-term.
- School stakeholders should select interventions that are the easiest to implement in their educational setting. If an intervention is challenging to implement, it is less likely to be successful.
- Implementation of an intervention is an important factor in determining its effectiveness. Implementation should be carefully considered by school stakeholders as a crucial element of any wellbeing intervention.

Level of Evidence

Below, we describe the various levels of scientific evidence and how we have ascertained the quality of the studies we include in the report (adapted the Joanna Briggs Institute (JBI) Levels of Evidence and Grades of Recommendation and Methods and critical appraisal for evidence-based practice; LoBiondo-Wood & Haber, 2022)

- Systematic Reviews and Meta-Analyses (level 1) : These are comprehensive reviews of the literature that synthesize the findings of multiple primary studies. In a systematic review, researchers typically assess the quality of each study included and assign a level of evidence based on the study design, sample size, potential biases, and other relevant factors. They then use this hierarchy of evidence to draw conclusions and make recommendations.
- Randomized Controlled Trials (RCTs) (Level 2): These are experimental studies where people are put into groups (e.g., treatment and control) by chance to see if something works or not.
- Quasi-experimental Studies (Level 3): Quasi-experimental studies are research designs that share similarities with experimental studies but do not involve random assignment of participants to groups. They aim to investigate cause-and-effect relationships but often lack the complete control of variables seen in randomized controlled trials (RCTs).
- Observational – Analytic Designs (Level 4): These studies are designed to provide evidence that helps establish cause-and-effect relationships or identify associations. To conduct analytic observational studies, researchers typically employ various study designs, including cohort studies, case-control studies, and cross-sectional studies.
- Meta-synthesis (Level 5): Meta-synthesis is a research method used to synthesize and analyse

findings from multiple qualitative studies. It involves systematically reviewing and integrating qualitative data from various sources to generate new interpretations or insights.

- Qualitative Studies (Level 6): Qualitative studies focus on exploring and understanding the experiences, perceptions, and meaning-making processes of individuals or groups. They often involve in-depth interviews, focus groups, or content analysis to capture the nuances and context of a phenomenon.

- Expert Opinions (Level 7): Expert opinions are typically reports or recommendations provided by panels of experts or professional organizations. They are not based on empirical research but rather on the collective knowledge and expertise of recognized authorities in a specific field. These opinions are valuable for providing guidance, consensus statements, or expert advice based on their experience and expertise.

In addition, we take into account several factors when deciding which interventions to include in this report, including sample size, the characteristics of the study population, reliability, and validity. These elements are crucial in determining the strength and relevance of the evidence. Larger sample sizes often lead to more robust findings, increasing the potential for broader applicability. However, smaller sample sizes can still provide valuable insights, particularly when studying specific or niche populations. The characteristics of the study population are also vital considerations, as research outcomes may vary based on participant diversity. Moreover, reliability and validity are of utmost importance. Reliable research designs ensure consistent reproducibility of results, while validity ensures that the study accurately measures what it aims to. Therefore, a research design that is both reliable and valid is essential for rigorous research. For further information on research methods, we recommend referring to the book 'Research Methods in Education' by Louis Cohen, Lawrence Manion, and Keith Morrison, as well as exploring resources on websites like Simply Psychology and Scribbr.

In delineating the various levels of evidence, it's imperative to emphasize that the prominence of interventions validated through RCTs does not diminish the value of interventions validated through qualitative studies. Rather, it underscores that certain interventions may be more amenable to rigorous scientific investigation due to the nature of their design, or the cost associated with conducting RCTs. It's essential to recognize that interventions established through qualitative research hold unique significance and may prove to be indispensable in specific educational settings.

TABLE 1: PHYSICAL ACTIVITY INTERVENTIONS

Intervention	Description	Details	Findings	Evidence Level
Move for Wellbeing in Schools (MWS) Smedegaard et. al. (2016) Smedegaard et al. (2017)	The intervention consisted of teacher workshops and the delivery of a PA programme. The MWS programme has three key components. 1. Brain breaks: short physical activity sessions during class, totalling to 50 minutes within a week (with 2 brain breaks in one school day) 2. Recess: teachers provided with resources in order for teachers to guide students physical play during break time, at 3 x 30 minute sessions a week 3. Physical Education: teachers implement 6 courses to the students, with each course consisting 4 x 90 minute sessions.	Ages 10-13 *n*= 3,124 School-based	· Teachers and students reported positive effects of the intervention on self-reported beliefs of the effectiveness of the intervention. · The implementation of the PA components was stable throughout the school year, and the teachers supported the notion that the intervention could promote student wellbeing. · The structured format of the intervention helped teachers in the implementation of the intervention, by including: competence development elements, setting of goals for new practices, and provision of ongoing support.	One of the largest PA intervention projects promoting psychosocial wellbeing among children and youths. Detailed information on project delivery and roll-out at the school level makes it possible to better inform future practice and conducted with an RCT study design.
The Activity and Motivation in Physical Education (AMPED) Lonsdale et al. (2015) Lonsdale et al. (2019)	The AMPED intervention aims to maximise opportunities for students to be active during PE lessons, as well as enhancing adolescents' motivation towards PE and PA more generally. The study was conducted in low socioeconomic areas of Western Sydney, Australia. The AMPED intervention targets secondary	Grade 8 *n*= 1,421 School-based, internet supported	· AMPED had a large, significant positive effect on pedagogy: maximising movement and skill development, reducing transition time, building competence, and supporting students · Significant increase in	Robust RCT with large population, included looking at an economically disadvantaged population.

	school PE teachers, and involves the following components: 1. Face-to-Face Workshop 1 (1 day) 2. Technology-assisted Implementation Task 1 3. Group Mentoring Session 4. Face-to-Face Workshop 2 (1 day) 5. Technology-assisted Implementation Task 2 6. Group Mentoring Session 7. BOOSTER intervention the following school year, involving ½ day Face-to-Face workshop, Task 3 of Technology-assisted Implementation task, and a final Group Mentoring Session		moderate-to-vigorous PA in students · Significant reduction in student sedentary times during PE · Mediators of the effectiveness of AMPED (ethnicity, gender, teacher pedagogy, student motivation) (Lonsdale et al., 2019)	
Physical Activity 4 Everyone Sutherland et al. (2016)	School-based intervention to prevent decline in adolescent PA levels. The intervention included adaptations to three facets of school life. 1. School environment: through the encouragement of PA activities during recess, as well changing school policy to foster PA 2. School curriculum: increase PA within PE classes, provide an enhanced PE programme, as well as develop personalised PA plans for students	Grade 7-8 *n*= 1,150 School-based	· Significant increase in moderate-to-vigorous PA after 12 and 24 months · Students in the intervention group were found to generally participate in 7 minutes more of MVPA each day after 24 months (in comparison to the control group)	This was an RCT with use of an objective measure of PA. There was a focus on disadvantaged populations and the multicomponent socioecological design.

	3. School community partnerships: creating working relationships and dialogues with community PA services as well as with families of the students The intervention in whole is a 2-year multicomponent PA intervention implemented in disadvantaged secondary schools, with a 12-month (mid-intervention) report on a cluster randomised trial.			
Physical Activity Across the Curriculum (PAAC) Donnelly et al. (2009) Gibson et al. (2008)	PAAC is a 3-year elementary school-based intervention, which aims to encourage PA within schools to ultimately reduce the number of obese children at this age. The PAAC intervention involved providing teachers with in-service training, in order to advise teachers on how to implement weekly 90-minute sessions of PA to students. Teachers received training from research assistants, who provided the teachers with support and advice when implementation issues arose within their classrooms.	Grade 2-3 at baseline and Grade 4-5 at the end of the study *n*= 4,905 School-based, classrooms	· PAAC had significant influence on BMI change in 3 years · Significantly improved academic outcomes · Significant increase in PA (Donnelly et al., 2009)	Robust design and longitudinal cluster randomised RCT with large population.
Lifestyle Education for Activity Program (LEAP) Saunders et al. (2006) Pate et al. (2005)	LEAP is an intervention which aimed to create instructional and environmental changes within the school settings to promote PA in adolescent girls (high school). The LEAP intervention targets curriculum change as well as school attitude and climate changes, to encourage physical exercise in and out of school. This intervention involved two key components. 1. Instructional change: the integration of teaching students to enjoy and engage	Grade 8-9 *n*= 2,111 School-based with family/ community components, targeted for girls	Significant increase in regular vigorous physical activity (8% more students in intervention school than control school who self-reported partaking in regular vigorous physical activity (Pate et al., 2005)	Strong and large-scale RCT.

	with PA in and out of school, provide opportunities for PA which might appeal to students more than traditional sports, as well as competitive sports 2. Environmental change: educators within the school as well as parents/carers were advised to role-model PA enjoyment and engagement to the adolescent girls, as well as engage in discussions surrounding PA and healthy lifestyles			
Switch-2-Activity Salmon et al. (2011)	The Switch-2-Activity programme was delivered through 6 teacher-led classroom sessions, which aimed to reduce student screen-time, and encourage PA. Each of the sessions involved the exploration of a particular topic, with use of a different strategy: 1. Introduction to PA and health: educating and providing students with knowledge 2. Patterns of TV viewing: providing students with the skills to self-monitor their own behaviour 3. Selective TV viewing: building on their self-monitoring skills and making appropriate behavioural changes in response 4. Identifying alternative activities: the promotion of PA and the development of motor and social skills	Grade 5-6, Ages 9-12 *n*= 1,048 School-based	· Significant reduction in TV watching, and computer screen time · Significant improvement in self-efficacy (in TV viewing, and physical activity)	Strong RCT, and contributes to diversifying the intervention populations, as this programme was delivered to children attending schools in low socioeconomic areas of Australia.

Highlights from Intervention Literature

Since the late 1900s there has been interest in designing interventions to address physical inactivity and health in young people. In recent years, as Smedegaard et al. (2016) highlighted, several large school-based interventions have been conducted with the overall conclusions indicating that increased PA during school hours is associated with better physical, psychological, and social, health and wellbeing. As a result, there is a significant number and range of interventions. Those interventions differ in terms of settings (in-school, after-school, home-based), geography, populations (early childhood to adolescence, teachers, parents, etc.), and outcome measurements (including objective measures such as BMI and subjective self-report assessments of motivation). While this can make it difficult to compare and draw conclusions across the literature, some highlights emerged about what intervention factors might be more (or less) effective.

Which Type of PA is Most Effective?

The PA interventions highlighted in Table 1 above do not necessarily provide prescriptive PA recommendations for schools. For example, the literature does not suggest that one type of activity is necessarily better than another. Rather, the PA interventions explored in this report encourage the personalisation of the types of PA delivered to the needs, skills, and contexts of the students.

The literature often calls for an increase of moderate-to-vigorous PA throughout the school week, particularly within PE lessons. In addition, it recommends the incorporation of physically active elements into other academic classes beyond PE, as well as providing opportunity for PA during recess/recreational time. Such recommendations might include the bringing in of additional resources such as sports equipment or games to facilitate increased opportunity for PA. The PA interventions also suggest increasing the weekly time spent involved in PA to be between 60-90 minutes, on top of the PA opportunities which are already included in an existing curriculum. Thus, the literature encourages the adoption of PA which ranges in intensity and effort which should be incorporated throughout the school day and week, rather than a definitive list of approved PA practices which increase wellbeing.

There are also themes that have been emphasized across these studies with regards to how to choose the type of PA to be included in the intervention. As previously noted, the chosen PA should be of an appropriate content and skill level for the students, to allow students to be motivated to engage in the PA intervention and carry such skills through into their daily lives. Providing students with the agency to choose which physical activities that they engage in, or collaborating with the wider school community in the decision-making process.

Successful PA interventions involve educating the teacher and students on the importance of PA and health, to allow for a holistic understanding of the intervention and help the school community as a whole to be more conscious of their own health. Teachers should receive thorough training in how to implement a PA intervention in order for the intervention to be effective, and teachers should be supported throughout this intervention process. A further characteristic which is highlighted in the literature is the importance to recognise and involve of role models within the PA intervention, such as parents/carers/teachers, as this helps to motivate students to engage in PA within and beyond the scope of the intervention.

The literature finds that PA interventions can significantly increase the amount of moderate-to-vigorous physical activity in students. Furthermore, PA interventions have been found to improve child and adolescent self-efficacy, as well as being found to improve student academic outcomes.

Approach (Whole School vs. Individual)

Despite recognition that environmental factors can shape or mediate PA in CYP, and the importance of taking other components into consideration (e.g., nutrition, and sleep), **most interventions are still focused on the individual level with less consideration towards social-ecological approaches**. One systematic review exploring implementation of school-based PA interventions noted that, the many of the studies were efficacy trials, and most focused on individual level interventions delivered through the school setting rather than on a whole-school approach (Naylor et. al., 2015). These findings are consistent with those of an earlier study by Golden and Earp (2012) who found that, despite the increase of theoretical affinity with a social-ecological approach, the focus of health promotion initiatives, including school-based interventions, in the past 20 years has primarily been on individual-level factors. A systematic review of PA among girls noted that PA interventions using educational and multicomponent strategies show larger effects (Biddle et al, 2014), suggesting that multi-factor interventions might have more impact than single-factor interventions. Several RCTs note that it is difficult to know the relative effect of each individual factor or whether all the factors are required to produce an effect (e.g., Pate et al., 2005; Saunders et al., 2006; Smedegaard et al., 2016; Sutherland et al., 2016). Still, **the support for school-based (with elements of family and/or community involvement), and multicomponent interventions are important to consider, given the effectiveness of these in line with socio-ecological theory** (Stokols, 1992). Biddle and

colleagues go on to suggest, however, that behaviour change sometimes take place in the absence of positive changes to the environment, suggesting that further research is needed in what works and for whom (Biddle et al., 2014).

Population (Gender, Age, and Baseline PA)

Existing literature highlights **certain groups (e.g., girls and those with lower baseline PA) benefit more from PA interventions**. One intervention, which focused on improving children's physical self-perception through a school-based PA intervention ('The Move for Wellbeing in Schools' study), found the greatest effects amongst students with the lowest baseline PA. The study conducted a sub-group analysis of gender, social class, body image, and leisure sport, which revealed significant differences at baseline for most self-perception variables. Subsequently, the study found that for students with no leisure sport participation at the intervention schools, the follow-up results showed a more positive development for global self-worth (Christiansen et al., 2018). In other research, targeted interventions, for those with the lowest level of fitness, were shown to be most effective (Ussher et al., 2007; Lawton et al., 2017).

Regarding differences in gendered interventions, Biddle et al. (2014) noted that based on their systematic review, **findings showed that interventions that targeted girls exhibited a higher effect size than universal intervention targeting both boy and girls**. This appears to be the case not only among adolescent girls (as might be expected due to self-presentation issues such as body image), but also among younger girls. Though some caution is recommended around these results (due to a relatively small effect size), other studies have supported the focus on girls, given the (often large) gap between male and female levels of PA (e.g., Dumith et al., 2011; Guthold et al., 2020; McMurray, 2020; Tucker, 2008). It has been argued that national efforts such as the "This Girl Can" campaign in the United Kingdom have been beneficial in closing the gender gap in PA through more visible active female role models (Guthold et al., 2020). The study suggests integrating social marketing campaigns with community-based interventions as a starting point for increasing PA levels among females, particularly in countries with large gender gaps. Furthermore, the study emphasises the cost-effectiveness of such efforts (Guthold et. al., 2020). Though there are limits to what schools can accomplish with respect to informing national policy, such schemes can be used as models for more localized efforts.

When designing interventions, differences in age should also be considered, given that **age-based abilities, preferences, and accessibility (as well as outcome measures) are different for children and adolescents.** A systematic review of 76 interventions conducted globally indicated that interventions delivered in the school setting that included physical education, activity breaks, or family strategies were the most helpful for children. Interventions offered in primary care settings and tailored advice/brief counselling were shown to be most effective for teenagers. A previous systematic review of the evidence discovered that around the age of ten, PA priorities shift from general PA with an emphasis on motor skill development to prescriptive PA (individual and group activities and organised sports) with an emphasis on health, fitness, and behavioural outcomes (Strong et al., 2005). **Therefore, while for younger children a focus on motor skill development through PE and recess/breaktime PA might be effective, adolescents may respond better to interventions that target (and potentially promote that they target), self-perception, enjoyment, and motivation.**

Length of Intervention Time

The duration of PA interventions appears to impact their outcomes, with recommended lengths varying by participant population and by age group. Biddle et al. (2014) found that shorter interventions (less than three months) were more effective among younger girls due to higher motivation and interest. However, Bechter et al. (2019) cautioned against relying solely on short-term effects, noting that long-term claims cannot be made without further investigation. One systematic review found that PA interventions lasting between three months and one year had the greatest effect on student motivation for PA. Shorter interventions showed significant effects in most variables, but interventions lasting more than a year showed stagnation in rating measures (Vaquero-Solis et al., 2020). Some longer-term RCTs, which ran between 1 and 3 years (e.g., Donnelly et al., 2009; Gibson et al., 2008; Pate et al., 2005; Saunders et al., 2006; Sutherland et al., 2016); and those which also took outcomes measures several months after the intervention ended (e.g., Lubans et al., 2016; Sebire et al., 2016; Smedegaard et al., 2016) were more able to track long-term or sustained results, though this has to be balanced with implementation burden (e.g., on teachers, staff, etc.) and financial considerations. Burns et al. (2017) note that in many interventions, the novelty and unique methodologies of these programs may initially elicit increases in PA behaviours, but these behaviours may return to approximate baseline levels over time due to relative decreases in motivational constructs. This merits further investigation.

Online Intervention

A report by the WHO argues that PA is not directly changed by an intervention but by a change in some personal, social, or physical variable as a result of the intervention, suggesting that, **if the factors that**

make PA appealing and enjoyable are understood, interventions and approaches can attempt to use this information to positively influence PA behaviour (Kelly et al., 2012). In an attempt to make PA more appealing and accessible to young people, several programs/studies have developed online interventions. One systematic review examined the influence of a range of online PA interventions on CYP's engagement with PA, finding that these interventions reported overall positive changes to CYP's PA behaviours, through increases in PA levels and emotions, attitudes, and motivations toward PA (Goodyear et al., 2023). The study acknowledges the potential benefits of online interventions in promoting PA participation. However, it also cautions that online interventions must be implemented carefully. The article cites previous research showing that if online interventions are used without adequate assessment and evaluation, they may have a negative impact on CYP's knowledge, attitudes, and behaviours related to PA (Chambers & Sandford, 2019; Öhman et al., 2014; Rich & Miah, 2017).

Barriers to Implementation

In the exploration of the barriers to implementation, it is vital that we consider the needs and experiences of the educators, as ultimately these are the individuals who are likely to be implementing the intervention. Often, educators are under time pressures and are already subject to high demands, thus it is important to consider the additional stress that implementing an intervention might have on their already full schedules (Rademaker et al., 2021; Walker et al., 2019). Ways in which time can be found to allow for an intervention to be implemented will first and foremost vary depending on the characteristics of the intervention. Certain physical activity interventions might be introduced within an extended Physical Exercise teaching period, or as an after-school activity (Caldwell et al., 2022; Cale & Harris, 2007). Other interventions might be better suited to implementation within the classroom, and the existing curriculum (Cale & Harris, 2007). Schools must not overburden their teachers, and must establish realistic goals, perhaps by increasing the time/efforts directed towards intervention implementation in steady increments to allow for teachers to adjust.

Intervention implementation significantly impacts outcomes but has received relatively less focus in the literature, with implementation challenges remaining around adopting and scaling interventions, and tracking outcomes beyond the end of the intervention. One key systematic review examined the evidence around implementation of school-based PA interventions, highlighting findings related to a) the relationship between implementation and health outcomes, and b), factors that influence implementation (Naylor et. al., 2015). Previous studies have identified a disparity between the development of effective interventions and the implementation of these interventions on a large scale in real-world scenarios (Durlak & DuPre, 2008; Glasgow & Emmons, 2007). Challenges that surfaced around implementation of interventions included: time, first and foremost, with teachers often mentioning the amount of time needed to prepare or deliver PA sessions or lessons, teacher overload, and competing demands related to other curricular needs; quality/availability of resources; supportive school climate; contextual appropriateness of the intervention; and availability of training and teacher self-efficacy (Naylor et. al., 2015, see p. 112 for full list of implementation challenges). These findings should inform the development of interventions that consider and minimize barriers to implementation (e.g., interventions that are less time-consuming for teachers, that require fewer resources, that take overall school climate into account, etc.).

Furthermore, **little is known about the implementation and impact of interventions after scaling up, highlighting the challenges and complexity of measuring implementation of multi-level and complex strategies in real world settings** (Greenhalgh et al., 2004; Greenberg & Abenavoli, 2017; Naylor et. al., 2015; Rowling & Samdal, 2011; Sallis et al., 2006). This is reflected in several of the RCT's which (even when the intervention was implemented in several schools with a large population) were often based in a single city, state, or region, without evidence of further scaling. Finally, the unsustainability of intervention implementation (and effects) in the long run is not well studied due to a lack of longer-term follow-through, and the challenges with maintaining behaviour, especially after the novelty of interventions has worn off (e.g., Burns et al., 2017).

Barriers to Physical Activity Interventions

Interventions focus on youth motivation to participate in PA, addressing barriers and behaviours that mediate their participation. The basic principle is that **if youth enjoy the activity, are involved in the development process, and are otherwise motivated to engage in PA, interventions will be more effective even in the longer run**. One systematic review matching young people's views about PA and effective interventions noted several barriers to PA, including not feeling competent enough to take part; negative reactions from peers over skill and choice of activity; feelings of inertia and conflicting interests; self-consciousness about bodies; parental constraints, sometimes related to concerns about safety or cultural restrictions; time, facilities, and dislike of highly structured activities or those organized by adults (Rees, 2006). Apart from material or physical barriers, many of the concerns expressed by young people (especially young women) notably have to do with the relationship between PA and self-perception and/or motivation. Interventions that attempt to address these kinds of barriers seem to be most effective when

young people themselves are involved in the research process and design. As Smedegaard and colleagues note (2016) involving stakeholders in the program and assessment processes can increase the likelihood of intervention being used on a long-term basis.

Recommendations from Implementation Science

The direct involvement of pupil voice in the development of interventions targeting children and adolescents is critical in ensuring effective promotion of PA, as highlighted by Kelly et al. (2012) in their WHO Report. In addition to expert recommendations, young people themselves have offered several suggestions that should be considered in the development of PA programs. First, the provision of increased opportunities for unstructured activity has been identified as a crucial aspect by both boys and girls (James et al., 2018). Furthermore, it is recommended that PA programs be made more locally accessible, and that existing facilities be improved to enhance the standards. Young people also suggested PA should be made more specific to their age group, and a choice of activities that includes greater variety should be provided. Furthermore, school PE programs could be improved by involving students in the consultation process over the selection of activities and introducing new activities such as aerobics and cycling (Rees, 2006). In addition, offering alternate, enjoyable, sociable, non-competitive forms of PE as realistic ways for change and improving the long-term participation in PE for children and youth (Belton et al., 2014) which could be especially beneficial for teenage girls (James et al., 2018).

In order for action to be taken effectively, many stakeholders must be fully engaged and responsive to implementation, including but not limited to: schools, families, sport and recreation providers, urban planners, and city and community leaders (Guthold et al., 2020). The European Heart Health Initiative (2001) offers recommendations on elements of PA promotion and ways in which these must intersect with multiple stakeholders to produce effect:

- Access to suitable environments and facilities are key determinants of wellbeing. Additionally, young people tend to be more likely to be physically active if they spend more time outdoors (Boone-Heinonen et al., 2010). This justifies an environmental approach to promoting PA, including policy and investment for safe walking and cycling routes, access to countryside and open space, as well as community sports and facilities.

- Family knowledge and involvement in encouraging PA can be important promoters of young people's PA. Parents may therefore need education and support to help them effectively encourage their children's initial and continued involvement in PA (Tudor et al., 2020).

- Given that after school and weekends are key times associated with PA for young people, the provision of facilities and services to promote activity at these times is crucial.

- Greater time invested in quality PE is also important. Properly designed and delivered PE programmes can enhance young people's enjoyment of and participation in PE. Conversely, qualitative research often notes strongly held negative views about PE, demonstrating how poorly delivered PE can discourage PA overall in life (Tudor et al., 2019).

- Further, school-based promotion of PA must extend far beyond the PE curriculum. Evidence suggests that a 'whole school approach' to health and PA promotion is warranted. This approach demands that PA promotion be integrated in broader efforts to promote health in schools.

Measurement

Method

Most studies of PA and wellbeing use some form of self-report assessment. These measures have strengths and limitations which are discussed below. Where possible, these largely subjective measures should be combined with some form of objective assessment (e.g., accelerometer, heart-rate monitor, etc.). The type of measurement which should be used in research and/or school settings depends on the aim, the setting, and the population involved (Kohl et al., 2000). Understandably, schools may not have access to objective measures, whereas self-report measures can be administered easily, quickly, and inexpensively. Below we explore the different types of measurement available and some of the strengths and weaknesses of each approach.

Self-Report and Objective Measures

Most research that explores PA in relation to wellbeing, mental health, and/or behaviour, employs self-report questionnaires (e.g., Goodyear et al., 2023). This approach is the most frequently validated method of PA assessment among children and adolescents (Kohl et al., 2000). This is due, in part, to self-report measurements being easy to implement and their ability to capture a range of different effects. Studies that use an objective measure of PA are less common (Bell et al., 2019), in part because these often rely on technologies that are more expensive and difficult to distribute to, and be used by, younger participants. However, using a combination of both self-reported questionnaires and objective measures of PA can have advantages (e.g., Biddle et al., 2014; Welk et al., 2000). Biddle and colleagues' systematic review (2019) suggests that objective monitoring tools may result in more precise assessments of outcomes and less measurement error, while self-report instruments may raise awareness of PA in participants and lead to behaviour change. The other benefit of this type of dual measurement design is that an objective measure used alongside a standardized self-report PA questionnaire can help researchers to account for varying contexts in which PA might be taking place while hanging onto the accuracy of objective measures. Using both types of data can be useful to understand the nuances in PA and wellbeing for CYP. The use of both needs to be balanced, however, with potential challenges in implementation, taking context (of schools and participant groups) into consideration.

Self-Report and Proxy-Report

There are many noted limitations of self-report questionnaires, such as unreliable estimates, recall bias, and misinterpretation of questions (Prince et al., 2008; Kirkpatrick et al., 2019). Also, however robust the measure is, the reliance on survey tools to generate data for the measurement of psychosocial wellbeing can only grasp parts of this complex phenomenon (Smedegaard et al., 2016). The use of self-report measurements has been especially critiqued for use with younger children due to their limited recall and more sporadic activity patterns (for example, short periods of PA with sporadic rest periods; Kohl et al., 2000; McNeil et al., 2009; Penpraze et al., 2006; Tucker, 2008; Welk et al., 2000). These challenges can be, and have been, mitigated by using proxy reports of the child's activity taken from parents or teachers (Kohl et al., 2000; Welk et al., 2000).

One systematic review of PA in pre-schoolers also indicated that proxy-report could be used in combination with direct observation and objective tools like an accelerometer, pedometer, heart rate monitor, for more accurate measurement (Tucker, 2008). The use of observation or activity monitoring, which tend to require more time and resources than self-report, needs to avoid placing undue burden on teachers and CYP. One study on measurement issues in the assessment of PA in childhood suggests that to simplify this kind of data collection, assessments could be focused on key times (time sampling) or places (location sampling) that allow children to be active, such as the time after school, during recess/breaktime, or during PE. This may also be useful to understand variability in activity patterns since children would all be exposed to the same stimulus or opportunity to be active (Welk et al., 2000).

Sample Questionnaires

Here we will outline subjective, objective and observational measurement instruments which have often been used in the field of PA intervention. Where possible, reliability and validity of the measurements are recorded in the table below. It is important to note that some researchers develop measurement instruments for use in their studies (Smedegaard et al., 2016), but as these instruments have not been assessed for reliability or validity beyond the respective studies, they will not be highlighted in this investigation into the methodology of PA interventions. The following instruments have also been identified as appropriate in the report because the themes of the measurement relate to wellbeing and PA outcomes which could be used to inform the evaluation of the interventions. The following questionnaires have been used in past studies to measure different PA and wellbeing effects. Some full questionnaire examples and more information are linked where available.

TABLE 2: SUBJECTIVE MEASURES OF PA FOR YOUNG PEOPLE

Self-report Questionnaire	Content	Age	Reliability	Language Validation	Availability
Health Behaviour in School-aged Children study (HBSC)	Q1: Participants were requested to indicate the frequency of being physically active for a minimum of 60 minutes during the preceding week. The question was accompanied by a definition of moderate-to-vigorous PA, which included examples and emphasized the activities that elevate the heart rate and cause breathlessness. Q2: Participants were asked to state how often they engage in exercise during their leisure time (excluding school hours) to the extent that they experience sweating or breathlessness.	11-15 years	Borderline to acceptable reliability was found for both moderate and vigorous physical activity across various countries. (Liu et al., 2010.; Bobakova et al., 2015)	English French Spanish	The questionnaire can be downloaded freely.
Programme for International Student Assessment (PISA)	Q1-2: Outside of school, during the past 7 days, on how many days did you engage in the following physical activities? One question for Moderate activity and one question for vigorous activity. Q3: This school year, on average, on how many days do you attend physical education classes each week? For these three questions,	15-16 years	So far, no peer-review article was found in terms of reliability of PISA's PA questions.	English French Spanish	The questionnaire can be downloaded freely.

	adolescents pick answers from 0-7days.				
Physical Activity Questionnaire for Older Children (PAQ-C) **Physical Activity Questionnaire for Adolescents (PAQ-A)**	The PAQ contains questions asking individuals to indicate their activity levels over the past week (7 days) by selecting from a list of activities and indicating their frequency of participation using a scale that ranges from 'no', 1-2 times per week, 3-4 times, 5-6 times, to 7 times or more. The questionnaire includes inquiries about physical activity during various time periods, such as physical education classes, recess, lunchtime, immediately after school, evenings, and the previous weekend. Participants are asked to indicate the frequency of their participation each day, ranging from 'none' to 'very often'.	8-14 years; 14-20 years	The PAQ is a commonly employed tool for evaluating physical activity in various countries and demonstrates a satisfactory level of reliability and validity.	English French Spanish	The manual can be downloaded freely online.
International Physical Activity Questionnaire short/long version (IPAQ-S; IPAQ-L)	The IPAQ is designed to provide standardised tools that can be used globally. The short version is recommended for national/regional surveillance systems, while the long version is recommended for research and evaluation purposes. The measure evaluates the	15-69 years	A strong level of psychometric properties across different countries for the IPAQ was found (Craig et al., 2003). Validity has also been supported in use of European adolescents (e.g., Hagströmer et al., 2008)	English French Spanish	Yes, under Creative Commons license CC BY 4.0

	intensity and duration of PA, as well as sedentary behaviour, as a means to estimate total PA. An example item: "Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure. "During the last 7 days, on how many days did you walk for at least 10 minutes at a time?"				
Youth Risk Behaviour Surveillance Survey (YRBS)	The Youth Risk Behaviour Surveillance System (YRBSS) is a biennial survey conducted by the Centres for Disease Control and Prevention in the United States. It focuses on capturing information related to adolescent health risk and health protective behaviours among grades 9 to 12. The survey covers a wide range of behaviours, including smoking, drinking, drug use, diet, and physical activity.	14-18 years	The test-retest reliability of YRBS questionnaire was found moderate for nearly all items. (Brener et al., 2002)	English Spanish	Both English and Spanish versions can be downloaded freely online.

TABLE 3: OBJECTIVE MEASURES OF PA FOR YOUNG PEOPLE

Objective Measure	Content	Age	Reliability
Accelerometer	A wearable device, often fastened onto a belt, wrist band, or around the ankle, which measures the acceleration of an individual. The acceleration measured is converted into a 'count', with a higher count indicating greater physical activity. However, accelerometers are not able to distinguish effortful movement, such as climbing stairs, carrying heavy objects, or cycling.	Typically used from age 8	The reliability of accelerometers is considered strong when it is worn over an appropriate period of time (between 4-12 days). (Trost et al., 2005; Ward et al., 2005; Vanhelst et al., 2019)
Pedometer	Often known as a step counter, a pedometer is a wearable device most commonly in the form of a watch. Steps are counted through arm movements which correspond with each step. Pedometers cannot measure activity beyond a step count, such as speed or intensity of movement.	Often used from age 5	The reliability of pedometers will differ depending on the model of pedometer, as well as the context in which they are being used. When using pedometers with children, the literature recommends a minimum of 3 days of wear in order for reliability to succeed $\alpha = 0.80$. (Stryker et al., 2007; Phillips et al., 2021)
Heart Rate Monitor	Electrodes are attached to the chest of the individual, and measures the electrical signal from the heart, indicating beats per minute. Though wearable during free movement, a heart rate monitor is not as portable or comfortable as other devices such as the accelerometer or pedometer.	From birth	Heart rate monitors are considered highly reliable and often used in medical contexts. However, an elevated heart rate is not always indicative of heightened physical activity and might instead be a measure of emotional arousal such as anxiety or stress. (Rowlands et al., 1997; Wang et al., 2017)

TABLE 4: OBSERVATIONAL MEASURES OF PA FOR YOUNG PEOPLE
(TYPICALLY USED WITH YOUNG CHILDREN)

Measure	Content	Age	Reliability	Language Validation	Availability
Children's Activity Rating Scale (CARS)	Following a schedule of 10-12 hours of observation, between 1-4 times a year, observers coded the level of activity on a scale from 1-5. 1. Stationary – no movement 2. Stationary – with movement 3. Translocation – slow/easy 4. Translocation – medium/ moderate 5. Translocation – fast, very fast/ strenuous	3-4 years	CARS was found to have high inter-rater reliability, with 84.1% of agreement between observers in coding. (Puhl et al., 1990)	English	The scale can be found freely.
The System for Observing Fitness Instruction Time for Preschoolers (SOFIT-P)	Using intervals of 10-second observations/recording, observers are asked to code 3 different decision sequence phases. Student activity levels are coded in the following: (1) lying, (2) sitting, (3) standing, (4) walking/moderate, and (5) vigorous. Lesson context is coded in the following: (M) general content, (K) knowledge content, (F) fitness, (S) skill practice, (G) game play, and (O) other/free play.	3-6 years	SOFIT-P is considered to be reliable, with kappa scores ranging from .68 to .92. (Sharma et al., 2011)	English	The scale can be found freely.

	Teacher interaction is coded in the following: (I) instructor promotes in-class physical activity/motor skills/fitness, (O) instructor promotes out-of-class physical activity/motor skills/fitness, (N) neither in-or-out of class physical activity/ motor skills/fitness is promoted.				
System for Observing Play and Leisure Activity in Youth (SOPLAY)	This observation system includes the 'scanning' of different areas of the school in different contexts. Observers are asked code: the physical environment, whether or not the children are sedentary, walking, or active, and then to code what the type of physical activity that the students are conducting.	5-12 years	SOPLAY is considered to be reliable, with over 88% inter-rater reliability. (McKenzie et al., 2020)	English	The scale can be found freely.
Observational System for Recording Physical Activity in Children (OSRAC)	Observers are asked to observe the child for 5 seconds, then record their behaviour in the 25-second interval following observation. This occurs over a 30-minute session. Observers are instructed to code behaviours relating to physical activity level, activity type, location, context, initiator of activity, group composition, and prompt for physical activity.	Childhood/ adolescence	OSRAC is considered to be a reliable measure, with strong interrater reliability. (McIver et al., 2009; McIver et al., 2016)	English	The scale can be found freely.

The provided subjective, objective, and observational measurements have been utilized extensively in the field of PA. This serves to provide readers with a range of instruments suitable for assessing PA in school settings. These diverse measurement approaches can be combined to gain a comprehensive understanding of PA in schools (Biddle et al., 2014; Tucker, 2008; Welk et al., 2000). However, as highlighted in the preceding section, each type of instrument possesses its own set of advantages and disadvantages.

A comprehensive review of measurement methods for assessing PA in children and adolescents has yielded several key findings that deserve emphasis (Kohl et al., 2000, p. 73):

a) It is recommended to avoid employing self-report recall methods when evaluating children who are younger than 10 years old.

b) For young children, direct observation and mechanical monitoring may be the most effective methods, while the involvement of interviewers can enhance the validity of recall and reporting, particularly among older children and adolescents.

c) Electronic monitoring stands out as the preferred choice for detecting and assessing PA patterns, especially in terms of intensity, over extended periods.

Hence, for children and adolescents aged 10 and above, self-report questionnaires represent a validated and easily implementable (although somewhat less precise) measurement method. These questionnaires can be complemented with objective measures whenever feasible. In terms of self-reported measurements, we recommend utilizing questions from well-established sources such as HBSC, PISA, PAQ, and IPAQ, as these have undergone empirical validation and are available in multiple languages. Conversely, for younger populations (those under 10 years of age), observation and proxy reports prove more practical, although their implementation should consider the time and workload of teachers.

Summary

This report underscores the insufficiency of physical activity (PA) among children and youth, a trend that originates in early childhood and persists throughout subsequent years. The extensive literature highlights a strong association between PA and wellbeing, especially the physical health and socio-emotional aspects of wellbeing during childhood and adolescence. Furthermore, the benefits of PA extend to influences on students' self-esteem, social, and cognitive development, pointing to a need for school leaders to consider integrating PA into their schools' broader wellbeing development agenda.

This report delves into a range of interventions and measurements based on their evidence levels. These resources serve to provide readers with a comprehensive understanding of PA research and to direct potential resources for schools to align with their unique needs. The report also addresses factors such as approach, the demographics of target groups, and the length of intervention which could impact the effectiveness of PA programs. In light of this, the report offers pragmatic suggestions derived from literature to guide the design and adoption of interventions. Incorporating pupil voice in the formulation of PA interventions emerges as a pivotal recommendation for effective PA agendas, as well as the enhancement of accessibility to local PA programs, and the improvement of existing facilities' standards. Furthermore, the offering of enjoyable, sociable, and non-competitive PA is an efficient approach to foster engagement among children and youth in the long run.

Finally, research indicates that the social context within which PA unfolds– particularly with regard to relationships involving peers, educators, coaches, and parents– plays a pivotal role in the success of PA. However, the majority of interventions still primarily target the individual level, with minimal integration of social-ecological perspectives. In fact, it is not solely schools, but also teachers, peers, and family involvement that play crucial roles as promoters of young people's PA. The adoption of a 'whole school approach' stands as a promising pathway to explore in this context.

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For a full list of references used in this report and access to additional supplementary materials, visit wellbeing.hmc.ox.ac.uk/schools.

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Appendix

Appendix: Physical Activity Interventions

Intervention	Description	Details	Evidence Level
Wessex Healthy Schools Award Scheme Moon et. al. (1999)	The award scheme provides structured frameworks, health-related targets and external support to help schools become health promoting. The scheme covers nine key areas—the curriculum, links with the wider community, a smoke-free school, healthy food choices, physical activity, responsibility for health, health-promoting workplace, environment, and equal opportunities and access to health (Rogers et al., 1993).	Ages 11-16 School-based	A controlled design.
Know Your Body Walter (1989)	The "Know Your Body" project, initiated in 1975 with funding from the National Heart, Lung, and Blood and the National Cancer Institutes, was developed in response to the empirically-validated suggestion that the primary prevention of chronic disease should begin in childhood. The aim of the program is to fa-vourably modify the population dis-tributions of risk factors for these diseases through changes in their behavioural antecedents.	Age 9 School-based *n*= 1,590 (The Bronx, intervention) *n*= 693 (The Bronx, control) *n*= 485 (Westchester, intervention) *n*= 620 (Westchester, non-intervention)	Overall strong RCT with large populations in two cities and 5 year longitudinal.
Pathways Caballero et al. (1998) Caballero et al. (2003)	Pathways is a multicentre school-based study aimed at reducing the alarming increase in the prevalence of obesity in American Indian chil-dren. It is designed as a randomized clinical trial, involving approximate-ly 2,000 third grade children in 40 schools in seven different American Indian communities. During a 3-year feasibility phase, which was just completed, the major compo-nents of the intervention (school food service, classroom curriculum, physical education	Grade 3 School-based *n*= 2,000	A randomized clinical trial, pilot tested.

	program, and family involvement) were developed and pilot-tested.		
Slice of Life Programme Perry et al. (1987)	'Slice of Life' is a 10-session high school curriculum designed to promote healthy eating and physical activity patterns with adolescents. The program is designed based on a social learning model, suggesting that changes in specific environmental, personality and behavioural attributes are likely to influence changes in eating and physical activity patterns.	Ages 14-15 School-based *n*= 173 (intervention) *n*= 97 (control)	RCT but less strong, with smaller population.
Switch-off 4 Healthy Minds (S4HM) Babic et al. (2016)	The S4HM intervention was guided by Self-Determination Theory and included: an interactive seminar, eHealth messaging, a behavioural contract and parental newsletters. The primary outcome was recrea-tional screen-time. Secondary out-comes included mental health (i.e., well-being, psychological distress, self-perceptions), objectively meas-ured physical activity, and body mass index (BMI).	Ages 12-14 School-based, online spaces *n*= 322	RCT, robust population, strong evidence but the results indicate a non-significant difference between control and intervention groups.
PE teacher-training program RCT Bechter et al. (2019)	Implement a teacher training program—based on well-established pedagogical strategies to improve key student outcomes (e.g., PE motivation, self-efficacy).	Ages 12-16 School-based, PE class *n*= 554	A controlled, cluster-randomized design, the focus on conceptual (SDT) and pedagogical (student-cantered learning) integration, and the inclusion of observer assessments to determine intervention feasibility.
PE teacher's autonomy intervention Cheon et al. (2018)	Implement an intervention program based on support for the autonomy of PE teachers to promote prosocial behaviours in students. We designed and carried out the present investigation to help PE teachers address the very practical problem of enhancing their students'	Grade 2 School-based, PE class *n*= 1,824	A needs-based motivational approach to explain the conditions under which students' prosocial increases and their antisocial behaviours decreases over the course of an academic semester.

	prosocial behaviour and diminishing their students' antisocial behaviour.		
ATLAS RCT Lubans et al. (2016)	The intervention was based on Self-Determination Theory and Social Cognitive Theory and involved: professional development, fitness equipment for schools, teacher-delivered physical activity sessions, lunch-time activity sessions, re-searcher-led seminars, a smartphone application, and parental strategies. Evidence from 14 secondary schools in low-income communities of New South Wales, Australia suggests that socio-ecological inter-ventions providing opportunities for young people to be active in differ-ent domains within and beyond the school day are needed.	Ages 12-14 School-based, boys *n*= 361	The study strengths include the cluster RCT design, longer-term follow-up to assess maintenance of intervention effects, as well as high rates of retention and intervention fidelity. The potential scalability of this program is another notable strength, which is demonstrated by interest from key stakeholders in the education system.
Manipulation of the self-determined learning environment on student motivation and affect within secondary physical education Perlman et al. (2013)	A 4-week (16-lesson) unit of bas-ketball following the skill–drill–game approach. Assess the psycho-social, motivational and affective responses of students in two differ-ent learning contexts. Findings sup-port the notion that engaging stu-dents in a highly autonomy-supportive context can facilitate change in the need for competence, motivation, and affect.	Ages 9-10 School-based, PE class *n*= 41 (highly autonomy-supportive (HAS) class) *n*= 38 (highly controlling (HC) class)	RCT design, but smaller population size than other RCTs.
Motivational Pathways to Leisure-Time Physical Activity Participation in Urban Physical Education: A Cluster-Randomized Trial	An autonomy supportive physical education (PE) instruction on student motivation and PA. The results show Autonomous exercise motivation was an indirect link transferring PE autonomy to PA intentions and participation.	Ages 11-13 School-based *n*= 408	RCT design with medium-large sized population. Used self-reporting methods at times.

Yli-Piipari et al. (2018)			
Use of in-home stationary cycling equipment among parents in a family-based randomized trial intervention Rhodes et al. (2018)	The purpose of this study was to examine the use of home exercise equipment in the form of exergame cycling compared to a stationary recumbent bicycle ergometer in front of TV in the home over 3 months among parents of an inter-vention with their inactive children. The findings suggested that irre-spective of modality, use of exercise equipment declined considerably for parents over three-months. Parents may also benefit from family physi-cal activity interventions, but it de-pends on their physical activity sta-tus, how much they would enjoy using the equipment, and their over-all perceived control over being physically active.	Ages 10-14 Home/family-based, targeted for insufficiently active CYP *n*= 73	Strong methods and RCT
Action 3:30, Delivery and Receipt of a Self-Determination-Theory-Based Extracurricular Physical Activity Intervention Sebire et al. (2016)	The implementation, fidelity, and receipt of a self-determination-theory-based after-school physical activity intervention (Action 3:30) delivered by teaching assistants (TAs) was examined using a mixed-methods process evaluation.	Ages 9-11 After-school *n*= 539	First mixed-methods theory-based process evaluation of an SDT-informed primary-school-based PA intervention. The quantitative and qualitative results, documenting the perspectives of multiple informants, have provided an in-depth exploration of the processes of intervention delivery by TAs and receipt as experienced by children.
Web-based Intervention based on SDT to help teachers support their students' autonomy Tilga et al. (2019)	This study investigated whether a Web-Based Autonomy-Supportive Intervention Program (WB-ASIP) for physical education (PE) teachers would alter their students' perceptions of (a) the teachers' multidimensional autonomy-supportive and controlling behaviors, (b) their own psychological need satisfaction and frustration, and (c) perceived intrinsic motivation.	Ages 10-15 Web-based *n*= 321	Fairly robust intervention with medium-large participant group. Models what online interventions could look like.

Switch What you View Do and Chew Gentile et al. (2009)	This study examined the immediate and short-term, sustained effects of the Switch program, which targeted three behaviours (decreasing chil-dren's screen time, increasing fruit and vegetable consumption, and in-creasing physical activity) at three ecological levels (the family, school, and community). Switch program yielded small-to-modest treatment effects for promoting children's fruit and vegetable consumption and minimizing screen time.	Grades 4-5 Home-based (and some school) *n*= 1,323	Most previous school-based interventions have utilized tight controls to ensure uni-form implementation, but these require frequent staff training and ongoing support. That approach is costly and limits sustainability. Our ap-proach was to standardize rec-ommendations to communi-ties, teachers and parents but to allow flexibility in how the materials were used.
Active Living Connections McNeil et al. (2009)	To identify if outreach support increases school-aged children's participation in recreational activities. This study found that outreach support for families was more effective in increasing children's participation in activities, particularly those of a physical nature, than the provision of information alone.	Grades 3-5 Home-based, family/ community *n*= 306	Strong evidence based on longer-term and robust RCT.
The Copenhagen School Child Intervention Study Bugge et al. (2012)	This study assessed short-term and long-term effects of a 3-yr controlled school-based physical activity (PA) intervention on fatness, cardiorespiratory fitness ($\dot{V}O_2peak$) and CVD risk factors in children.	Ages 6-7 School-based, PE class *n*= 696 (baseline)	The main strengths of our study were the length of the intervention, the inclusion of a 4-yr follow-up postintervention and the use of accurate methods of measuring PA, $\dot{V}O_2peak$, and CVD risk factors.
FunAction Canada Bush et al. (2010)	This study offers preliminary evidence that noncurricular physical activity promotion programs that apply social marketing principles can be effective in engaging multi-ethnic, underserved adolescents in physical activity.	Grades 7-8 School-based, non-curricular *n*= 276	Non-randomized, and too short a timeframe. But it contributes to the literature regarding non-curricular, school-based physical activity intervention studies designed for a multi-ethnic, underserved population.

PLAY (Promoting Lifestyle Activity for Youth) Pangrazi et al. (2003)	This study examined effects of a school-based intervention called PLAY (Promoting Lifestyle Activi-ty for Youth) on physical activity levels and BMI of students. Partici-pants included 606 fourth-grade students selected from a stratified sample of 35 schools in Arizona and placed into four groups: PLAY & PE, PLAY Only, PE Only, and No Treatment. Results indicated the treatment was effective at increasing the physical activity level of chil-dren, especially girls. No significant differences between groups were found for BMI.	Grade 4 School-based *n*= 606	Interesting design in terms of having the children divided into four groups rather than just control and intervention, showed some varying effects according to program versus normal PE class.
Las niñas saludables Larsen et al. (2018)	This study aimed to assess the feasibility, acceptability, and potential efficacy of a web-based physical activity intervention for Latina adolescents in a single-arm pilot trial.	Ages 12-18 Web-based *n*= 21	Strengths of this study included the novel, high-risk population; Web-based intervention channel; formative research; and individually tailored, theory-based intervention content.
Dance-Based Physical Education (DBPE) Makopoulou et al. (2021)	Examine the effects of a Dance-Based Physical Education (DBPE) intervention on reading comprehen-sion (RC). The study employed a mixed- methodology: combining a pre-post test quasi-experimental re-search design (intervention, n = 24; control n = 18) with process evalua-tion (follow-up) focus groups. Overall, the findings suggest that the tailored integration of dance and reading within PE can bring about meaningful gains in RC.	Grade 4 School-based *n*= 32	The present study provides a useful template for future DBPE research – both practically and methodologically.
Multidimensional dance program Amado et al. (2020)	Learn the effect of pupil's gender on their motivational level and the psy-chological consequences that might arise in the cognitive, affective, and behavioural domains. A quasi-experimental study was carried out at four schools in Mexico, with 12 physical education teachers and 40 natural groups of pupils aged between	Ages 11-17 School-based *n*= 921	Robust design, large population size.

	11 and 17 (M = 13.17). The groups were randomly assigned to either an experimental group (24 groups, 447 pupils) or a control group (16 groups, 474 pupils). A prior training programme was car-ried out with the teachers in the ex-perimental group to enable them to support the psychological need for autonomy, competence, and related-ness.		
Multidimensional dance program Amado et al. (2014)	Verify the effect produced on the motivation of PE students of a multi-dimensional programme in dance teaching sessions.	Ages 14-16 School-based *n*= 47	High quality design, with multidimensional model. average effect size.
TARGET Abós et al. (2016)	Grounded in self-determination the-ory and achievement goal theory, this quasi-experimental study evalu-ated the effectiveness of a teaching intervention programme (TARGET) to improve predisposition towards physical education based on devel-oping a task-oriented motivational climate and supporting basic psy-chological needs. The final sample consisted of 35 secondary education students, aged 15–17 (M age = 15.35, SD = 0.49), divided into two groups: control (n = 15) and exper-imental (n = 20). The intervention programme was applied in the ex-perimental group to 12 acrosport unit lessons based on motivational strategies by means of TARGET areas (Task, authority, recognition, grouping, evaluation and time).	Ages 15-17 School-based *n*= 35	Good Quality (according to Vaquero-Solis et al, 2020).
West Midlands Active Lifestyle and Healthy Eating in School Children (WAVES) Study	The West Midlands ActiVe lifestyle and healthy Eating in School children (WAVES) study is a child-hood obesity prevention program targeting children aged 6-8 years. This 12-month intervention includes structured moderate to vigorous PA opportunities every school	Grades 1-3 School-based	Cluster randomised controlled trial with control group (re-ceiving citizenship education resources) Cluster randomised controlled trial with control group (receiving citizenship education resources).

Adab et al. (2018)	day, cooking workshops for both chil-dren and parents, signposting of local family physical activity oppor-tunities and promoting healthy life-style messages through a six-week programme (Villa Vitality).	*n*= 1,392 (baseline) *n*= 1,249 (first follow-up in 15 months) *n*= 1,145 (second follow-up in 30 months)	