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# FINAL REPORT: OUTCOMES

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## ABOUT FIT TO STUDY

### Aims and key findings

In 2017-18 researchers from the University of Oxford and Oxford Brookes University tested whether **a one-year programme of HIIT-style training during PE lessons could boost fitness and improve learning and thinking skills and mental health** in secondary schools. Laboratory experiments show that the brain can change, and cognitive skills can improve, with more physical activity and fitness. The purpose of Fit to Study was to see if this evidence could be translated into a school setting.

Over 16,000 Year 8 pupils in 93 state secondary schools in England took part in the trial. **Half the schools incorporated HIIT-style training into Year 8 PE lessons and half taught PE as usual.** During the school year, pupils completed assessments measuring activity levels during PE; cardiorespiratory fitness; thinking speed and flexibility; memory; self-control and mental health. They also reported their feelings about exercise, and their physical activity during the week. A smaller group had their brains scanned.

We found **no evidence that fitness, learning and thinking skills or mental health were any better in the schools that included HIIT in their PE lessons, compared to the others.** Neither was there any evidence that increasing activity and fitness led to changes in the brain. We cannot be certain why this is, but one explanation is that the trial did not deliver a large enough dose of vigorous activity during the year to improve pupils' fitness and boost their brain health. But the good news is that **we did find evidence supporting the message that more physical activity and higher cardio-respiratory fitness are positive for learning and thinking, mental wellbeing and brain health.**

## THE NEUROSCIENCE BACKGROUND

Exercise that raises the heart and breathing rate can stimulate the release of growth factors, which improve the health of existing brain cells, and also promote the growth and survival of new cells and the blood vessels that sustain them (1). This mechanism is most obvious in two brain areas: the hippocampus (responsible for long-term memory) and the pre-frontal cortex (responsible for attention and thinking skills, or executive function) (2). It underpins ideas about why and how physical activity and cardio-respiratory fitness might support learning and thinking skills. Physical activity and fitness can also improve mood, resilience to stress and feelings of wellbeing via biological and social mechanisms (3,4).

## HIIT-STYLE TRAINING IN PE LESSONS

**Results.** Pupils did not do as much vigorous activity during PE as we intended. This was a problem because we needed to increase fitness to improve brain health and cognitive skills. We asked PE teachers from half the schools to add an extra 10 minutes of vigorous physical activity to every one-hour lesson (20 minutes per week in total) throughout the school year. We encouraged them to deliver an active warm-up and bursts of aerobic exercise such as star jumps and running on the spot in every session. Fewer than half the schools managed to deliver the training as planned in even half of their lessons.

**Teachers said they would recommend brief, easy fitness exercises to help promote physical activity in school – but they also reported barriers to delivery** including lack of time and space, other lesson objectives, and low motivation.

**Findings in context.** There is debate about whether HIIT and vigorous activity programmes are a useful public health strategy. A few minutes' regular, hard effort can improve many adolescent health outcomes – as long as the programmes are followed faithfully (5). And HIIT appears to be particularly effective at improving fitness when it is done 2-3 times a week at a very high intensity(6). But with high-intensity exercise comes high perceived exertion, which can be off-putting: inactive young people, who stand to benefit the most, find this type of training particularly challenging(7). Generally, when young people enjoy physical activity in school, they are motivated to keep going for longer(8). Even if teachers delivered HIIT-style training in all lessons, pupils might not have worked vigorously enough to benefit.

**Take-home message.** HIIT can be a powerful tool for improving health outcomes but our training had low effectiveness in PE settings. Based on teacher feedback, **briefer, more enjoyable HIIT could be useful for improving pupil fitness.**





## PHYSICAL ACTIVITY, FITNESS & MENTAL HEALTH

**Results.** There was no evidence that more physical activity and higher fitness led to improvements in mental health, but we found much to support the idea that **an active lifestyle goes hand-in-hand with mental health and wellbeing.** The study used public health advice on physical activity as a guide: this says that young people should do, on average, at least an hour a day of a moderate-to-vigorous activity that raises heart and breathing rates. More active days per week, and higher cardiorespiratory fitness, were both linked with lower levels of problems or behaviours that signal psychological distress (and in particular with 'internalising' problems such as fears, worries or unhappiness). This was especially true for boys. Being in the habit of exercise, and having more positive attitudes to being active, were linked with higher self-esteem.

**Findings in context.** Mental health problems are affecting more young people. Social, psychological and biological influences during adolescence -

family conflict, deprivation, abuse and genetic factors, for example - can all play a part in mental distress (9). But we also know that the physical health, self-esteem, positive reinforcement and the social connections that structured physical activity can provide are powerful protective factors against mental health problems (9). Public health guidelines emphasise the connection between physical activity and mental health(10): our findings support this message and add to evidence that **cardio-respiratory fitness might also be linked to mental health.**

**Take home message.** Young people have little control over many of the big issues with potential to harm their mental health. Getting and staying active to improve and maintain cardio-respiratory fitness is a positive step they can take to help protect themselves against mental ill-health.





**Results.** Again, there was no evidence that more physical activity and higher fitness led to improvements in cognitive skills. But the results support the idea that **physical activity and fitness are linked with aspects of learning and thinking.** We found small but clear positive relationships between physical activity during the week and memory, the ability to think fast and flexibly, and self-control. Higher fitness was even more strongly linked with better scores on these assessments. This was especially true for girls in the case of thinking speed and self-control. Finally, there was a positive link between these skills and an active lifestyle – being a regular exerciser with good fitness and positive attitudes to physical activity.

## PHYSICAL ACTIVITY, FITNESS & LEARNING SKILLS

Watch the Fit to Study video explainer for Key Stage 3 pupils



**Findings in context.** So far, much of the data linking physical activity and learning/thinking comes from older adults – there is not much to suggest this is also true for younger people (11). Different types of studies show that, in some cases, physical activity immediately before a lesson can improve focus on academic tasks (12). But our results add to growing evidence that **cardiorespiratory fitness is linked with adolescent learning/thinking skills**(13).

**Take home message.** Physical activity that builds or sustains fitness seems particularly important for learning and thinking skills built on better brain health. There might be a case for monitoring cardio-respiratory fitness during school PE.

## PHYSICAL ACTIVITY, FITNESS & THE BRAIN

Watch the Fit to Study  
video explainer for Key  
Stage 3



**Results.** Using brain scanning, we found **links between active lifestyles and healthy brain development.** More activity, higher fitness, less sitting time and more positive attitudes to exercise were linked with many positive outcomes in the brain including the flow of blood, the density of neural connections and overall volume and surface area. Surprisingly, we did not find any connection between physical activity, fitness or the volume of the hippocampus, the region responsible for memory.

**Findings in context.** New scanning techniques make it possible to investigate the effect of physical activity and fitness on different areas of young people's brains more thoroughly than ever before. Our results add to what scientists are still learning about these relationships. At the moment, we can say that taking part in physical activity appears to stimulate brain regions responsible for some learning and thinking skills, including the hippocampus and the pre-frontal cortex, but more work still needs to be done (2).

**Take home message.** Physical activity and fitness is likely to boost young people's brain health, which could support learning and thinking.

**Our two-minute video for schools explains why physical activity is good for brain health. Find it on YouTube:**  
[https://youtu.be/u8SsE\\_QPKIM](https://youtu.be/u8SsE_QPKIM)

## PHYSICAL ACTIVITY IN PE LESSONS

- 7% of lesson time spent in vigorous activity
- 25% of lesson time spent in moderate-to-vigorous activity
- Fitness lessons most active for boys and co-ed groups
- Track athletics and games most active for girls
- Field athletics least active for all groups
- Fitter pupils enjoyed PE more - this was especially true for boys

**Results.** Before the trial started, we measured the intensity and duration of physical activity taking place in PE lessons across different schools, sports and class groups (single-sex and co-educational). We assessed vigorous activity, because this is what we wanted to adapt and increase. We also measured moderate-to-vigorous activity, because this is the focus of public health guidelines. In a standard one-hour PE lesson, pupils spent on average 7% of their time doing vigorous activity and 25% doing moderate-to-vigorous activity. Co-educational and boys-only classes were most active in fitness-focused lessons. Girls-only classes were most active during track athletics and field/racquet/ball games. In all class groups, pupils were least active during field athletics lessons. Fitter pupils enjoyed PE more - this was especially true for boys.

**Findings in context.** PE teaching guidelines suggest that pupils should be actively moving for at least 50-80% of available lesson time (14). Pupils are not meeting this target, and the activity levels we measured are well below what other studies have reported (15).

**Take home message.** If the main purpose of PE lessons is to deliver activity - rather than teaching skills or fostering enjoyment, for example - then our findings are concerning.





## THE FIT TO STUDY TEAM

Thanks all the schools, teachers, pupils and parents who made this research study possible

You can read more about the Fit to Study trial here:



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