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LEADING ARTICLE

Standing Classrooms: Research and Lessons Learned from Around the World

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Abstract Children spend between 50 and 70 % of their time sitting while at school. Independent of physical activity levels, prolonged sitting is associated with poor health outcomes in adulthood. While there is mixed evidence of health associations among children and adolescents, public health guidelines in the USA, UK, Australia and Canada now recommend young people should break up long periods of sitting as frequently as possible. A potentially effective approach for reducing and breaking up sitting throughout the day is changing the classroom environment. This paper presents an overview of a relatively new area of research designed to reduce youth sitting time while at school by changing the classroom environment ($n = 13$ studies). Environmental changes included placement of height-adjustable or stand-biased standing desks/workstations with stools, chairs, exercise balls, bean bags or mats in the classroom. These 13 published studies suggest that irrespective of the approach, youth sitting time was reduced by between ~44 and 60 min/day and standing time was increased by between 18 and 55 min/day during classroom time at school. Other benefits include increased energy expenditure and the potential for improved management of students' behaviour in the classroom. However, few large trials have been conducted, and there remains little evidence regarding the impact on children's learning and academic achievement. Nevertheless, with an increasing demand placed on schools and teachers regarding students' learning outcomes, strategies that integrate moving throughout the school day and that potentially enhance the learning experience and future health outcomes for young people warrant further exploration.

Key Points

Standing classroom interventions in youth reduced sitting time by up to 60 min/day and increased standing time by 55 min/day.

For the majority of children, classroom behaviour was improved with the implementation of standing classroom interventions.

The impact of standing classroom interventions on academic performance is still unknown.

Further exploration in this area of research is warranted.

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1 Introduction

1.1 Why Reduce Sitting in Youth?

In the last 50 years, physical activity has progressively decreased and sedentary behaviour (i.e. prolonged sitting) has increased markedly as a result of hi-tech innovations

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and economic progress [1]. In adults, time spent in sedentary behaviour is associated with an increased risk of cardiovascular disease [2–5], metabolic syndrome [6], type 2 diabetes mellitus [3, 4, 7], mortality caused by cardiovascular disease [2–4, 7], all-cause mortality [3–5, 7] and depression [8]. Although in youth the evidence is less consistent [9–11], sedentary behaviour (television viewing, proxy sedentary behaviour) has been associated with overweight [12, 13], poor fitness in childhood and raised cholesterol in adulthood [14]. Most recent evidence showed that several markers of inflammation and endothelial dysfunction were unfavourably associated with sedentary behaviour [15], signalling associations with cardiovascular health in children. Furthermore, time spent in sedentary behaviour negatively influences self-esteem [13, 16], life satisfaction [16], psychological well-being [17], pro-social behaviour [13], academic performance [13, 18] and cognitive development [19]. While it is possible to be physically active and highly sedentary [20, 21], reducing sedentary behaviour is still critical to health [22]. Several studies report high levels of sedentary behaviour in youth globally [23], and sedentary behaviour in childhood has been shown to track into adolescence [24] and adulthood [14]. Considering the health, psychosocial and cognitive risks related to sedentary behaviour, the health benefits associated with different physical activity intensities [25], and the knowledge that sitting increases as children get older, interventions to limit these behaviours and increase activity (light to vigorous intensity) among youth are needed.

1.2 Why Reduce Sitting in the Classroom?

There is strong support for the concept of providing a supportive environment for behaviour change within the home and school environments [26]. As children's environments have a dominant influence on their daily physical activity [27], interventions that target those environments are warranted. One such environment is the school, where children spend up to 6 h/day, and 50–70 % of which is spent sitting [28–30]. Changing the classroom environment to an activity-permissive one by reducing sitting time is an emerging area of research, and this paper aims to provide an overview of the literature to date. An activity-permissive environment is a classroom environment that allows movement and activity during classroom lessons [27].

2 Does Changing the Classroom Environment Reduce Youth Sitting Time?

A variety of environmental interventions that aim to reduce classroom sitting time and increase standing/movement have been implemented in schools and evaluated for effectiveness (see Table 1 for published studies) [27, 31–44]. Most of these studies have removed traditional desks and chairs from classrooms and replaced these with height-adjustable, or stand-biased, desks or workstations. One of the first studies [44] provided children in a German classroom with standing tables with tops that tilted and encouraged 'dynamic' sitting; the control condition was a grade-matched classroom with traditional furniture in Belgium. Significant differences between the intervention and control conditions were reported in observed bouts of static and dynamic sitting (53 and 97 %, respectively).

Benden and colleagues in the USA [31, 35–37, 39–41] have used stand-biased desks and stools in their school interventions. A stand-biased desk is at a fixed height (adjusted to an appropriate level for the child) and can have a foot rest (see Fig. 1). In one of the studies, participants were provided with a Stand2Learn LLC (College Station, TX, USA) stand-biased desk (model S2LK04) and stool (model S2LS04). Mean energy expenditure was significantly higher in the autumn/fall (+0.16 kcal/min) and spring (+0.08 kcal/min) semesters than in the control group. Overall, the studies by Benden and colleagues [31, 35–37, 39–41] showed an increase in energy expenditure in the short- and longer-term interventions as a result of the stand-biased desks.

Hinckson and colleagues in New Zealand used standing workstations (Guangdong Furniture Factory, China) without stools in their studies [32–34]. Each workstation accommodated four to five children and included a circular workstation in the centre of the classroom and semi-circular stations situated strategically around the central workstation (Fig. 2). Children with similar floor-to-elbow height were grouped together, and the standing workstations were adjusted by researchers to accommodate their specific height. Swiss (exercise) balls, bean bags and mats were available to use when the children were tired. Preliminary evidence (over 4 weeks) indicated that children in the intervention group sat less (44 min difference between control and experimental), stood longer (54 min) and engaged in fewer transitions (five counts) from sitting to standing than the control group [34]. Over 9 intervention weeks, the intervention successfully increased standing by 55 min/day compared with the control classroom [33].

In Australia and the UK [30, 45], children aged 9–15 years old used individual height-adjustable sit–stand desks (WorkFit-PD and LearnFit® desks; Ergotron®, St Pauls, MN, USA) that moved up and down manually with the use of a lever and allowed the children to work in a seated or standing position (Fig. 3). Existing stools or chairs belonging to the schools were used with the desks. Due to lack of space in the UK classroom, a bank of six desks was placed in the classroom and teachers rotated the children around to use the desks (1 h exposure per day). In

Table 1 A summary of studies incorporating standing desks or adjustable desks in the classroom environment

Study, location	Study design	Intervention	Intervention duration	Sample size and age range	Primary outcome	Findings
Aminian et al. [33], Auckland, New Zealand	Controlled trial	Height-appropriate standing workstations replaced traditional desks/chairs in intervention classrooms. Swiss balls, bean bags provided	9 weeks, with follow-up at 22 weeks	I: 18 C: 8 9–11 years	Time spent sitting, standing and stepping—activPAL™	Over the school day, intervention group reduced their sitting time by 45 min and increased standing time by 55 min
Benden et al. [35]; Blake et al. [40], Texas, USA	Pilot RCT	Sit–stand desks replaced all standard desks in 2 intervention class rooms. Stools provided	1 school year	I: 31 C: 27 6–7 years	EE—BodyBugg® armband	By week 12, intervention group spent at least 75 % of class time standing. EE was increased by 17 % in the intervention group relative to controls
Benden et al. [36], Texas, USA	Within-subjects trial	Sit–stand desks replaced all standard desks in 1 class room. Stools provided	5 months	I: 9 6–8 years	School hours EE—BodyBugg® armband	EE increased by 25.7 % when children used the sit–stand desks relative to traditional desks
Benden et al. [41], Texas, USA	Controlled trial	Sit–stand desks replaced all standard desks in 2 intervention class rooms. Stools provided	Outcome measures taken at a single timepoint	I: 15 C: 27 7–9 years	Directly observed posture and self-reported levels of discomfort	No differences in time spent in non-preferred postures between control and intervention groups. Discomfort was lower in intervention group
Benden et al. [39], Texas, USA	Controlled trial	Sit–stand desks replaced all standard desks in 12 intervention class rooms. Stools provided	1 school year	I: 202 C: 135 7–9 years	School hours EE and steps—SenseWear™ armband	EE increased by 0.16 and 0.08 kcal/min in the fall/autumn and spring semesters in the intervention group. Steps higher in the intervention group
Cardon et al. [44], Hanover, Germany (I) and Flanders, Belgium (C)	Pilot controlled trial	Intervention classroom equipped with ergonomic furniture allowing varying working postures, including a standing desk	1.5 years	I: 22 C: 25 8 years	Directly observed posture, accelerometer-determined activity and self-reported discomfort	Intervention group more time spent in dynamic sitting, standing and walking and movement. No differences in discomfort between groups
Clemes et al. [30], Bradford, UK	Pilot controlled trial	Six sit–stand desks replaced standard desks (sitting 6 children) in 1 class room. Children were exposed to the desks for >1 h/day. Stools provided	9 weeks	I: 16 C: 14 9–10 years	Class time spent sitting, standing and stepping—activPAL™	Intervention group reduced their sitting time by 52 min and increased their stepping time by 14 min
Clemes et al. [30], Melbourne, VIC, Australia	Pilot RCT	Sit–stand desks replaced all standard desks in 1 class room. Chairs provided	10 weeks	I: 24 C: 20 11–12 years	Class time spent sitting, standing and stepping—activPAL™	Intervention group reduced their sitting time by 44 min and increased their standing time by 18 min

Table 1 continued

Study, location	Study design	Intervention	Intervention duration	Sample size and age range	Primary outcome	Findings
Dornhecker et al. [37], Texas, USA	Controlled trial	Sit–stand desks replaced all standard desks in 12 intervention class rooms. Stools provided	1 school year	I: 158 C: 124 7–9 years	Directly observed classroom engagement and off-task behaviour	Intervention group exhibited greater levels of academic engagement relative to the control group
Hinckson et al. [34], Auckland, New Zealand	Pilot controlled trial	Height-appropriate standing workstations replaced tradition desks in intervention school classrooms. Swiss balls and bean bags provided for sitting	4 weeks	I: 23 C: 7 9–10 years	Daily time spent sitting, standing and stepping—activPAL™	Over the whole school day, intervention group reduced their sitting time by ~1 h and increased standing time by ~40 min
Koepp et al. [42], Idaho, USA	Pilot within-subjects trial	Height-appropriate standing desks replaced standard desks. Stools provided	5 months	I: 8 10–11 years	Classroom activity—Walk4Life pedometer, and classroom behaviour	Classroom steps increased by 362 steps/day (not significant). No significant changes in behaviour
Koskelo et al. [43], Eastern Finland	Controlled trial	Intervention participants provided with sit–stand desks and adjustable chairs	2 years	I: 15 C: 15 16 years at base	Photographed sitting/standing posture, muscle tension and self-reported pain	Sitting/standing postures improved in the intervention group and muscle tension declined. Neck–shoulder pain reduced significantly in the intervention group
Lanningham-Foster et al. [27], Minnesota, USA	Within-subjects trial	Students undertook lessons in their traditional classroom (1 week), in an activity-permissive classroom that included standing desks (2 weeks), and in their traditional classroom with standing desks (8 weeks)	12 weeks overall	I: 24 9–11 years	Accelerometer-determined physical activity	Children moved significantly more in the activity-permissive classroom than in the 2 traditional classroom conditions

C control group, *EE* energy expenditure, *I* intervention group, *RCT* randomised controlled trial

Fig. 1 Stand-biased and seated desk (photograph courtesy of Stand2Learn LLC)

Fig. 2 Standing workstations

Australia, a whole classroom was fitted with the desks and stools. In both sites, a traditional classroom served as the control condition. Despite the implementation differences, there were similar reductions in children's objectively assessed class sitting time in both study sites of −52 min in the UK intervention condition (compared with −7 min in the control condition) and −44 min in the Australian intervention condition (compared with −28 min in the control condition) [30].

Overall, environmental interventions in the classroom have typically lasted for one or two terms (9–22 weeks) [28, 31–34, 45], though the German/Belgian and US studies lasted between 1.5 and 2 years [31, 44], with the majority implemented in primary [28, 32–40, 44] rather than secondary schools [31, 45]. Many of these studies could be considered 'natural experiments' as students were able to choose voluntarily how long they sat for each day (no specific daily targets prescribed). For example, 70 % of students in one study did not use the stools at all and stood,

Fig. 3 The Ergotron® WorkFit-PD desks, as used in the UK study intervention classroom, with existing school stools

while in another 30 % stood for about 75 % of the time [35]. In the standing workstation studies, sitting time reduced and standing time increased even when exercise balls, bean bags and mats were placed in the classroom for use when children were tired [33, 34]. When children are given a choice between sitting and standing during class, the studies suggest that children choose to sit less.

In our overview of the studies conducted thus far (Table 1), the results indicate that irrespective of the type of standing desks, whether height-adjustable [38, 45] or stand-biased [31–34], individual [31, 38, 45] or group [31–34], at a primary school [31–34, 38] or secondary school [31, 45], with stools [31, 38, 45] or without [32], alongside exercise balls, bean bags and mats [32–34] or not, for shorter [32–34, 38, 45] or longer [31] periods, youth sitting time is reduced and standing time is increased during classroom time at school.

3 Do We Understand the Long-Term Academic Impacts?

Among school-aged children, higher television viewing time (proxy for sitting time at home) has been associated with attention difficulties, slowed reading progression, lower cognitive test performance and less leisure time spent studying and reading; all of which may potentially reduce academic achievement [13]. Similar data for the school setting are not widely available but a few studies have examined the relationship between classroom sedentary behaviour and cognitive functioning and academic performance. Preliminary anecdotal accounts from students, teachers and principals suggest favourable outcomes [41], including improved classroom behaviour. In the USA, standing desk environments have been associated with greater engagement than in traditional rooms and, in particular, obese children seemed to benefit more from the environmental change than their sedentary peers in

traditional classrooms [38]. While the importance of educational design and learning performance has been previously recognised [46], little research has examined whether standing desk interventions may also improve academic outcomes, via either improvement in academic behaviours (e.g. students' ability to focus and engage) and management (e.g. the control of disruptive behaviour), or students' cognitive ability. For this area to progress, robust and standardised measures of cognitive ability (e.g. test of attention, working memory, executive functions), academic behaviours (e.g. behavioural and attention–inattention observations and teacher self-report measures) and academic outcomes (e.g. grades, discipline totals, standardised test scores and teacher evaluations) are needed over long periods of time with large randomised controlled studies. Arguably, this aspect of the intervention will ultimately drive acceptance and widespread adoption by educators more than any potential health improvements.

4 Common Perceptions and Barriers

4.1 Potential for Pain and Discomfort

A concern sometimes expressed by teachers and parents is that excessive standing during the school day might cause pain and discomfort to the child. Unfortunately, results from this area of research are equivocal. Cardon and colleagues found in the "Moving School" intervention that rates of self-reported back or neck pain in young children did not differ significantly between the experimental (ergonomic furniture and standing desks) and control (traditional desks and chairs) groups; 47 % of children in the intervention class reported general neck or back pain, compared with 26 % of children in the control class [44]. In contrast, Koskelo and colleagues [43] reported significant reductions in neck–shoulder pain in the intervention group (sit–stand desks/adjustable chairs) compared with the control group in adolescents. Furthermore, studies have shown both positive and negative associations between lower back pain and sitting in children [47–53]. Nevertheless, the prevalence of back pain in school children has been reported consistently [47, 54] and as high as 51 % [50]. Trevelyan and Legg suggested that to reduce pain related to sitting in the classroom it is necessary to implement interventions that aim to decrease classroom sitting time [47].

Hinckson and colleagues [34] found that primary school children reported little to no musculoskeletal pain or fatigue following the use of standing workstations after 4 weeks. Similarly, Aminian and associates [33] showed no substantial differences between baseline and final reporting of neck, elbow, wrist, hip/thigh, knee and foot/ankle pain following a 9-week use of standing workstations. In a recent Australian pilot study examining the feasibility of height-adjustable desks in a secondary school after one school term [45], just over 50 % of students reported that the sit–stand desks gave them pain in their legs or back. As pain and discomfort are highly individualised sensations, it is difficult to determine whether this was due to use of standing desks or a pre-existing condition. However, the majority of adolescents reported that the desks helped them to pay attention and concentrate in class, work well during lessons and enjoy the lessons more. The use of standing desks in classrooms needs to be considered in the context of the ergonomics of standing, ensuring that posture is appropriate, desks are at the correct height and static standing is discouraged. There is also likely to be a period of adjustment for children to condition their muscles to work this way. These issues are discussed in Sects. 6 and 7.

4.2 What do the Teachers Think?

Addressing the issue of prolonged sitting in the classroom requires a comprehensive approach so that students, parents, teachers and senior school staff have the opportunity to contribute to the changes of the classroom environment. Qualitative analysis of New Zealand teachers' interviews [33] indicated that their experiences were generally positive, commenting that the standing workstations offered increased space, heightened social interactions, happier children, easier supervision and better behaviour. Some [32], however, were concerned about the loss of control over the class, random movements and off-task behaviour, and difficulties in managing some behaviours. The concerned teachers also commented that less physically active students and overweight students found the desks more challenging. However, it was also noted that the warm summer weather may have contributed to the fatigue (not just the standing). Overall, teachers recognised the importance of being life-long learners themselves, accepting new practices, adapting to the furniture and being flexible in their approaches. Similarly, Australian secondary school teachers [45] were positive about the use of standing desks, indicating that students were more active, concentrated better and paid more attention. However, some studies have reported classroom space to be an issue, with some unable to accommodate standing desks for all students [30]. Teachers also commented on logistical issues such as needing to ensure that shorter students were located at the front of the class so they could see the whiteboard [30].

Although the use of standing desks is an effective way to decrease sitting time in the classroom, teachers' attitudes towards these interventions are paramount to the adoption,

success and sustainability of the intervention. Different experiences and teaching styles result in different ways of teaching and managing a classroom. Positive effects on students' learning, behaviour and social skills can be achieved in a learner-centred teaching style [55, 56], while an authoritative style, in which the teacher consistently manages the classroom but supports students' autonomy and has a personal interest in students, is also associated with the most academically and socially competent students [57, 58]. Teachers play an important role in the successful adoption of standing furniture in a classroom environment and therefore it is important that strategies are put in place to ensure teacher support.

5 What is the Cost?

The implementation of standing desks or workstations in schools can be very effective; however, the associated costs and effort involved with incorporating and installing furniture, and altering teaching practices, may prevent schools from choosing them over traditional desks and chairs. The costs of a standing desk intervention can be relatively low. Studies from the USA and New Zealand reported that standing workstations were approximately 40 % cheaper than traditional seated desks and chairs [33, 35]. For example, the cost of two sets of workstations was ~$US1500 (five workstations per set). Others [35] reported that the sit–stand desks and stools were approximately 20 % more expensive than standard seated desks and chairs. Further long-term intervention research is required to address the cost effectiveness of incorporating standing desks and adjustable workstations into the classroom environment. It is possible, however, that as more schools start to use them, a reduction in price by the manufacturers may be observed.

Schools have allocated budgets for furniture and it seems that the cost to incorporate standing desks or workstations in classrooms is not prohibitively expensive. Most school furniture is purchased when schools are built or renovated. As the responsibility often falls to facilities managers, planners, and the architect and design community, efforts should be made to educate these groups on the benefits of standing desks in classrooms while utilising other less obvious, grass roots efforts to raise money for off-cycle (not in the normal buying pattern for school furniture) and small interventions. Common examples for fundraising include local education foundations, large national charities, religious charities tied to parochial schools, parent/teacher organisations, national science funds such as the National Science Foundation (NSF)/National Institutes of Health (NIH) in the USA and, finally, web-based funding such as http://www.gofundme.com or http://www.standupkids.org. Principals and superintendents also seem to manage to find funds for small-scale installations with select or motivated teachers. As experimentation turns to policy and exception to practice, we anticipate the installation of activity-permissive learning environments to become standard.[1]

6 What are the Best Practices for Research Methods in the School?

To collect data in the dynamic setting of a classroom, one must be connected to the teacher and school daily. In this way, certain aspects of the data collection can be modified to fit within the academic culture without disrupting it. Common research methodologies to measure outcomes include wearable sensors, video, interviews, surveys and behaviour observation techniques. The wearable devices used in the above studies include the activPAL™ (PAL Technologies Ltd, Glasgow, UK) inclinometer/accelerometer placed on the thigh and the SenseWear™ (BodyMedia, Inc., Pittsburg, PA, USA) armband. Both have been used for up to 24 h/day over 7 days. At a minimum, the full school day should be included in data collection and analysis. New tools for this type of research are constantly being introduced to the market, but activPAL™ and the SenseWear™ are validated against gold standard devices and video so using them continues to be a good option. While accelerometers such as the ActiGraph™ GT3X+ (Actigraph, Pensacola, FL, USA) are commonly used to assess children's physical activity, being hip-worn they are not as capable of assessing sitting time or postural transitions [59]. Survey methods were sometimes customised, such as the "smiley" face survey for first-graders or the Ergonomic Technique for Assessment of Posture (ETAP) survey for seated versus standing postural assessment [60]. More common techniques such as the Nordic Musculoskeletal Questionnaire for pain and discomfort can provide some consistency from study to study [36, 47]. Optimal study design to evaluate standing desk interventions would be a fully powered cluster randomised controlled trial, with school as the unit of randomisation. However, to date most studies have limited resources and so have been pilot trials with either case–control designs or within-subject trials. Children from the same school but in different classrooms have often been allocated to intervention or control and, as such, several studies have reported likely contamination of the intervention effects [34–38].

[1] Activity permissive in this context refers to classroom modifications such as standing desks that permit replacement of sedentary behaviour with light or moderate physical activity.

7 What are the Best Practices for Standing Desk Interventions?

Implementation of standing furniture in the classroom has not yet gained much traction with schools. Research that highlights to schools the potential benefits of such changes on education and classroom management to help prioritise the purchasing of standing furniture in their budgets is needed. Perhaps an injection to furniture budgets from governments will ensure their adoption while sparking innovation in design and classroom methods. Manufacturers will also continue to respond to needs for improved ergonomics, leading to reduced cost per child as evidenced by the many adult standing desk solutions now flooding the market place. The classroom standing desk market is a decade or more behind the adult market. However, the market is still growing and adapting to modern technology such as electronic controls for customisation, wireless charging stations and monitoring of and affecting behaviours through smart phones and watches based on metrics stored by the desks. A current limitation in the children's market is that desks appropriate for children in the earlier years of primary school are scarcely available, limiting both the research and implementation of standing desks in these crucial years when healthy lifestyle behaviours are established. However, other alternatives (e.g. standing at easels) have been trialled [61].

Researchers and health professionals should work closely with teachers and schools to improve knowledge about the benefits of regularly interrupting sustained bouts of sitting, and be advocates for policy and practice changes in schools and in their wider communities.

8 Conclusions and Recommendations

Based on the current emerging evidence from the field we can make the following recommendations:

- Although standing desks or adjustable workstations can be used to replace traditional sitting desks and chairs, these two types of desks could be used in combination. Individual desks serve to delineate private or personal space and encourage a private sense of ownership [32]. On the other hand, in most primary schools at least, the modern style of teaching and learning is collaborative and interactive and group workstations are a staple of the modern classroom [32]. As individual standing desks are quite mobile, they can also be moved around to create more collaborative workspaces, which gives the advantage of both individual and group workspace.
- Youth should frequently interrupt their sitting time with standing rather than engage in long bouts of static standing. Regular stretching and shifting of their balance from foot to foot are also recommended when standing for longer periods.
- Students and parents should consider proper footwear that accommodates standing for longer periods of time. Athletic shoes with lower heels tend to be the most commonly recommended. Policy makers should consider this when establishing dress codes. The use of rubber mats to stand allows micro adjustments and alleviates static postures.
- The use of a footrest or foot-rail on both the stool (if used) and the desk are appealing to students attempting to shift weight and alternate posture. Biomechanically, this feature allows large muscle groups on one side to rest while shifting the load to the other.
- Teachers should be instructed on proper ergonomic fit for standing desks when considering the task and the students' anthropometry. In general, if fully adjustable desks are not available, multiple heights of fixed desks can be set up by age and grade level to allow students to 'fit' themselves to available desks. Ideally the child's elbows should be at 90° while standing, with their forearms resting on the desk.
- School districts should encourage student and staff experimentation in the application of activity-permissive learning environment strategies for maximum student comfort and engagement.

The importance of educational design and learning performsance has previously been recognised [46] and many of our recommendations arise from our experience in working with teachers and schools to modify classroom environments. However, as suggested in various points above, further research is needed to identify the most effective approach/es for reducing and breaking up youth sitting time during class lessons. Many of the studies identified employed a 'natural experiment' approach where changes were made to the classroom environment and no other strategies were employed. It is also important to examine whether it is more effective to add behaviour change tecniques [62] to standing/activity-permissive classroom interventions; for example, training teachers and youth on the importance of reducing and breaking up sitting throughout the day, providing standing/interrupting sitting targets (e.g. several times per hour; goal setting) and pedagogical training to assist teachers in delivering their usual curriculum in a standing or active way [61]. Furthermore, it would be interesting for researchers to explore whether reducing sitting time in the classroom also reduces children's sitting time in different environments, e.g. in the home, and to identify behaviour change mechanisms that underpin this potential transfer of behaviour. Additionally, youth are the 'next workers' who will move into settings

such as offices and the raised expectations could help drive cultural change in the future if we start early—i.e. in schools. We do not know how much sitting is too much (in terms of total time), but emerging evidence shows that how it is accumulated matters. Breaking up prolonged sitting time (and therefore reducing sitting time) is important, but research needs to further explore a dose–response relationship to help inform guidelines in settings such as schools.

There is much promise with using standing desks in primary and secondary school classrooms. A crowded curriculum is frequently cited by teachers, principals, and education departments and organisations as a reason for not implementing physical activity programmes. Environmental changes to classrooms provide a major opportunity for youth to move their bodies (low to vigorous intensity) more throughout the day.

Compliance with Ethical Standards

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