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"Does 2 hours of PE and 2 hours of school sport make a difference to children's health?"

A-CLASS PROJECT

Research Findings
Summary Report

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Acknowledgements

Sportslinx is a collaborate partnership between key agencies across the city to improve the health and well being of Liverpool children.

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Foreword

A-CLASS
PROJECT

With the epidemic of childhood obesity and apparent decreasing levels of children's physical activity and fitness, the Government have attempted to put into place policies to stem the tide toward poor health (DH,2004, Foresight Report, 2007). These policies have focused on reducing childhood obesity (PSA 12), and increasing physical activity through physical education and school sport to 4 hours per week (PSA22, subsequently increased to 5 hours in 2007). The Sportslinx programmes of health promotion, and fitness and lifestyle assessment have worked in tandem with schools sports partnerships to deliver 4 hours of physical education and school sport. Unfortunately there is no robust scientific evaluation of the effects of the 4 hour promise on children's health, lifestyle and fitness. The A-CLASS (Active City of Liverpool, Active Schools and Sportslinx) project was designed to assess the effectiveness of the extra 2 hours of after school sport on the health, fitness, skill and fatness of 160, 9-10 year old Liverpool girls and boys who lived in deprived areas of the city.

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Introduction

Aims

The aim of the A-CLASS project was to assess whether:

"the 4 hour promise could improve the health and fitness of 9-10 year old children in Liverpool?"

Objectives

Baseline

To take baseline measures of: maturity, body composition, cardiovascular health, fitness, physical activity, skill and physical self-perceptions/self esteem, and to compare results between boys and girls, and non-overweight and overweight children. We also wanted to assess levels of health risk against criterion measures (where available).

Intervention

To compare the effect of 3 types of intervention (2 structured, 1 unstructured) on the body composition, cardiovascular health, fitness, physical activity, skill and physical self-perceptions/self esteem of 9-10 yr. old Liverpool children at baseline, 9 and 12 months.

Methods

Project design

Based on preset criteria of school size (>400 primary schools: >250 junior schools) and deprivation (IMD>40) we randomly selected 16 schools and invited them to a meeting to discuss the project. After this meeting 8 schools were randomly selected to participate.

Description of the Interventions

Two schools were allocated to 1 of four conditions:

Condition 1: High intensity physical activity (HIPA);
Children in these schools were provided with a twice-weekly, 1 hour high intensity multi-activity after-school club, which was delivered by qualified multi-activity coaches. Heart rates were kept above 75% of maximum during these sessions.

Condition 2: Fundamental Movement Skills (FMS);
Children in these schools were provided with a twice-weekly, 1 hour after-school multi-skill club, which was delivered by qualified multi-activity coaches. These sessions focused on developing locomotor and object-control skills.

Condition 3: Physical Activity Signposting Scheme (PASS);
Children in these schools were provided with a weekly, 30 minute classroom session where weekly physical activity tasks were discussed and set. Four 4-6 week blocks of challenges were delivered alongside a reward system.

Condition 4: Control;
Children in these schools received basic information on physical activity and health provided by the British Heart Foundation.

Programme Duration

Pilot project ran January to April 2006.

The intervention project ran from October 2006 to November 2007.

What did we measure?

Cardiovascular health:
We measured the lining of the main artery of the neck (carotid intima-media thickness), the hydraulic power of the heart (diastolic function), the mass of the left ventricle, blood pressure, and heart rate.

Fitness and physical activity:
We measured aerobic fitness on a treadmill, and physical activity every 5 seconds over 7 days using an accelerometer. We also measured heart rate during the structured FMS and HIPA sessions.

Body Composition: We assessed bone mineral content and density, muscle mass and body fat using a DEXA scanner. We measured height and weight, sitting height and we estimated maturity. We also measured 8 skin folds, and waist and hip circumference.

Fundamental Movement Skills:
We measured 4 locomotor (hop, jump, sprint and dodge) and 4 object-control skills (catch, throw, kick and strike) using detailed video analysis.

Physical self-perceptions and self-esteem: We measured self-esteem and physical self-perceptions including sports competence, body image, strength, and body condition.

Qualitative research: We assessed the effectiveness of the PASS scheme by interviewing children, parents and teachers.

Questionnaire: We assessed children's sports participation, parental activity and other aspects of lifestyle via questionnaire although these data are not included in this report.

How often were the measurements taken?

The measurements were taken at baseline in September and October 2006, then at mid-point in June and July 2007 then finally between mid-October and November 2007 immediately after the intervention had finished (post test).

How many children completed all measurements?

Of the 160 children who initially agreed to take part, 152 started and 145 completed the project respectively. Ten boys and 24 girls in the HIPA, 17 boys and 20 girls in the FMS, 16 boys and 25 girls in the PASS and 15 boys and 18 girls in the Control group completed the project.

Reward Scheme

To aid compliance A-CLASS branded T-Shirts, water bottles, baseball caps, Frisbees, yoyos, pedometers and music CDs were presented at various stages throughout the project.

Results

Physical Activity

Baseline

Physical Activity during the week and at weekends in girls and boys:

Boys engaged in slightly higher levels of physical activity during the weekend compared to the week, whereas girls activity levels were higher in the week compared to the weekend. On average children in Liverpool exceeded the 60 minutes of recommended activity by between 15 and 25 minutes per day. Boys were more active than girls and a higher proportion of their physical activity (approx 12%) was vigorous compared to girls (approx 7%).

Body fat and Physical Activity:

Children who engaged in less than 60minutes of physical activity carried approximately 30% body fat compared to 27% in children who engaged in >60 but less than 90 minutes, and 26% in children who engaged in >90 minutes. This data is very important as it clearly shows that 60 minutes is not enough physical activity to maintain a healthy amount of body fat.

Intervention

Boys: Physical activity in all boys groups increased from baseline to 9 months, with greatest increases seen in the intervention groups (15-22 minutes increase). Weekend activity only increased in the FMS group by about 10 minutes although this group was the least active at the weekend. At post-test (12 months) physical activity decreased significantly in all groups to a point below baseline. At all testing points all groups exceeded the 60 minute recommended dose of physical activity with only the FMS group failing to meet this target on weekends.

Girls: At 9 months there was no change in week or weekend activity for all groups with the exception of the control group who significantly increased their weekend activity. All groups exceeded the dose of 60 minutes physical activity with the exception of the Control group at baseline and FMS group at baseline and 9 months. At post test physical activity decreased significantly in all groups to a point where the control group failed to meet the 60 minutes criterion whereas the intervention groups just exceeded it.

On weekends the girls in the Control and FMS groups had very low levels of physical activity compared to the PASS and HIPA groups who just exceeded it.

The key messages are that even if children attain 60 minutes of daily physical activity they may still be over fat and that more active children have greater lean mass. We have also demonstrated that these programmes increased or maintained physical activity in boys and girls respectively. Although these activity levels were not sustained after the project had finished.

Cardiorespiratory Fitness

Baseline

At baseline boys were over 10% fitter than girls and data suggests that both boys and girls were of average fitness compared with other Western groups of similar aged children (Bar-Or and Rowland, 2004). Non-overweight children had cardiorespiratory fitness levels that exceeded overweight children’s scores by over 20%.

Intervention

Boys: Cardiorespiratory fitness decreased in all groups from baseline to mid-test. At post test, HIPA and FMS cohorts fitness levels returned to baseline values, which were greater than 50 $mlO_2/kg/min^{-1}$, compared to declines in fitness for the Control and PASS groups over the project.

Girls: Cardiorespiratory fitness remained constant from baseline to mid-test in the Control and PASS groups, whilst FMS and HIPA cohorts’ fitness declined. At post test, HIPA fitness scores had returned to baseline values and were similar to the control group. HIPA and Control group participants had higher fitness values than PASS and FMS groups at post test.

The direction of cardiorespiratory data are opposite to the physical activity data and may demonstrate an interesting deviation between the dose of physical activity (frequency x intensity x duration) and cardiorespiratory fitness and/or reflect difficulties in measuring physical activity. These data show that the intervention did not provide enough stimulus to improve fitness.

Body Composition

Baseline

Using age specific cut points for BMI data 28% of boys and 34% of girls were overweight and 18% of boys and 8% of girls were obese. Using DEXA data girls were 30 and boys 25 percent total body fat. Trunk fat was also higher in girls at nearly 25% compared to almost 20% in boys. Boys also had significantly greater bone mineral content and density and greater lean mass than girls. Differences in boys and girls results are partly biological and partly behavioural in that boys engage in more vigorous activity than girls.

Intervention

All children increased in total fat mass by the end of the 12 month intervention. However, the greatest rate of increased total fat mass was in the control group. This rate of increase was at least 50% greater than all intervention groups. The control group gained 2.2 kg, compared to the PASS, HIPA and FMS groups that all gained around 1.4 kg over 12 months. Furthermore differences were maintained in the structured exercise groups, even after adjusting the data for physical activity. Similar results were found in percent trunk fat with participation in the structured exercise groups (FMS and HIPA) being most effective. There were no differences in changes in lean body mass, or bone mineral content or density between the groups.

First the results confirm Sportslinx data that a significant proportion of Liverpool children are overweight and obese. However they also indicate the problems of using BMI to predict overweight. These results from the intervention programmes were encouraging and demonstrated that accumulation of body fat could be limited by appropriate physical activity programming.

Cardiovascular Health

Baseline

Physical activity was not related to any cardiovascular measure. Heart function and carotid intima-media thickness (a marker for atherosclerosis) were not related to physical activity, cardiorespiratory fitness or body composition. The size of the left chamber of the heart (left ventricular mass) was positively related to body fatness and cardiorespiratory fitness.

Intervention

Smaller increases in left ventricular mass were apparent in the intervention groups compared to the control thus prevented unwarranted gains in heart size at this age. Furthermore reductions in blood pressure were noted in the intervention groups as well as positive improvements in diastolic function. Increases in carotid intima-media thickness were smaller in the intervention groups than the control.

Positive changes in cardiovascular health were apparent without changes in fitness or physical activity suggesting that some local vascular adaptation may have taken place as a result of the intervention. There were little differences in the changes in cardiovascular measures between different intervention groups, with the exception of the PASS group that revealed smaller changes in carotid intima-media thickness that the HIPA or FMS groups. This was surprising given that we hypothesized that the HIPA group would demonstrate the greatest changes in cardiovascular measures.

Fundamental Movement Skills

Baseline

In boys the prevalence of proficiency did not exceed 60% except in the over arm throw whilst only 30% of girls were proficient at the hop. Fundamental movement skills should be mastered by the age of 8 and thus low levels of skill at baseline were particularly worrying. Boys and girls had similar proficiency levels in locomotor skills (hop, vertical jump, dodge, sprint) but boys were between 4 and 6 times more proficient in object-control skills (catch, throw, strike, kick). Percent body fat was also negatively related to locomotor skills performance.

Intervention

The number of locomotor skill components increased at mid-test in all intervention groups with further increases noted at post test in the FMS and HIPA groups. The greatest improvement occurred in the FMS group where the number of locomotor skill components achieved increased by more than 15%, which was significantly higher than the Control group. HIPA participants also had higher locomotor skill competence at post test than their Control counterparts, whilst PASS had no effect.

The number of object-control skill components increased in all groups at mid-test with greatest increases noted in the FMS group. At 12 months, the FMS group had increased the number of object-control skill components by over 30%, scoring significantly higher than all other groups. Baseline results reveal poor-to-moderate levels of fundamental movement skill proficiency.

The intervention results were particularly encouraging as they demonstrated that fundamental movement skills are malleable and sensitive to change. They also demonstrated that after school clubs need a clear focus on skill as opposed to high-intensity activity to increase competence in all skills. Further, interventions should be aimed at younger children to maximise the potential for skill development.

Physical Self-Perceptions

Baseline

Self-esteem and physical self-perception profiles including sports competence, physical condition, body attractiveness, physical strength, physical self-worth and self-esteem reflected encouraging aspects of mental health in participants. Boys always scored slightly higher than girls whereas physical strength and body attractiveness recorded the lowest scores in the profile.

Overweight children had significantly lower perceptions of sports competence, physical condition, physical self-worth and self-esteem than non-overweight weight children, whilst there was a strong trend for a difference in body attractiveness also.

Intervention

Boys: The FMS and HIPA interventions positively impacted on physical self-perceptions compared to the Control group, whilst the PASS group declined from mid-test to post test thus had no effect.

Girls: The PASS group increased self-esteem. No positive intervention effect was observed for physical self-perceptions through the project. Unfortunately participation in the FMS group was associated with more negative physical self-perceptions, as scores in the FMS group declined at mid-test, with deficits stabilising to post test.

These results suggest that levels of self-esteem and physical self-perceptions in girls and boys are relatively healthy. In boys, structured exercise sessions stimulated increases in perceptions of physical condition and sports competence as well as smaller changes in body attractiveness.

Unfortunately all intervention groups caused more negative perceptions of body attractiveness and physical competence in girls. This may be a result of co-educational sessions in which girls may have assessed competence by means of social comparison with boys. Alternatively participation in the intervention may have increased focus on physical abilities, drawing attention to lack of competencies, thus causing lower self-perceptions.

Summary

Baseline data demonstrated that Liverpool children need physical activity programmes to stem the tide of rising obesity, declining levels of fitness and poor levels of skill. Even though children's levels of physical activity exceeded the 60 minutes recommendation they were still over fat. Fitness levels were adequate but fundamental movement skills were much lower than expected especially girl's object-control skills. Cardiovascular measures and self-esteem/physical self-perceptions were good reflecting low risk of heart and mental health respectively. Fatter children generally scored lower on most tests compared to their normal weight peers.

The intervention programmes had a larger effect on boys results compared to girls. Boy's physical activity increased at mid-test but decreased at post test. Girl's physical activity levels were maintained at mid-test but declined at post test. The intervention did not improve girls or boys fitness. An encouraging finding was the slower increase in body fat in all intervention groups compared to control and there were also positive effects on heart function, heart size and blood pressure. The most malleable aspect of children's health was their fundamental movement skills as children in the FMS group demonstrated large changes in object-control skills ad moderate increases in locomotor skills. Physical self-perception scores changed positively in boys who participated in FMS and HIPA interventions. All interventions may have had a negative effect on the perceptions of body attractiveness in girls, whilst other physical self-perceptions were also lower in girls who took part in the FMS group.

In summary, the national investment of 2 hours of PE and 2 hours of school sport has a positive effect on some aspects of children's health although some improvements are difficult to maintain. Further investigations are warranted to follow up this programme of research. We recommend that further investigations are required into the effects of activity programmes using larger groups of girls and boys of different ages. In particular, high levels of body fat and poor fundamental movement skills require more urgent attention as does the effect of activity programmes on girls' health and well being. Finally, the effects of these programmes on children's health require longer term investigations in studies that are longitudinal in design.

1. About the A-Class Project

Rationale

- Physical activity is an essential part of a healthy lifestyle, yet there is widespread concern that nearly 95% of children are not sufficiently active enough to benefit their health (Riddoch *et al.*, 2007).

- The promotion of physical activity to benefit fitness and health is a key component of both the Choosing Health White Paper (Department of Health, 2004) and the Liverpool Active City Strategy (Liverpool PCT, 2005). Additionally, the Government has set a target to halt the year-on-year rise in childhood obesity by 2010.

- These policies and strategies aim to provide a range of activity opportunities to encourage people to build physical activity in to their daily lifestyle (Liverpool PCT, 2005).

- In children, the Liverpool Active City strategy aims to:

  - Increase by 1% per year the proportion of children who meet daily activity guidelines.

  - All children will have two hours of physical education (+2 hours of school sport) per week in schools by 2010.

- Whilst it is recognised that interventions are necessary to increase physical activity in children, more research is needed to understand which interventions are most effective.

Project Overview

- The A-CLASS (Active City of Liverpool, Active Schools and Sportslinx) Project is a unique multi-disciplinary project, supported by the Neighbourhood Renewal Fund and Liverpool City Council's SportsLinx Project.

- The project aimed to increase children's physical activity through the provision of after-school clubs or a lifestyle physical activity signposting scheme (PASS). The project supported the Physical Education, School Sport and Clubs Links (PESSCL) strategy (DCMS/DfES 2003).

- This project was unique in that it provided a comprehensive evaluation of a developmentally-appropriate field intervention for children, monitoring the physical activity levels, fitness, fundamental movement skills and markers of health over 12 months.

- The project included "Research Coaches" whose unique role involved managing and delivering the intervention whilst simultaneously measuring the effectiveness of the programme.

- This project represented one of few physical activity interventions, backed by robust scientific research, ever to be conducted in the UK children.

2. Methods

Project design

- The A-CLASS project was designed in partnership with the local authority Sportslinx team and the Partnership Development Managers from each of the 3 school sports partnerships that were in existence (subsequently increased to 4).

- Partners agreed the aims of the programme (which reflected the policies related to physical activity at that time) and approved the research evaluation framework.

- The project was designed in 2 phases. Phase I was an exploratory phase which involved 9-11 year old children in a 9-week intervention. Phase II was a 12 month intervention involving 9-10 year old primary school children from deprived areas of the city.

- The project design incorporated various interventions to determine the type of programme that may be effective. Four groups were examined:

1) Control (CON)

2) Physical Activity Signposting Scheme (PASS)

3) High-Intensity Physical Activity (HIPA)

4) Fundamental Movement Skill (FMS)

- The interventions were designed to assist children to meet the then national target of achieving at least 2 hours of physical education and school sport per week (DCMS/DfES, 2003).

Selection of schools

- Following ethical approval from the Institutional Ethics committee, schools were identified as eligible to participate according to the following selection criteria:

  - School enrolment >400 for primary schools, or >250 for junior schools

  - School situated in area of low socio-economic status (a score >40 based on the Index of Multiple Deprivation: Noble *et al.*, 2004)

  - School sport facilities available for use (accessible twice-weekly)

  - Limited current after-school club provision

- 16 schools were identified as meeting the selection criteria. These schools were invited to a meeting at the university which gave an overview of the project. Following the meeting, all invited schools consented to participate in the programme. Due to limited capacity within the project design, 8 schools were randomly selected to take part.

- The 8 schools were then randomly allocated into one of the 4 groups within the project design (two-schools per group).

Participant recruitment

- All children from year 5 (aged 9-10 years) in each of the 8 schools were given the opportunity to participate.
- Each child was given a letter containing a medical form, participant information sheet and consent form to be completed by parents/carers.
- **Figure 1** shows the flow of the participants through the project.
- **152** children were selected to participate in the project
  - Informed consent was received from **292** children (59% response rate).
  - **140** children (48%) were excluded for not meeting the inclusion criteria or for medical reasons, or because they either left school or were withdrawn by their school prior to baseline.
  - At nine months **149** children continued to participate; 2 children had left school, whilst 1 child withdrew from the project. After 12 months **145** children remained - a 5% attrition rate

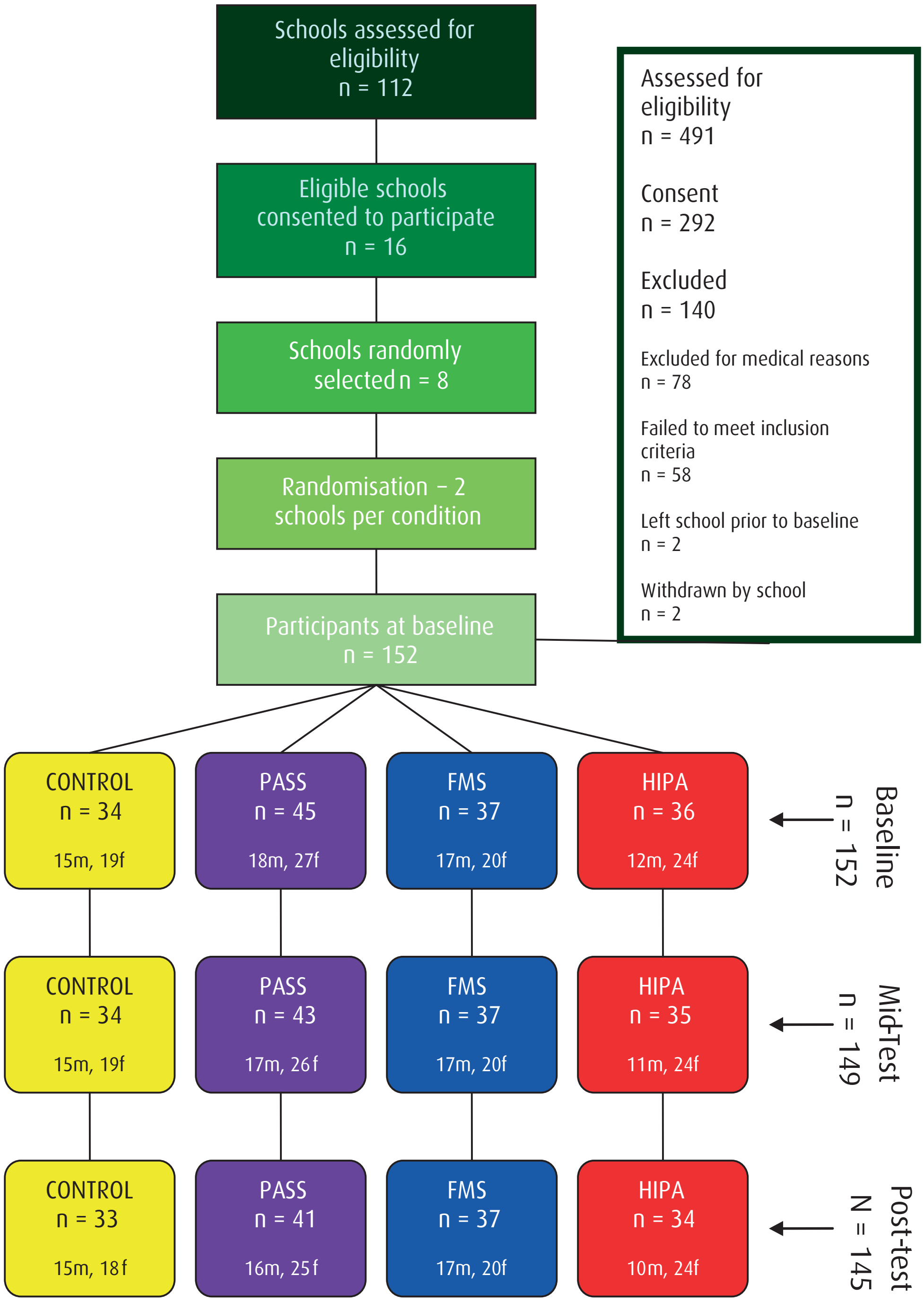
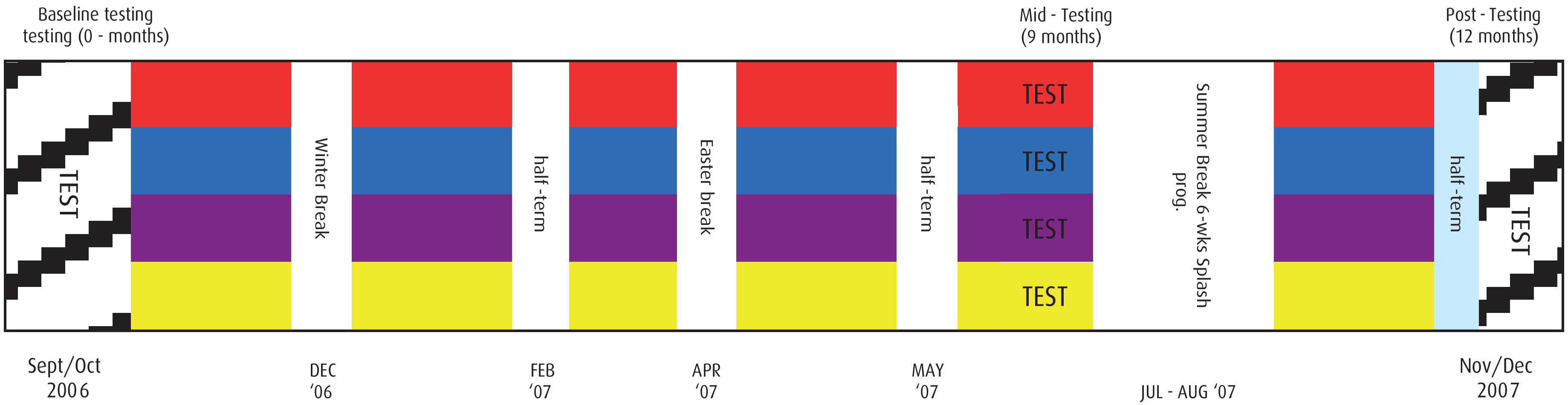


Figure 1 Process of participant selection and flow of participants through the project (CONSORT)

This shows that 152 children were selected to participate in the project at baseline, with 145 children remaining in the project at post-test.



CON: Control Group. This group did not receive any A-CLASS coaching, and only participated in testing.

PASS: Physical Activity Signposting Scheme Group. The A-CLASS PASS coach visited school every week to deliver PASS missions and encourage participation in physical activity

FMS: Fundamental Movement Skill Group. A-CLASS coaches delivered an after-school multi-skill club twice-weekly (2 x 1hr) focussing on 8 improving fundamental movement skills.

HIPA: High Intensity Physical Activity Group. A-CLASS coaches delivered a high intensity after-school club twice-weekly (2 x 1hr) focussing on vigorous weight-bearing activity incorporated into games and circuits.

Figure 2 A-Class Project intervention design

This shows a timeline for the project and describes how the project was organised.

Description of the interventions

The High-Intensity Physical Activity and Fundamental Movement Skill interventions were twice-weekly hour long after-school clubs, delivered by qualified A-CLASS coaches. In contrast, the Physical Activity Signposting Scheme (PASS) intervention was delivered in school-curricular time but did not include any structured exercise. The control group received information leaflets on heart health.

High-Intensity Physical Activity

- The sessions consisted of whole body muscular activity which aimed to keep children moving and maintain children's heart rates above 70% of their maximum (~145 beats.min-1). Children took part in fun multi-activities such as circuits, dance and games.

- Previous research has found that vigorous high intensity activity can be beneficial in reducing body fat improving bone strength and also cardiovascular function and fitness (Gutin *et al.,* 2002; Ruiz *et al.,* 2006).

Physical Activity Signposting Scheme (PASS)

- PASS aimed to increase habitual physical activity and decrease sedentary behaviour.

- PASS was delivered in school time by an A-CLASS coach, and comprised of weekly missions that each child needed to complete. The missions were delivered in four x 4-6 week blocks each separated by a 6 week break (see **Table 1**).

- PASS sessions consisted of giving children their missions (for examples see **Figures 3** and **4**), providing feedback on the previous week's missions, and administering stickers for every returned mission. If all the missions were returned in a block, a prize was presented (see Reward Scheme in **table 3**). Parents were encouraged to take part in the missions.

- To aid in the development of PASS, focus groups were carried out with children, parents and teachers.

Fundamental Movement Skills

- This after-school club aimed to improve proficiency and mastery of 8 fundamental movement skills: locomotor skills - the hop, vertical jump, dodge, sprint; and object-control skills – the throw, catch, kick, and strike.

- Developmentally-appropriate sessions were planned using activity resources designed by the Youth Sports Trust (Hanford *et al.,* 2005). Each session focused on two skills, and included a mixture of games, practices and individual learning activities, with a variety of equipment and coaching methods used to stimulate participants.

Mission	Outline of mission
Block 1. Oct '06 – Dec '06 **The children were encouraged to:**	
Map drawing	Draw a map of the local area and house
Pedometer challenge	Write down how many steps that they had achieved each day
New activities	Think of activities that they could do around the house
TV monitoring	Monitor how much television that they watched in a day
Intelligent viewing	Reduce their television viewing to two hours a day
Replacing TV with activity	Replace television viewing with physical activity and also to reintroduce pedometer challenge.
Break. Dec '06 - Feb 07.	Focus groups with parents and teachers were undertaken.
Block 2. Feb '07 – April '07	
Photograph challenge	Disposable camera's were issued to take pictures of active places
New game	To design own game and take pictures of this game
Active Transport	Encouraging the children to use active transport
Energy balance	Children rated food they ate and activity they did, and asked does it balance?
Reducing screen - watching	The children were asked to reduce computer use as well as TV watching
Break. Apr '07 – June 07	Focus groups with parents and teachers were undertaken.
Block 3. June 07 – July 07	
60 minutes of activity	Points were given for each minute of activity that was undertaken
Fitness Challenge	Children timed themselves doing physical activity tasks
Scavenger Hunt	To find certain household items in the quickest time they could
Whatever	Children were told that they could do whatever they wanted
Decisional balance	Choice between being active or sedentary in different situations
Break. Jul '07 – Sept '07	Focus groups with parents and teachers were undertaken.
Block 4. Sept 07 – Oct 07	
Design own mission to increase activity x2	Children were issued with a few rules to design their own missions for 2 weeks
Design own mission to decrease sedentary behaviour	Children were issued with a few rules to design their own missions
Advocacy poster	Children were asked to draw a poster based on their choice between physical activity and sedentary behaviour

Table 1 Outline of PASS Missions

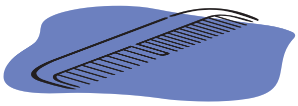
This table shows an outline of the weekly missions that were given to the children as part of PASS throughout the duration of the project. The missions were designed to increase habitual physical activity and decrease sedentary behaviours such as TV viewing.

PASS Missions

Scavenger Hunt

Time started:

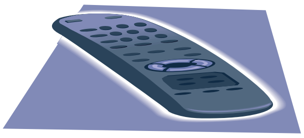
Item 1: comb



Item 2: toothpaste

Item 3: mug

Item 4: remote



Item 5: book

Item 6: can

Time completed:

Figure 3 Example of a PASS mission: Scavenger Hunt

The aim of the scavenger hunt is to find the household items on the mission in the quickest time possible. Each child was given a number of scavenger hunts to complete to help them gain 60 minutes of activity a day. The child was encouraged to ask a member of their family to time them, in order to include them.

Pedometer Challenge

Write in the number of steps you do each day in the table below
At the end of each week add up your daily number of steps
Remember to reset your counter every day.

DAY	TUES	WEDS	THUR	FRI	SAT	SUN	MON
Number of steps							

Figure 4 Example of a PASS mission: Pedometer Challenge

Everyone who took part in PASS was given a pedometer. This mission asked the children to wear the pedometer every day for a week and to chart how many steps they did each day. The aim was to beat their previous day total and to try and get at least 10,000 steps. As well as encouraging children to be active this would also highlight to them and their family how many steps they do or don't do.

Reward Scheme

- Rewards were given to the children to increase compliance to the project. Incentives were offered for attending coaching sessions, testing days, and physical activity monitoring compliance.
- The distribution of rewards are shown in Tables 2, 3, and 4 (see below)

The rewards included:

- **A-CLASS T-shirt**
- **Pedometer**
- **Yo-Yo**
- **Frisbee**
- **Music CD**
- **Beachball**
- **A-CLASS Baseball cap**

Table 2

	B-line testing	B-line PAM	10 sessions	25 sessions	40 sessions	Mid-Test	Mid PAM	60 sessions	Post-test	Post PAM
HIPA FMS	-	-	A-CLASS T-Shirt	Water bottle	Pedometer	-	-	A-CLASS Baseball Cap & music CD	Frisbee & beach ball	A-CLASS yoyo

Table 3

	B-line test	B-line PAM	Start PASS	1st Block	2nd Block	3rd Block	Mid-Test	Mid PAM	4th Block	Post-test	Post PAM
PASS	-	-	Pedo-meter	A-CLASS T-Shirt	Water bottle	A-CLASS Baseball Cap	-	-	A-CLASS music CD	Frisbee & beach ball	A-CLASS yoyo

Table 4

	B-line test	B-line PAM	Post-test	Post PAM
CON	A-CLASS T-Shirt	Water bottle	Frisbee & beach ball	A-CLASS yoyo

B-line = baseline
PAM= physical activity monitoring

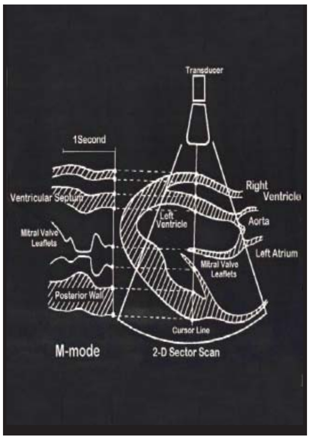
Tables 2 (HIPA & FMS), 3 (PASS) and 4 (CON): Distribution of Rewards

These tables show how incentives were used to encourage children to attend coaching sessions, testing days and comply with physical activity monitoring.

A-Class Project - Research Areas

The areas listed (below) are of key interest to the A-CLASS Project and were monitored over the 12 month intervention. The following sections will describe the methods and findings from the A-CLASS Project in each of these specific research areas.

- **Physical activity**
- **Fitness**
- **Cardiovascular Health**
- **Body composition**
- **Skill development**
- **Physical self-perceptions**



How to understand the following sections:

- The A-CLASS Project was a 12 month intervention, and involved testing at 3 time points.
- The following sections of this report describe the findings at each of these time points.
- Baseline results give us an indication of the current status of children's health because this information was collected at the start of the project, prior to the intervention.
- Intervention results compare the data collected at baseline to data collected at 9 months (mid-intervention (mid-test)) and 12 months (after the intervention (post-test)) to see if there was any change.

3. Physical Activity

Introduction

Physical activity is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen *et al.,* 1985, p.126).

- Increased levels of daily physical activity participation are associated with lower risks of coronary heart disease, diabetes, obesity and osteoporosis, for example (CMO, 2004; Strong *et al.,* 2005). It is thought that being active during childhood reduces the health risks associated with inactivity both now and in later life.
- Riddoch and colleagues (2007) measured physical activity using objective techniques and found that over 95% of children failed to meet physical activity recommendations.
- Further in Liverpool only 18% of the adult population were active for 30 minutes, 3 times per week (Sport England, 2006).
- Since activity levels are thought to track from childhood to adulthood (Telama *et al.,* 2005), it is logical that providing opportunities for physical activity in childhood could increase the likelihood of being physically active in both adolescence and adulthood, benefiting current and future health.

Methods

Children's physical activity levels were assessed using a small, lightweight monitor (called an accelerometer – see **Figure 5**) over seven consecutive days on three separate occasions. These were October-December 2006, June-July 2007, and September-October 2007, and correspond to the A-CLASS testing phases (**Figure 2**).

Figure 5 Accelerometer

This was used to measure physical activity. These pictures show what it looks like and where it should be worn.

- The accelerometer was worn on the right hip (see **Figure 5**) during all waking hours except during water-based activities. It is able to assess the frequency, intensity and duration of children's physical activity levels across weekdays, weekend days, and the whole week.
- The monitors were set to record activity every 5-seconds, therefore providing a detailed picture of the children's physical activity levels and intensity of the activities undertaken. For children to be included in the weekday or weekend analyses, they had to have worn the monitor on at least three weekdays (9 hours a day) at each time point (plus one weekend day for weekend analyses).

Results - Baseline

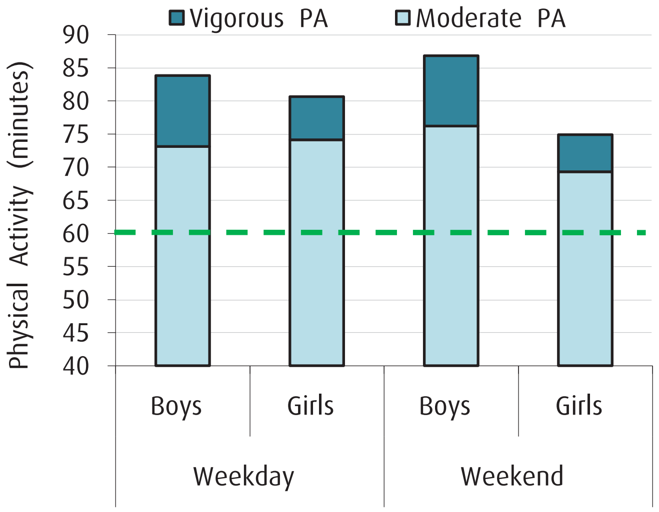


Figure 6 Boys and girls physical activity levels during weekdays and weekends

Boys and girls engaged in similar amounts of moderate-to-vigorous physical activity (MVPA) during weekdays, though boys engaged in more vigorous activity than girls. At the weekend, boys engaged in more MVPA, moderate and vigorous physical activity than girls.

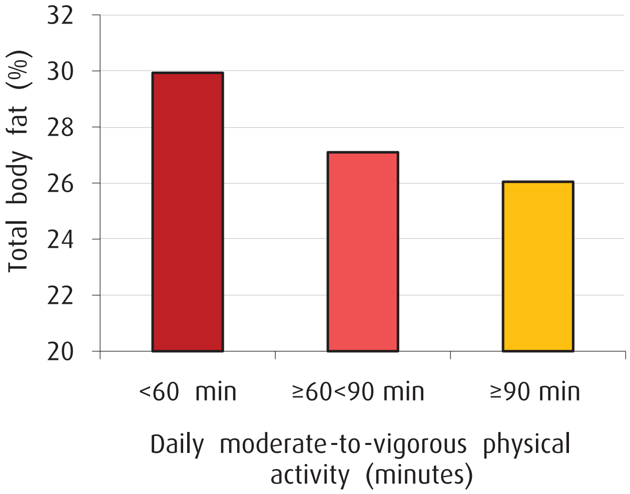


Figure 7 Tertiles of time spent in moderate-to-vigorous physical activity per day and percent total body fat

Children who participated in over 90 minutes of physical activity per day had the lowest percent of body fat.
Participation in 60-90 minutes of activity was also associated with significantly lower body fat than those who failed to meet the recommended guidelines.

What does this mean?

- As shown in **Figure 6**, baseline results indicate that boys and girls engage in similar amounts of physical activity during weekdays, though at the weekend boys engage in more and higher intensity activity than girls. Previous research has also shown that boys engage in slightly more moderate-to-vigorous physical activity (MVPA) than girls, with larger differences found in vigorous physical activity (VPA) (Trost *et al.*, 2002; van Mechelen *et al.*, 2000).

- **Figure 7** shows a strong negative relationship between time spent in physical activity and body fat (total and trunk), with participation in over 90 minutes of MVPA associated with the greatest protective effect. Therefore we would recommend that children spend at least 60 minutes in MVPA but work towards increasing this to over 90 minutes.

- A closer analysis of physical activity patterns reveals that non-overfat children are more active than overfat children, particularly at weekends. It may be that weekend physical activity has a greater influence on body fat than weekday physical activity, as during the weekend children have less formal restrictions on their time and can freely choose their level of physical activity.

- Interventions should focus on girls' activity and increasing children's MVPA, particularly as physical activity is positively related with fitness (Brage *et al.*, 2004), and the intensity of activity may be more important in the prevention of childhood obesity than total physical activity participation (Ruiz *et al.*, 2006).

Results - Intervention

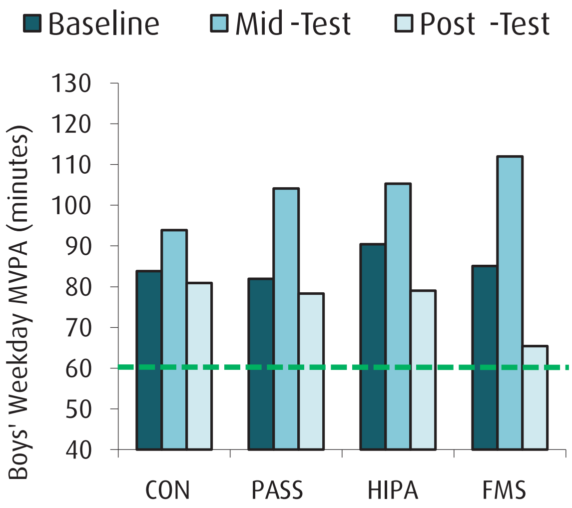


Figure 8 Intervention effects on time spent in moderate-to-vigorous physical activity during weekdays in boys

Weekday MVPA increased in all groups from baseline to mid-test, but decreased sharply at post-test.

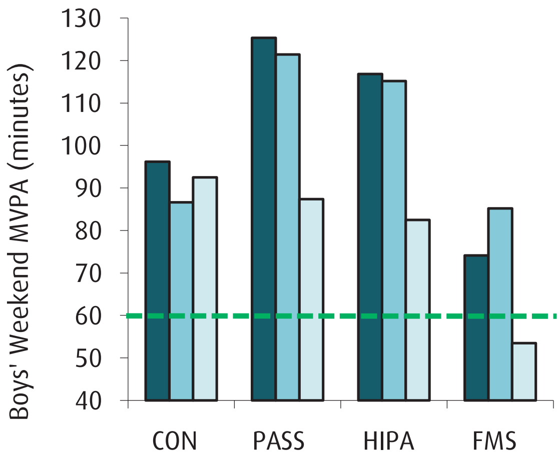


Figure 9 Intervention effects on time spent in moderate-to-vigorous physical activity at weekends in boys

FMS increased weekend MVPA from baseline to mid-test. At post-test, all groups were lower than at baseline.

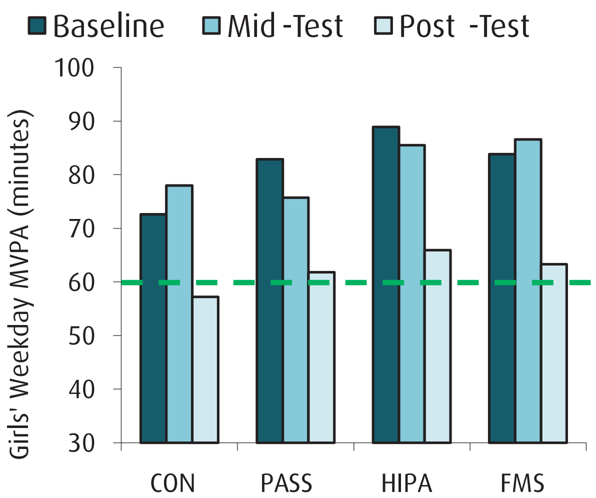


Figure 10 Intervention effects on time spent in moderate-to-vigorous physical activity during weekdays in girls

FMS and CON increased weekday MVPA from baseline to mid-test. At post-test, all groups were lower than at baseline.

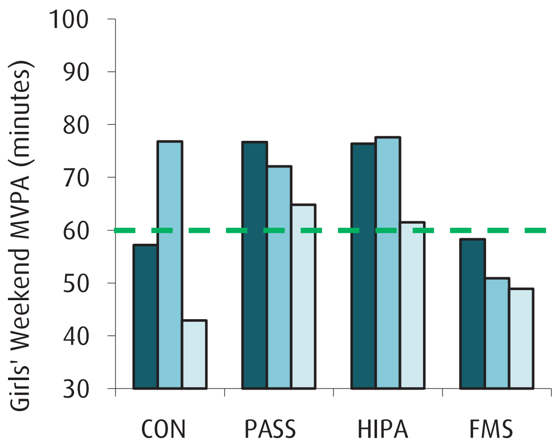


Figure 11 Intervention effects on time spent in moderate-to-vigorous physical activity at weekends in girls

CON increased weekend MVPA from baseline to mid-test. At post-test, all groups participated in less than at baseline.

What does this mean?

- As shown in **Figure 8** and **Figure 9**, the results from the physical activity monitoring generally show that, for boys, the interventions were effective in increasing MVPA between baseline and mid-test. Increases in VPA were observed for the HIPA and FMS intervention groups between baseline and mid-test. However, at post-test, MVPA and VPA were lower than the baseline scores.

- For girls (see **Figures 10** and **11**), the FMS intervention increased MVPA between baseline and mid-test. Increases in VPA between baseline and mid-test were observed for the FMS and CON groups. Both MVPA and VPA were lower at post-test than at baseline.

- Boys were more active than girls across all groups. There may be a need for girls' only interventions to physical activity levels.

- Physical activity levels decreased at the conclusion of the project. This may be an age-related decline, irrespective of intervention group. It could also be attributable to physical activity levels falling once the intervention had finished, and no other physical activity programmes being available to replace these sessions. Future projects should seek to include exit strategies for participants to sustain participation.

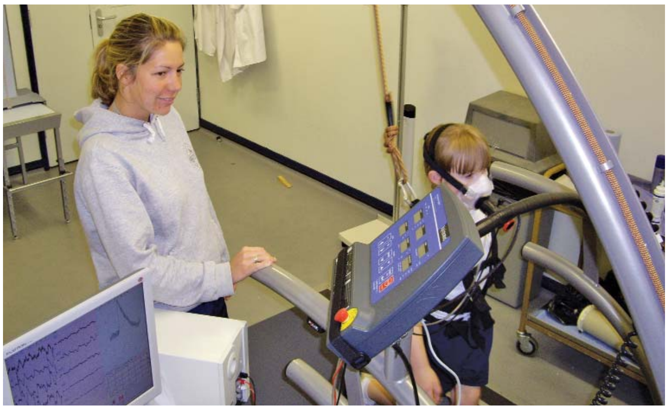
- Some children were not included as they failed to wear the monitor for sufficient time. Improving compliance with physical activity monitoring in children represents an important challenge for physical activity researchers. Future research should consider strategies to motivate children to wear physical activity monitors for the correct length of time – forgetfulness and tedium were the main reasons for non-compliance.

4. Physical Fitness

Introduction

Cardiorespiratory or aerobic fitness is a health-related component of physical fitness and is defined as the ability of the body's circulatory and respiratory systems to supply fuel and oxygen to the working muscles during sustained physical activity.

- In children low levels of cardiorespiratory fitness are associated with risk factors for cardiovascular disease, such as hypertension and insulin resistance (Anderssen *et al.,* 2007), and low fitness during childhood is associated with low fitness in adulthood (Twisk *et al.,* 2002).
- Improving the cardiorespiratory fitness of children is important for preventing the development of cardiovascular disease in the future, whilst improving the quality of life and health status of young people (CMO, 2004).
- Data from ~16,000 Liverpool 9-10 year old children (Sportslinx) indicates that there has been a significant decline in the cardiorespiratory fitness of 9 to 10 year olds in Liverpool between 1998-2004 (Stratton *et al.,* 2007).
- The A-CLASS Project aimed to accurately determine the cardiorespiratory fitness levels of children in the project, and to evaluate the effect of various interventions on cardiorespiratory fitness over twelve months.



Cardiorespiratory fitness
is the overall capacity of the cardiovascular and respiratory systems, and the ability to carryout prolonged strenuous exercise.

Figure 12 Fitness test on the treadmill

Methods

- Cardiorespiratory fitness for each participant was assessed at each time point in the project using a discontinuous, incremental exercise test. The test involved children walking and running at progressively increasing speeds on a treadmill until volitional exhaustion (**Figure 12**).
- To determine maximum cardiorespiratory fitness, (which is the peak amount of oxygen the body can consume per kilogram of body mass per minute (VO_{2peak}; $ml.kg^{-1}.min^{-1}$)) a gas analysis system was used, with a facemask covering the nose and mouth, allowing capture of exhaled air.

Results - Baseline

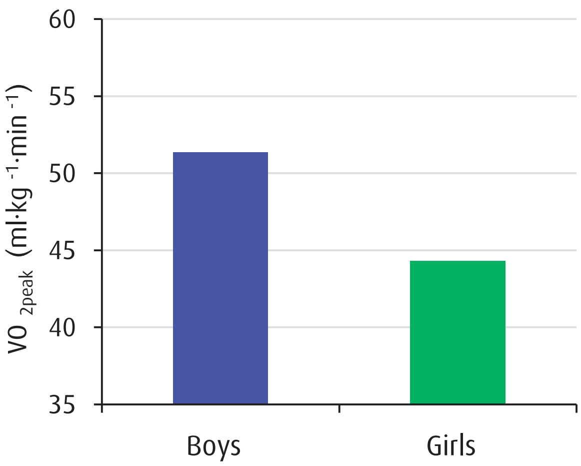


Figure 13 Gender differences in fitness

This shows that boys had higher levels of cardio-respiratory fitness than girls at baseline.

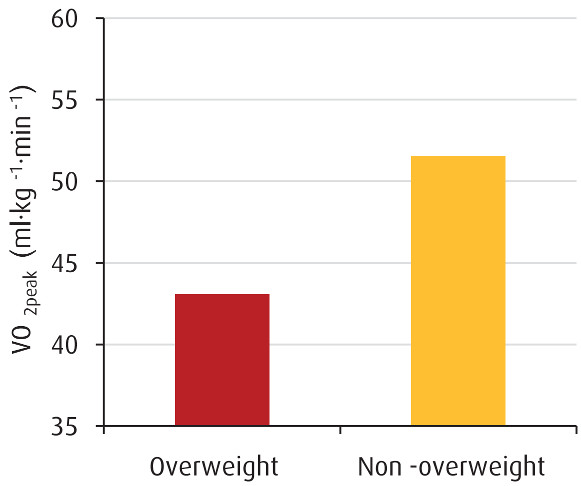


Figure 14 Differences in fitness between non-overweight and overweight children

This shows that non-overweight children were significantly fitter than overweight children

(as classified by body fat reference curves (McCarthy *et al.*, 2006).

What does this mean?

- Cardiorespiratory fitness levels of children in the A-CLASS Project are comparable to similarly aged children from the United Kingdom and other countries (Hussey *et al.* 2007; Dencker *et al.* 2007).
- Boys fitness is higher than girls' (**Figure 13**), and such sex differences during the prepubertal period have been attributed to a larger stoke volume of the heart in boys (Rowland *et al.* 2000) and differences in body composition and especially in body fat mass content (Rowland, 1996; Eiberg *et al.,* 2005).
- Though boys are more physically active than girls from an early age, and were more active than girls at baseline, no compelling evidence exists to suggest habitual physical activity contributes to sex differences in fitness (Armstrong *et al.,* 1996).
- Overweight children had lower fitness levels than their non-overweight counterparts when adjusting for body mass (see **Figure 14**), similar to previous research (Unnithan *et al.,* 2006), with this again likely attributed to differences in body composition.

Results - Intervention

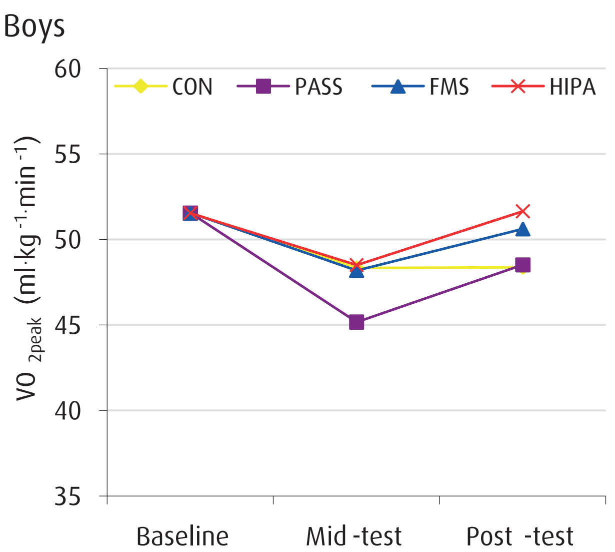


Figure 15 Intervention effects on fitness in boys

At mid-test PASS fitness scores were significantly lower than all other groups. At post-test HIPA and FMS fitness scores were meaningfully higher than CON and PASS.

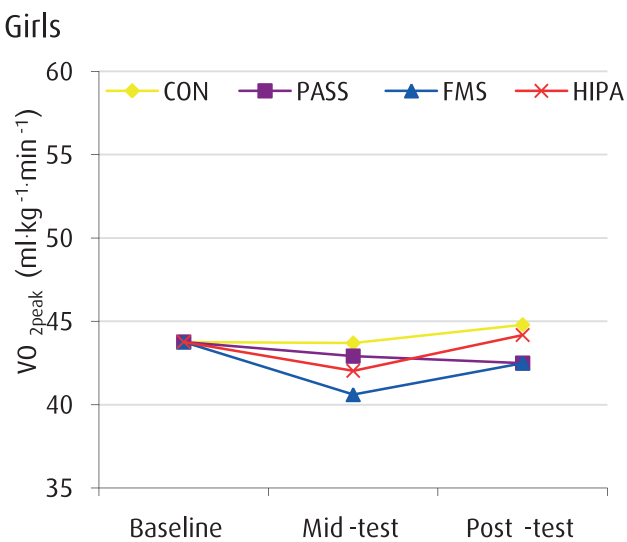


Figure 16 Intervention effects on fitness in girls

At mid-test, FMS fitness was significantly lower than CON, and meaningfully lower than PASS and HIPA. HIPA was meaningfully lower than CON. At post-test, CON and HIPA fitness scores were meaningfully higher than FMS and PASS.

What does this mean?

- Boys' fitness decreased in all groups from baseline to mid-test (**Figure 15**). At post-test, HIPA and FMS fitness returned to baseline values, compared to declines for CON and PASS over the project. Biweekly HIPA and FMS clubs appear protective against fitness declines for boys of this age.

- Girls' fitness remained constant from baseline to mid-test in the CON and PASS groups, whilst FMS and HIPA declined (**Figure 16**). At post-test, HIPA fitness returned to baseline values and was similar to the CON group. Similar to boys, HIPA appears protective against fitness declines in girls, though this is suggested with caution due to a similar effect of no intervention over time.

- No improvements in fitness were observed for any group over the project. This is unsurprising and largely attributable to intervention sessions not being frequent or intense enough.

- To improve fitness in prepubertal children, programmes should consist of 3-4 sessions/week, each for 30-60 minutes, at intensity $\geq$ 80% maximum heart rate (HRmax), with training length appearing less decisive (Baquet *et al.*, 2003).

- HIPA was most likely to promote fitness; however sessions were biweekly with a mean intensity of ~70% HRmax, thus falling short of recommendations. Factors such as ensuring a balance between enjoyment and fatigue made it practically difficult to achieve the required intensity during sessions.

- Future interventions aiming to improve fitness need at least three sessions per week that conform to recommended intensities and durations to be effective.

5. Body Composition

Introduction

- Overweight and obesity are major health risk factors for a number of other chronic diseases, including cardiovascular diseases, musculoskeletal disorders, type II diabetes and some cancers (WHO, 2006). Such risk factors have been found in children and have been linked to body fatness (Rizzo *et al.,* 2007) and level of physical activity (Andersen *et al.,* 2006).

- The rapid increase in overweight statistics for 7-11 year old children (Lobstein *et al.,* 2003) and the development of excess abdominal fat in children as young as 6-years old suggests that the entire paediatric population may be at a potential health risk (Stratton *et al.,* 2007).

- Children who are more active have lower body fat (Saelens *et al.,* 2007) and healthier bone mineral status (MacKelvie *et al.,* 2003) than their less active counterparts. The pre and early pubertal years are the most important for maximising bone gains through physical activity which is thought to protect against fracture risk and delay the onset of osteoporosis.

Methods

General Anthropometry

- Body mass, height and sitting height were measured in all children. Body Mass Index (BMI) was calculated as mass divided by stature (kg/m^2). Multiple skin-fold and girth measures were also taken to account for changes in body shape and fat distribution.

- As children mature at different rates, all results were adjusted for changes in maturation. Maturity was calculated in years before or after peak height velocity, using a maturity calculation (Mirwald *et al.,* 2002).

Body composition: body fat, muscle and bone

- Dual-energy X-ray Absorptiometry (DEXA) provides both total body and segmental data on body composition (fat mass, lean mass (muscle) and % body fat) and bone data (bone mineral content and density). This information is collected from a total body scan (**Figure 17**).

- Bone mineral content (BMC) and density (BMD) are indicators of bone strength; BMC is the absolute amount of bone mineral present, BMD is BMC x area. Bone strength information was gained from scans of the total body, the lumbar spine (back) and the femoral neck (hip joint).

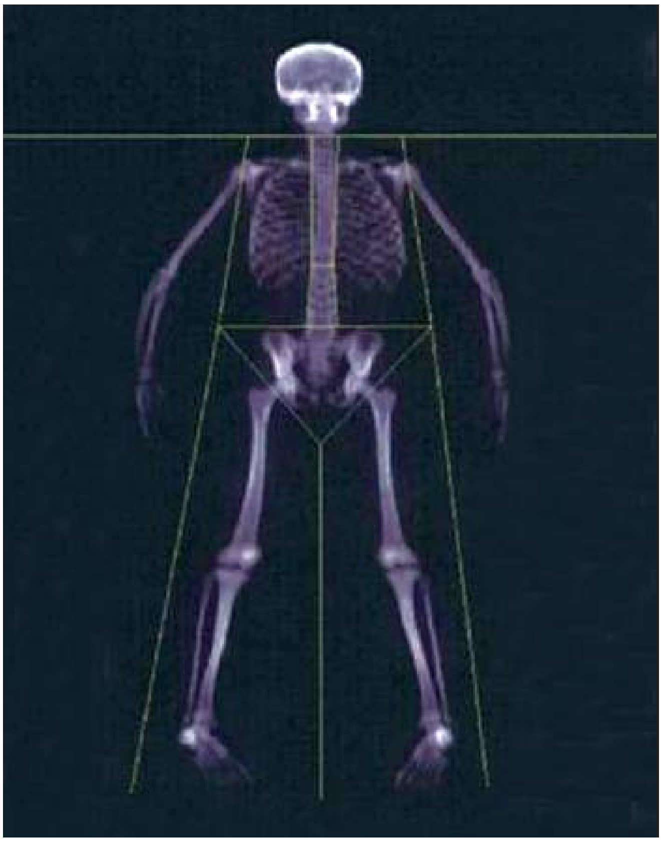


Figure 17 Total body DEXA scan.

Results - baseline

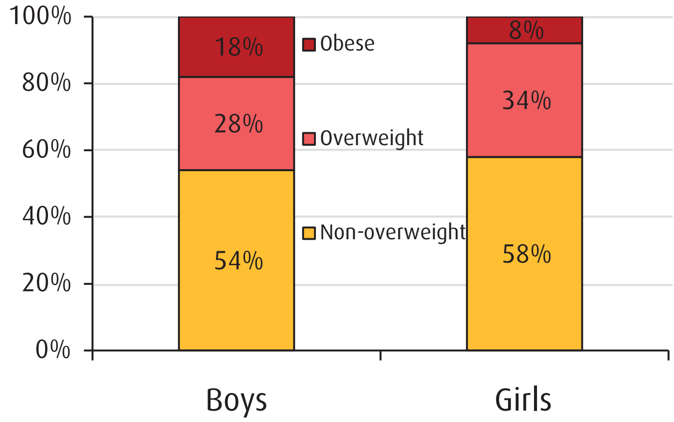


Figure 18 Percentage of boys and girls classified as non-overweight, overweight and obese

Over 40% of boys and girls were classified as overweight or obese using BMI.

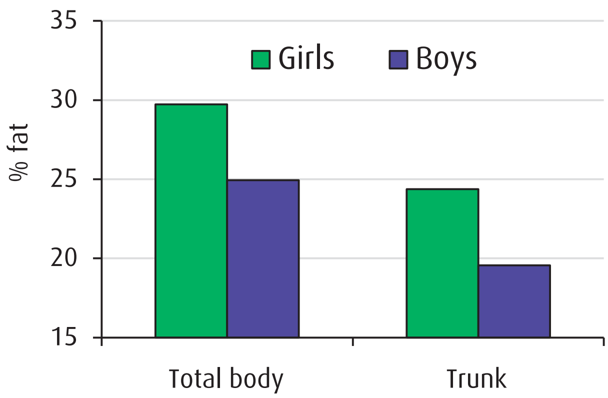


Figure 19 Differences in percent total body fat and trunk fat between boys and girls

Girls had significantly higher (~5%) total body fat and trunk fat than boys.

- Total lean mass (muscle) was significantly greater in boys compared to girls, as was total body bone mineral content and bone mineral density, and femoral neck bone mineral content and bone mineral density.
- Time spent in vigorous physical activity was positively related to total body bone mineral density.

What does this mean?

- 44% of children were classified as overweight or obese according to age-specific cut-off points (Chinn and Rona, 2004). As shown in **Figure 18**, more boys were obese than girls.
- DEXA and skinfold analysis found girls to be ~5% fatter than boys in total body and abdominal regions (**Figure 19**). Girls consistently have a greater percentage of their weight as fat than boys from 5 years of age through to adolescence. The DEXA data is contradictory to BMI results and highlights the problem of using BMI as a surrogate measure of fatness in children. This is because BMI does not account for true measures of fat and lean (muscle) mass.
- Mean total body fat (%) classified boys and girls as overweight according to body fat reference curves (McCarthy *et al,* 2006), this suggests interventions to combat obesity are necessary. Importantly, excess trunk fat is associated with increased risk of type 2 diabetes and cardiovascular disease (Bjorntorp, 1990), irrespective of total body fat and should be monitored closely.
- Gender differences in bone mineral content and bone mineral density could be explained by genetic or lifestyle factors – for example boys engaged in more vigorous physical activity than girls which may account for the observed disparities.

Results - Intervention

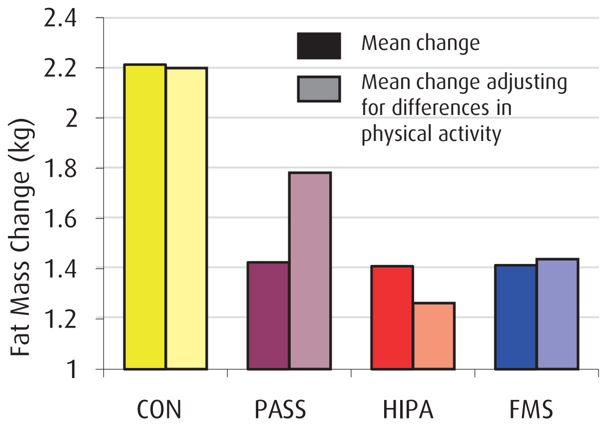


Figure 20 Changes in total body fat mass from baseline to post-test

All interventions observed significantly smaller increases in fat mass than CON. Following adjustments for time spent in physical activity, only HIPA was associated with significant differences.

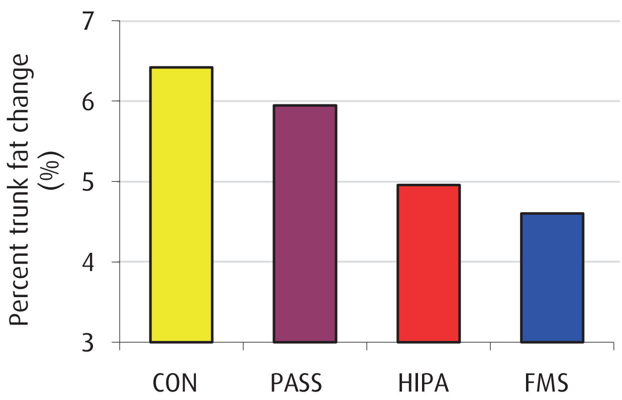


Figure 21 Changes in percent trunk fat from baseline to post-test

FMS participants increased trunk fat significantly less than control participants (4.6% vs 6.4%).

- No significant changes in percent body fat were found.
- No differences were found between groups in lean mass (muscle) at mid-test. However, at post-test, PASS had a significantly smaller increase in lean mass than control (0.7kg less).
- The largest gain in total body bone mineral content was observed by PASS, increasing by 3.3% and 4% more than the control group at mid-test and post-test, respectively. No significant changes were revealed by HIPA or FMS despite gaining more than the control.

What does this mean?

- All interventions had a positive effect on body fat mass compared to the control group by minimising its increase over the duration of the project. HIPA was significantly beneficial in minimising body fat increase independently of time spent in habitual physical activity (see **Figure 20**).
- No intervention effect was found in percent total body fat, though results suggest that the structured exercise sessions, particularly FMS, were effective in minimising trunk fat accumulation (**Figure 21**). This is important as excess trunk fat is associated with increased risk of cardiovascular disease and type 2 diabetes (Bjorntorp, 1990).
- Studies have also demonstrated physical training can produce favourable changes in body fat (McWhannell *et al.,* 2008), but most have been conducted in overweight and obese populations (Barbeau *et al.,* 1999; Gutin *et al.,* 2008). One school-based study only observed favourable outcomes on body fat when exercise classes' were supported by healthy lifestyle education (McMurray *et al.,* 2002).
- Overall, HIPA was most effective at promoting positive changes in body composition. This suggests that children should be provided with increased opportunities for high intensity physical activity.

Introduction

- The cardiovascular system is comprised of the heart, blood and blood vessels. Any disease that impacts on this system can be termed a cardiovascular disease. These diseases are the most prevalent 'killers' in the UK accounting for over 216,000 deaths in 2004 (Office of National Statistics, 2005).

- Treatment, and crucially prevention, of cardiovascular diseases are of great importance. To prevent such diseases, a clear understanding of its development, risk factors and early detection is needed.

- In a majority of cases the atherosclerotic process underpins cardiovascular disease. Atherosclerosis occurs when plaque builds up on the inner lining of arteries and reduces blood flow through the vessel. Despite its clinical symptoms emerging in later life; atherosclerosis is a progressive process thought to begin in childhood, (McGill *et al.,* 2000). Age-dependent physiological thickening has been found to appear on the arterial walls of children aged 5-14 years (Ishizu *et al.,* 2004).

- The progression of lesions on the vascular walls can be monitored through measurements of the carotid intima-media thickness, which is an independent predictor of coronary artery disease (de Groot *et al.,* 2004).

Methods

- Cardiovascular function (**Figure 22**) is assessed using echocardiography. Echocardiography uses ultrasound techniques to image 2D slices of the heart which provides real time structural images.

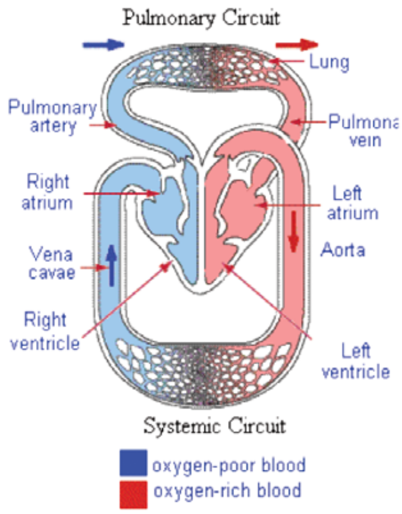


Figure 22 Cardiovascular system.

- A non-invasive probe was placed on the participant's chest wall to view images of the heart (**Figure 23**). Measurements of the heart were then taken to distinguish its size, shape and ability to function optimally.

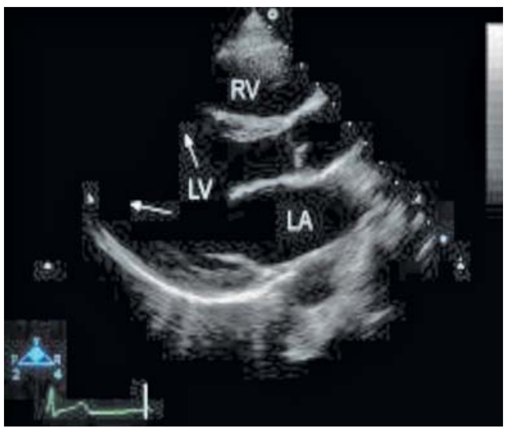


Figure 23 Echocardiograph heart image

The large chamber (LV) is the part of the heart that supplies the whole body with blood. Above it is the right chamber (RV) which pumps blood to the lungs.

- The left side of the heart pumps blood flow to the whole body and therefore is important to assess. An abnormally enlarged left chamber (LV) is an independent risk for cardiovascular disease (Savage *et al.,* 1990).

- Further assessment of heart function is made by measuring the velocity of the blood flow through the heart valves. This allows the monitoring of the pressure and volume at which the blood is leaving the heart.

- The echocardiograph can also be used to assess the main artery supplying blood to the brain from the heart (the carotid artery: see **Figure 24**). Blood flows through the vessel (black) and the distance between the red and green line is an indication of future cardiovascular disease risk (carotid intima-media thickness).

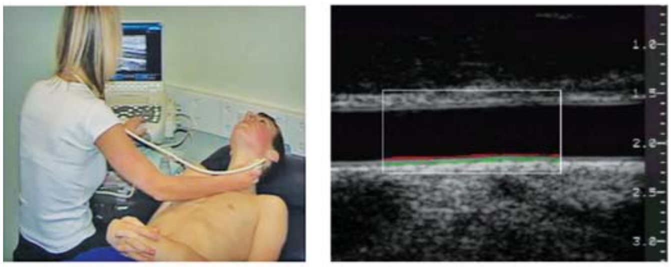


Figure 24 Probe placement for assessment of the carotid artery and example echocardiograph image

- Resting heart rate and blood pressure were also recorded. Blood pressure is a useful measure as it shows the pressures the heart is under both at relaxation and contraction. Those with higher blood pressures again are seen to have a higher CV risk.

Results - Baseline

- Physical activity was not related to any cardiovascular measure.

- Heart function and carotid intima-media thickness (a marker for atherosclerosis) were not related to body composition, physical activity or cardiorespiratory fitness.

- The size of the left chamber (LV) in the heart was positively related to body composition and cardiorespiratory fitness.

What does this mean?

- The finding that increased body composition and higher fitness was associated with larger heart size (LV) is likely a result of normal growth i.e. the larger the child, the larger their heart.

- Despite poor cardiorespiratory fitness and excess adiposity in some 9-10 year old schoolchildren in the project, there was no evidence of advanced or early risk of cardiovascular disease that is normally seen in adults (Diaz *et al.*. 2006) and occasionally other studies in children (Sharpe *et al.,* 2006; Rizzo *et al.,* 2007).

- This suggests that this age group represents a "window of opportunity" whereby cardiovascular health intervention programmes (that aim to reduce adiposity and/or increase cardiorespiratory fitness) could be implemented before a significant increase in cardiovascular disease risk that is often seen in adolescents or adults with obesity or low fitness (Borodulin *et al,* 2005; Hu *et al.,* 2004).

Results - Intervention

- Heart function improved in all groups over the course of the project; however PASS and FMS improved significantly more than CON.

- Blood pressure significantly reduced over time, particularly in intervention groups.

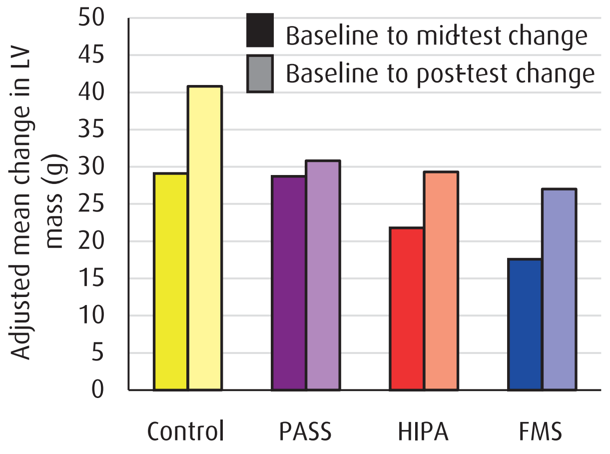


Figure 25 Mean changes in heart size (LV mass)
(adjusting for changes in maturation and fat mass)

Heart size increased over the project in all children. Change in heart size was significantly smaller in HIPA and FMS than CON.

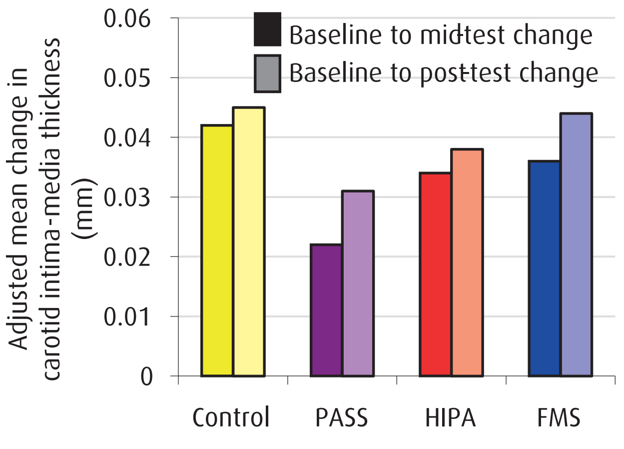


Figure 26 Mean changes in carotid intima-media thickness

(adjusting for changes in maturation and fat mass)

Carotin intima-media thickness increased in all groups. The intervention groups changed less than CON, with PASS significantly smaller.

What does this mean?

- Over the course of the project heart size, function and carotid intima-media thickness all increased, irrespective of participant group. This likely represents normal body growth over this 12 month period.

- As shown in **Figure 25**, participation in the interventions, particularly FMS, were associated with smaller increases in heart size (LV mass) than the control. This suggests that such interventions could prevent unwarranted increases in fat mass thus lessening the increases in heart size in pre-pubertal children.

- Carotid intima-media thickness increased in all groups (see **Figure 26**). Whilst this atherosclerotic process could not be totally prevented or reversed, participation in the intervention groups appeared to slow down this process. This was without any improvements in physical activity or fitness, suggesting some local vascular adaption may have taken place. Any explanation for the exact cause or mechanism is purely speculative but changes in vascular health have been reported with training in children in other studies (Watts *et al.,* 2006).

- Surprisingly, HIPA was not as effective at improving cardiovascular variables as FMS or PASS. Clearly the lack of training effect on fitness, physical activity and body size may underpin this lack of change, although this did not prevent some changes in other groups.

7. Fundamental movement skills

Introduction

- Failure to master basic movement skills may provide a barrier to participation in physical activity (Gallahue & Donnelly, 2003). Such skills are classified as locomotor skills, object-control skills or stability skills. Locomotor skills include hopping, skipping, jumping and running. Object-control skills are kicking, catching and throwing, whilst examples of stability skills include dynamic balance or turning.

- Children who are less skilled may feel less confident in a physical activity setting and therefore less motivated to participate (Ulrich, 1987). Skill competence is associated with numerous benefits, including increased participation in organised sport (Okely *et al.,* 2001a), higher levels of fitness (Okely *et al.,* 2001b), and reduced risk of overweight or obesity (Okely, Booth & Chey, 2004).

- Descriptive studies conducted in Australia have revealed worryingly low rates of skill proficiency in children (van Beurden *et al.*, 2002; Booth *et al.,* 2006). However, little is known about the skill proficiency of UK children. Furthermore, research is needed to determine the effectiveness of multi-skill clubs.

Proficiency
is defined as possessing all or all but one required component of a skill

Methods

- Eight skills were assessed using a modified protocol (Department of Education and Training, NSW, 2000).

  Four locomotor skills:
  Hop, vertical jump, sprint run and dodge

  Four object-control skills:
  Catch, kick, overarm throw and strike

- One trained tester analysed skill competence using video analysis and process-based methods (which focus on the way the skill is performed rather than the product of the performance). **Table 5** describes the skill assessment task criteria used. A score was then calculated for each skill based on the total number of skill components performed correctly (Okely *et al.,* 2001a).

- To investigate baseline differences and examine the effectiveness of the intervention on these skills the number of skill components checked as present was examined. Two summary variables - "locomotor skills" (sum of hop, vertical jump, dodge and sprint run) and "object-control skills" (sum of kick, catch, throw and strike) were created to investigate potential differences between different forms of movement skills.

- The prevalence of **proficiency** in each skill at baseline was investigated to examine how many children pass through the skill proficiency barrier. It is not enough to simply be able to perform the skill; children need to master a skill to incur the benefits associated with skill proficiency.

Table 5 Fundamental movement skill assessment tool

This describes the tasks and the criteria used to assess skill competance.

SKILL	TASK	CRITERIA
Hop	Hop as fast as you can over a distance of 10m	1. Support leg is bent in preparation and then straightens to push off 2. Takes off and lands on forefoot 3. Swing leg moves in rhythm with support leg 4. Able to hop on both right and left legs 5. Head and trunk stable with eyes focused forward 6. Arms bent and move to assist leg action
Vertical Jump	Jump and touch the wall as high as you can	1. Eyes focused forwards or upwards throughout the jump 2. Crouch with knees bent and arms behind the body 3. Forceful upward thrust of arms as legs straighten to take off 4. Legs straighten in the air 5. Contact ground with front part of feet and bend knees to absorb force of landing 6. Balanced landing with no more than one step in any direction
Dodge	Dodge through a series of cones placed in zig zag formation, 3m apart	1. Bend knees during change of direction 2. Push off on outside of foot when changing direction 3. Body lowered during change of direction 4. Eyes focused in direction of travel 5. Can dodge to either side 6. Arms move to assist action
Sprint	Run a distance of 30m as fast as possible	1. Lands on balls of feet 2. Eyes focused forward, head and trunk stable throughout the run 3. High knee lift (thigh almost parallel to the ground) 4. Knees bend at right angles during the recovery phase 5. Arms bent at least 90 degrees 6. Arms DRIVING forward and back in opposition to legs
Catch	Catch a tennis ball thrown underarm from a distance of 10m	1. Eyes are focused on the ball throughout the catch 2. Feet move to put body in line with object 3. Hands move to meet ball 4. Hands and fingers positioned correctly to catch the ball 5. Catch and control the ball with hands only (well-timed closure) 6. Elbows bend to absorb force of the ball
Over - arm Throw	Throw a tennis ball overarm as far as possible	1. Eyes are focused on the target throughout the throw 2. Stand side-on to the target 3. Arm moves in a down-ward and backward arc 4. Step towards the target with foot opposite throwing arm during the throw 5. Hip then shoulders rotate forward 6. Throwing arm follows through down and across the body
Kick	Kick a size 4 ball towards a target as hard as possible	1. Eyes are focussed on the ball throughout the kick 2. Forward and sideward swing of arm opposite kicking leg 3. Step forward with non - kicking foot placed near the ball 4. Hip extension and knee flexion of at least 90 degrees during preliminary kicking movement 5. Contact the ball with the top of the foot (a "shoelace" or instep kick) 6. Kicking leg follows through high towards the target after ball contact
Strike	Using a t-ball stand and a foam baseball bat, hit a tennis ball as far as possible	1. Stand side-on to target 2. GRIP: hands next to each other, hand closest to handle end matches front foot 3. Front foot steps forward (weight transfers from back to front) 4. Hips then shoulders rotate forwards 5. Ball contact made on front foot with straight arms 6. Follow through with bat around body

Results - Baseline

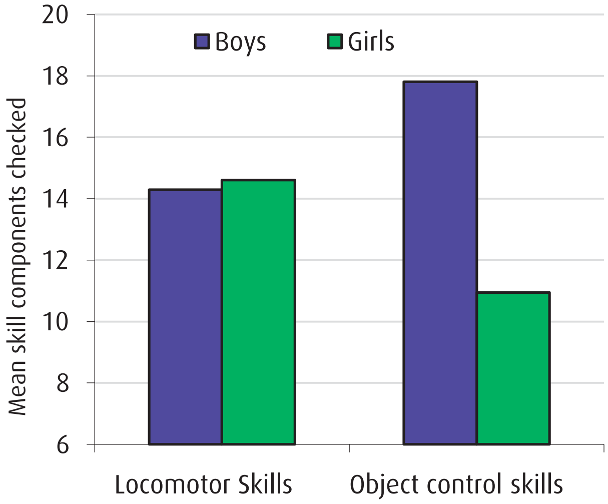


Figure 27 Gender differences in locomotor and object-control skills

(adjusting for differences in age, maturation, physical activity, body fat, and perceived skill ability)

Boys perform better at object-control skills but there is no difference in locomotor skills.

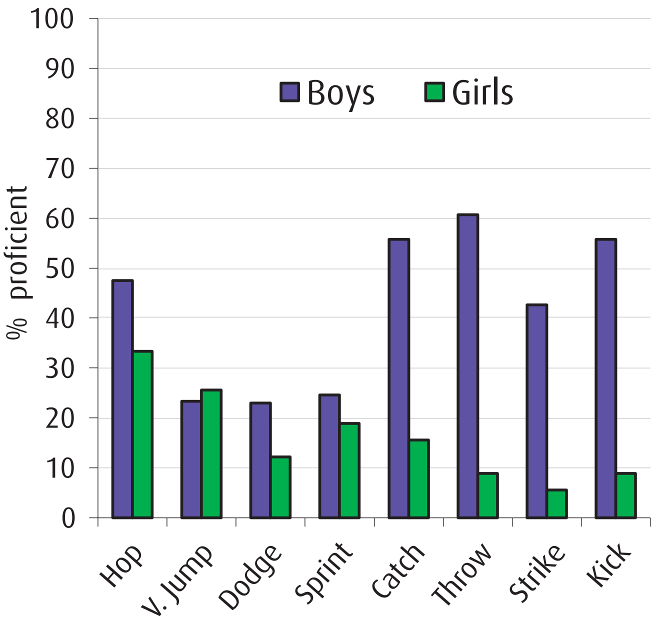


Figure 28 Gender differences in skill proficiency
Boys were more advanced than girls in seven out of eight skills; however these differences were only significant in the four object-control skills - the catch, overarm throw, strike and kick.

What does this mean?

- In boys, the prevalence of proficiency did not exceed 60% in any skill except the over-arm throw, whilst in girls only the hop had over 30% rated as proficient (**Figure 28**). This suggests there is great potential to improve fundamental movement skill competence.

- This is concerning given that children should master most fundamentals by 8 years of age (Payne & Isaacs, 2002). However, the development of fundamental movement skills is not automatic, in order to develop, skills need to be taught and practiced.

- Gender differences in object-control skills (**Figures 27 and 28)** may reflect the different activities which children typically participate in at this age. More boys play ball sports than girls and so have further opportunities to develop skills such as kicking, catching and throwing (Booth *et al.,* 2006).Conversely girls are more likely to participate in activities such as dance which do not reinforce object-control skills. Differences are also formed in unstructured settings such as school play.

- Gender differences are environmentally and culturally induced, rather than biological (Thomas, 2000). If we provide similar opportunities for instruction, practice, encouragement, and feedback to both boys and girls then observed gender differences can be reduced (Booth *et al.,* 2006).

- Higher % body fat was associated with poorer locomotor skill performance (Foweather *et al.,* 2008). Consequently, improving locomotor skills may positively impact on adiposity in overweight children.

Results - Intervention

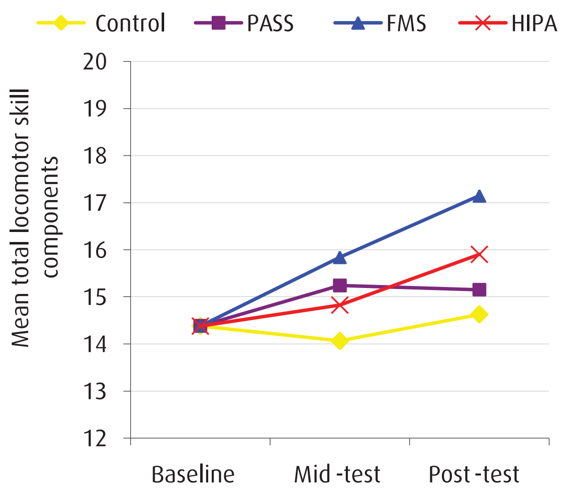


Figure 29 Intervention effects on locomotor skills
(adjusting for baseline differences)

Locomotor skills improved the most in the FMS intervention, whilst participation in HIPA was also associated with small gains.

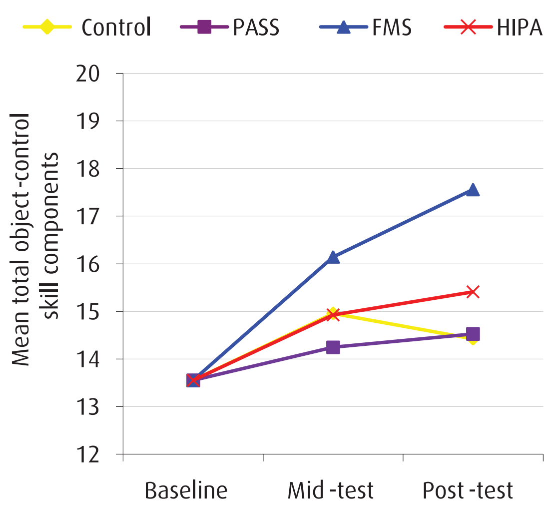


Figure 30 Intervention effects on object-control skills
(adjusting for baseline differences)

Object-control skills improved the most in the FMS intervention, scoring significantly higher than all other groups.

What does this mean?

- In the FMS group, which focused on increasing skill competence, intervention effects were comprehensive - both locomotor and object-control skills were substantially improved compared to all other groups (see **Figures 29** and **30**).

- The HIPA intervention also resulted in a small positive effect on locomotor skill components at post test compared to the control (**Figure 29**). This likely reflects the HIPA intervention content, with a focus on movement games like tag or relays, and jumping activities rather than ball games. Consequently, dodging, hopping, jumping and sprinting skills may have benefited from HIPA activities.

- PASS showed no effect on skill scores (see **Figures 29** and **30**). As a lifestyle programme, PASS was not designed to increase skill competence and offered no structured exercise sessions. The findings suggest that to improve skill competence in children of this age directed practice is required.

- The magnitude of the effects observed following participation in the FMS group were pleasing, particularly as the ideal window of opportunity for fundamental movement skill development is from 3-8 years of age and attempts to improve competence outside this period can be challenging.

- These findings highlight that 9-10 year old children still have the capacity to increase skill competence, but future interventions should be aimed at younger children to maximize the potential for change.

8. Physical self-perceptions

Introduction

- Improving self-esteem may have positive benefits on children and adolescents' behaviour and mental well-being (Ekeland *et al.,* 2004).
- Self-esteem can be defined as a person's value of the good in one's self description (Campbell, 1984). This description is based on perceptions of competence in different aspects of the self, termed domains.
- In children, these domains include perceptions of scholastic competence, social acceptance, athletic competence, physical appearance and behavioural conduct (Harter, 1985).
- Physical activity participation is influenced by physical self-perceptions (perceptions of physical competence). Fox and Corbin (1989) propose that physical self-perceptions are derived from perceptions of physical condition, body attractiveness, physical strength and sports competence (see **Figure 31**).
- Physical self-perceptions are important as individuals who perceive themselves to be competent in an activity are more likely to be motivated to continue participating and exert effort. However, those with low perceived physical competence are less likely to exert effort and may withdraw from participation.

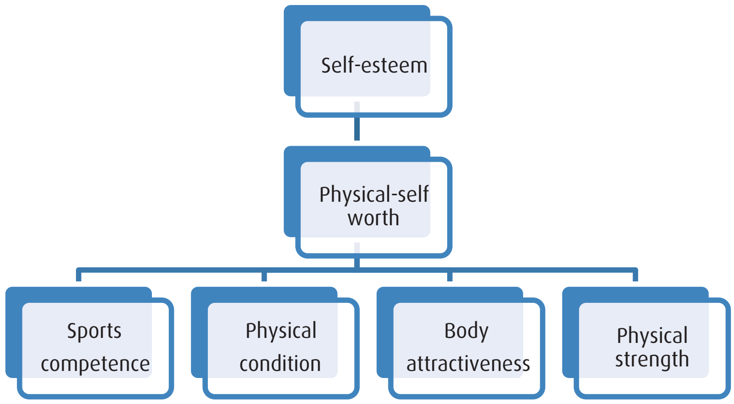


Figure 31 Physical self-perception profile

This shows the factors that are important in assessing perceived physical self-worth in children.

Methods

- Physical self-perceptions were assessed using a modified version of the children and youth physical self-perception profile (CY-PSPP: Whitehead, 1995). The questionnaire comprises of 36 questions, which represent the six constructs in (**Figure 31**).
- An example of a question for sports competence is shown in (**Figure 32**). For each question children must read the two statements and decide which one is most like them. Next they must decide if it is "really like me" or "sort of like me".
- Every question is scored from one to four (four meaning highest self-perception), with the maximum score for a construct being 24 and the minimum 6. Eight further items were added to determine perceived competence in each of the assessed fundamental movement skills.

Figure 32 CY-PSPP question

This shows a question used to assess perceptions of sport competence.

Results - baseline

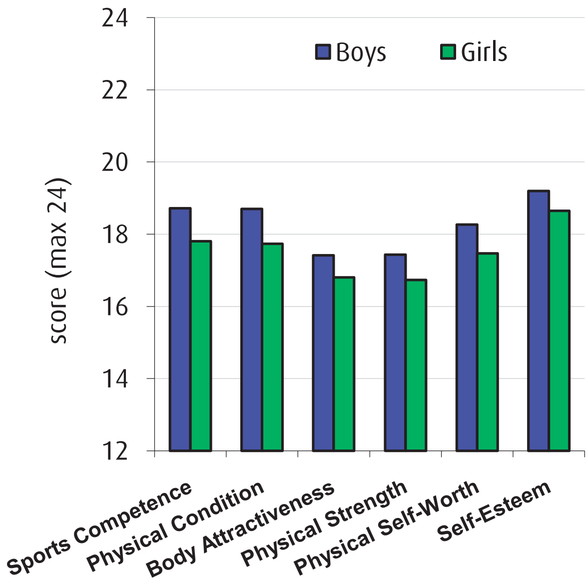


Figure 33 Differences between boys and girls in CY-PSPP

Boys had higher self-perceptions than girls in all constructs, though these differences were not statistically significant.

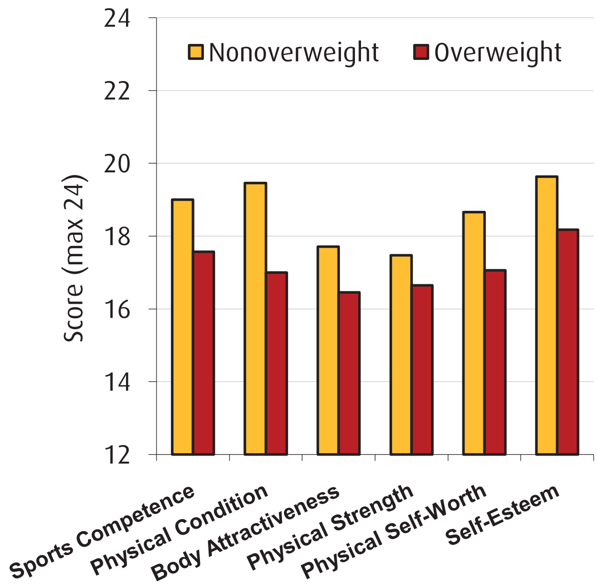


Figure 34 Overweight and non-overweight differences in CY-PSPP

Overweight children had significantly lower perceptions of sports competence, physical condition, physical self-worth and self esteem, whilst there was a strong trend for body attractiveness also.

What does this mean?

- The physical self-perception profiles of boys and girls in Liverpool were pleasing, and suggest that children of 9-10 years of age have relatively high physical self-perceptions.

- Reasons for gender differences (**Figure 33**) in physical self-perceptions are unclear. Perceptions of competence can stem from actual competence or social support. Boys were more competent than girls in some measured outcomes i.e. boys possessed better fundamental movement skills, fitness, and had lower levels of body fat. This may explain higher perceptions of sports competence, physical condition, and body attractiveness.

- Alternatively, gender differences may be due to social and cultural factors (Welk and Eklund, 2005). Boys value physical competence more than girls, and have greater expectations for success in physical activity and sport (Eccles *et al.,* 1993). These social pressures could explain higher perceived physical competence. Conversely, girls may not see themselves as "the sporty type", they place little value on physical competence and so have lower self-perceptions.

- As shown in **Figure 34**, overweight children had lower physical self-perceptions than non-overweight children (as classified by McCarthy *et al,* 2006).

- These differences could have been due to differences in actual competence - overweight children scored lower than non-overweight children in measures of fitness and locomotor sport skills, for example.

Results - intervention

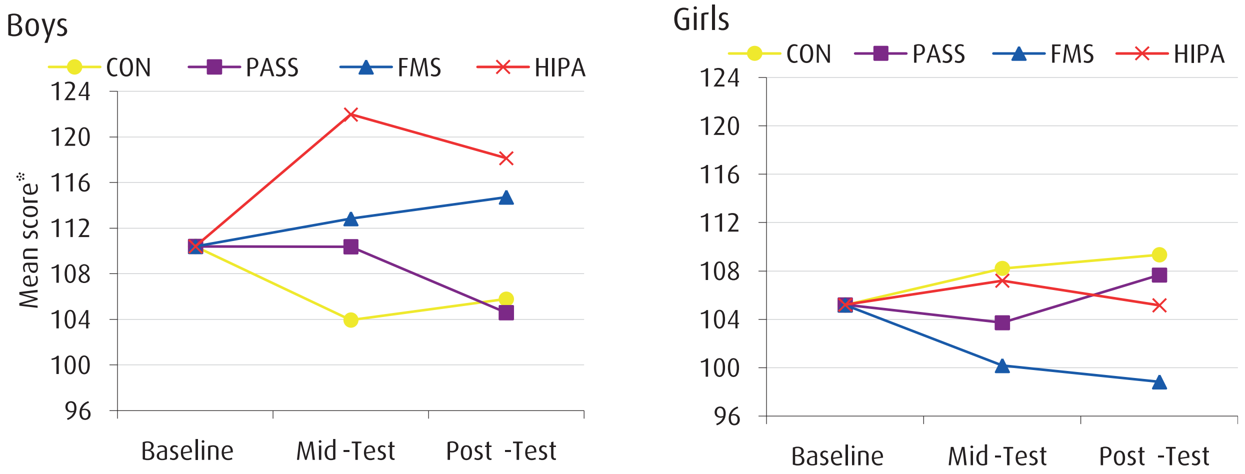


Figure 35 Intervention effects on total physical self perception score

In boys, HIPA and FMS positively impacted physical self-perceptions, whilst PASS had no effect. In girls, no positive intervention effect was observed, however participation in FMS was associated with more negative physical self-perceptions.

More specifically in boys:

- HIPA and FMS positively benefitted perceptions of sports competence, physical condition, physical self-worth and self-esteem. HIPA increased perceptions of strength, whilst FMS enhanced boys' perceived attractiveness
- PASS had no effect

More specifically in girls:-

- No effect on perceived sports competence
- PASS, HIPA and FMS lowered perceptions of attractiveness compared to CON. Also, FMS and HIPA were associated with lower physical self-worth
- PASS and FMS associated with lower perceived physical condition
- PASS increased self-esteem but FMS participation associated with lower self-esteem.

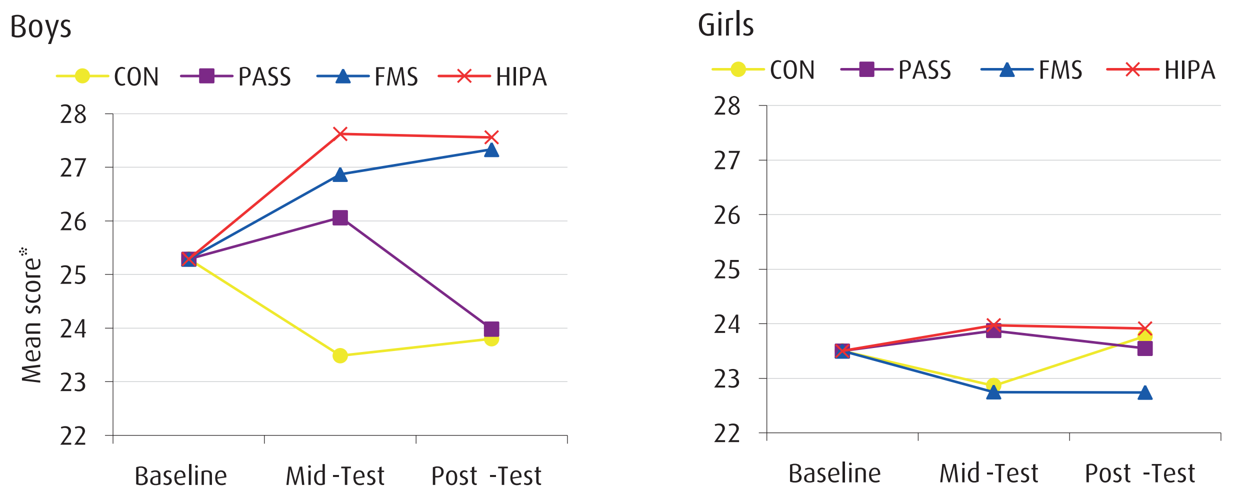


Figure 36 Intervention effects on perceptions of competence in fundamental movement skills

In boys, participation in HIPA and FMS increased perceived skill ability, whilst PASS increased perceived skill ability capared to CON at mid-test but not post test. In girls, perceived skills ability did not change significantly from baseline in any group.

Results - intervention

- In boys, participation in FMS and HIPA interventions enhanced perceptions of physical competence, and self-esteem, whilst PASS had no effect (see **Figure 35**). This suggests that, for boys, structured exercise sessions best impact on physical self-perceptions.

- HIPA aimed to increase fitness; therefore it was not surprising that HIPA was associated with enhanced perceptions of physical condition, although no difference in physical fitness per se was observed. Sessions also included circuit training, which may have increased perceptions of strength. HIPA did not seek to improve sports skills, so it is interesting that boys' perceptions of sports competence increased. This may reflect the observed HIPA increases in locomotor skills.

- Participants in FMS improved skill competence, which likely enhanced perceptions of sports competence. This proved that increasing actual competence influences perceptions of competence. FMS also impacted perceived physical condition. It could be that boys in the FMS group perceived their fitness to increase via participation in the after-school club, although no physiological change in fitness was observed. More positive views of body attractiveness were also unexpected, particularly as this is difficult to change through exercise (Fox, 1997).

- In contrast to boys, participation in PASS, FMS and HIPA were not associated with any benefit on physical self-perceptions in girls (see **Figure 35**), though PASS was associated with increased self-esteem.

- Participation in FMS, HIPA or PASS was associated with more negative perceptions of body attractiveness in girls. Participation may have raised self-presentation awareness which, coupled with societal pressures on girls to conform to an unrealistic ideal of a slim and slender body (McCabe *et al.,* 2002), lowered perceptions of attractiveness. Additionally, the intervention coincided with a period of physical maturity, and associated increases in body fat, moving girls away from this cultural ideal body image (Niven *et al.,* 2007).

- The gender differences in the intervention findings may be due to several factors:

  - Participation in the intervention may have increased the importance that girls attached to being physically competent, which may previously have been discounted. This in turn may have increased focus on physical abilities, and drew attention to lack of competencies, causing lower self-perceptions.

  - Boys may have been more aware of changes in actual competence than girls. This is highlighted by perceptions of skill ability (**Figure 36**). Participation in the FMS intervention significantly improved skill competence in both genders but only boys' perceptions of skill ability increased.

  - The after-school club included boys and girls. Participating with boys may have affected girls' perceptions of competence, particularly if they were assessing competence by means of social comparison - boys had higher levels of fitness and skill than girls. Girls may be happier in single-sex sessions, with many reporting displeasure at mixed gender sessions in our coaching evaluation forms.

- Further research, should be conducted to better understand the mechanics of change in physical self-perception.

9. PASS - Research findings

Introduction

Over 90% of children's daily activity is accounted for outside of structured exercise (Trost *et al,* 2002), thus it is important to improve children's lifestyle behaviours.

- PASS (Physical Activity Signposting Scheme) is a lifestyle intervention aimed at increasing habitual physical activity and reducing sedentary behaviour. PASS is based on social-cognitive theory (Bandura, 1986). This theory suggests that the person, the behaviour and the environment interact with each other and this determines a change in behaviour.

- A central aspect of this theory is self-efficacy (the belief of how capable someone perceives that they are at performing a given task). People are more likely to be successful if they believe that they can achieve, as they see obstacles as surmountable and are more likely to persevere.

- PASS encourages children to use their physical and social environment to their advantage, and also aims to improve self-esteem.

Methods

- Information regarding the design and content of the PASS intervention can be found on pages 12-15.

- Focus groups were undertaken to inform the design and evaluation of PASS. All children and their teachers participated in the focus groups; one of the head-teachers also participated; whilst in total nine parents took part.

PASS mission return rate

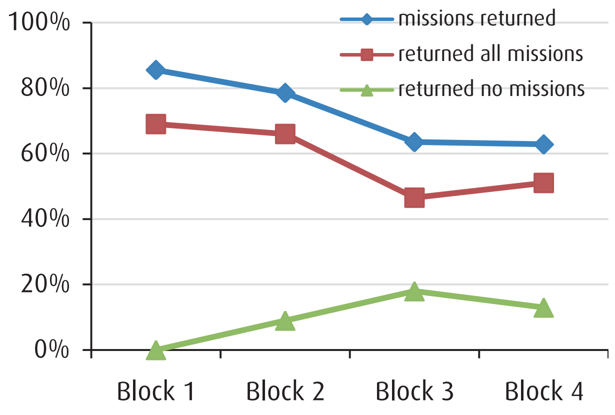


Figure 37 Compliance and return of PASS missions

The return rate slowly decreased until blcok 3, when there was a slight increase to block 4.

- **Figure 37** shows the return rate of PASS missions. In block 1, many missions were returned. Children appeared to be motivated to return their missions either because of the prize (a t-shirt) or because 'you told us to'.

- In block 2, the number of missions returned fell slightly. Some parents said they had not seen the missions. As a result of this feedback, return slips were put on the missions to increase parental support. Return slips on the missions had to be signed by a parent in order to gain a star.

- By the end of block 3 return rates had decreased further. Some children were losing interest in the missions. Parents also reported that the children had lost enthusiasm.

- Following feedback from children and parents in block 3, children were asked to make up their own missions in block 4 to make them more fun, which may have stimulated a small increase in return rate.

Process findings

Analysis of focus groups: Block 1

- All of the children were very enthusiastic about PASS and enjoyed the missions. *'I enjoyed it as I got to learn different things about what keeps you healthy' and ' We got to do more activity than we used to do and it helped us instead of being lazy we got to be active'.* These quotes show that children enjoy being active, but sometimes they do not have a reason to be active. These missions gave them a reason.

- A lot of the children struggled with the missions which aimed to reduce TV watching. Comments arose such as *'terrible it was murder' and 'I found it hard to stop watching TV, but I stopped it in the end'.* Although the children found this challenge difficult their self-efficacy improved as they realised that they were capable of achieving the task of watching two hours of TV a day.

- The teachers were very enthusiastic about the missions. They were not sure if actual activity levels had increased but suggested that the children's awareness of the importance of physical activity had improved.

- Parents who participated were positive about PASS as they believed that being active is important. The parents agree with the teachers in that they are not sure if activity levels have altered. One parent said in response to the question 'what changes do you see in your child's activity levels: *'Not really any long term, the week of the mission they would be but after this they go back to normal'.* Two parents also suggested that children did not understand the relationship between food and activity and would like more education on this.

- As a result of these comments the next block of missions were designed. These were designed to try and change the activity behaviour of the children over a longer period. Therefore a disposable camera was given to each child to take pictures of themselves being active over the next six weeks. In addition a task on energy balance was designed to help the children learn about the food – activity balance.

Analysis of focus groups: Block 2

- There was a mixed response after the second block of missions. Most of the children still enjoyed the tasks and all were still attending, however some children found the second block more challenging. For some children they appreciated the challenge whereas others didn't: '...... *it was easier on the first one (block) and you didn't have to do that much physical activity, but now at the second turn you have to do more physical things it's like pushed us and when it's pushed us you started getting used to it more and more'.* Compared to '*I can't be bothered*'.

- The head teacher of one of the schools said that the awareness about activity was increasing in both the parents and children who were taking part but also in those who are not. The parents believed that it was better that the tasks were more challenging in that they had to do more thinking and more activity.

- Some parents said that they did not see the missions. One of the parents who did see her child's mission every week was very positive about PASS – both mother and daughter completed the missions together and improved their lifestyle. Parents said that it would have been better if they had been involved from the beginning, suggesting a meeting at the start explaining what PASS was and what would be expected of them and their children.

Table 6 Comparison of information from focus groups on different themes

This table summarises children's, parents and teachers perspectives on various themes emerging with PASS

Was there a perceived increase in physical activity?	
Children believe that their physical activity levels have increased, whereas teachers and parents disagree	*CHILD:* *"I learnt about how it can affect your life forever and I just thought about it and now I play more games."* *TEACHER:* *"I wouldn't say it's been that great a difference on their own habits however I think their attitude has changed"* *PARENT:* *"it's been a good thing and they've been learning and it's how they want to adapt now that they have done the project"*
Increased awareness?	
Teachers, children and parents demonstrated an increased awareness of physical activity and sedentary behaviours. Not only are the children more aware of how much or little physical activity they are doing, but they are more aware of enabling factors which would allow them to augment their physical activity levels.	*CHILD:* *"My dad never used to take me out to like different parks but now with the cameras and that we went to different parks and I liked that and people are active there."* *PARENT:* *"some of the things she has brought home have made her realise what she's doing and what she's not doing and what she should be doing"* *TEACHER* *"getting them to write down how much telly they watch I think has scared them and their parents"*
Increased self-efficacy?	
Children are more confident in their ability to carry out physical activity and reduce sedentary behaviours. They feel that they have the skills and belief to be able to do this now. Teachers and parents also see that some of the children were encouraged to take part in different activities. Some missions increased self-efficacy, whereas others did not. Missions were designed to improve self-efficacy by being a sufficiently challenging, however sometimes missions were too difficult so the children gave up.	*CHILD A:* *"A-CLASS has encouraged me to believe that I can be more active and fit"* *CHILD B:* *"I feel different because I used to go on the computer loads but when I went to A-CLASS they like helped you like not watching as much telly"* *PARENT:* *"I think Harry is more confident now, [I'm not sure] if that's because of what he's doing in school or whether I get on his case about it"* *TEACHER:* *"like if an activity comes up at school they may not have done it before but now they might have a little more confidence to take part"*
Programme duration	
For some children the enjoyment of PASS appeared to dwindle after the second block of missions, however for others they were keen to continue with PASS for as long as they could. There was also a mixture of responses from parents and teachers, some thought that the children needed extra support in becoming active, others felt that the project had continued for too long.	*CHILD C:* *"it's quite boring"* *CHILD D:* *"If you carry on longer it's making you get more and more active"* *PARENT:* *"I don't know if it's long enough, you can't tell much in a year"* *TEACHER:* *"the only thing I would say about it in a negative way is that it has gone on too long"*

Analysis of focus groups: Block 3

- By the end of block 3, some children were losing interest in the missions. One child suggested that this was because it was the end of term (it was just before the summer holidays). However, another child said *'people might not want to give up the time to do the missions cos they might want to have fun'*. When asked how they could be more fun another child said *'tell us to make a game up and that and play out with your mates'.*

- Parents also reported that children had lost enthusiasm for completing the missions. It was becoming *'like homework, it's a chore'*. Children don't talk about it at home anymore and are fed up of filling in charts.

Analysis of focus groups: Block 4

- Block 4 was altered slightly in response to the lack of enthusiasm after block 3. The missions in block 4 were designed to increase children's autonomy. To achieve this, children were asked to design their own missions for three weeks and finished with designing a poster based on their choice to be active or sedentary. Designing their own missions worked well for some children, however others found it difficult to keep thinking of new things and therefore gave up.

- The return rate recovered slightly in block 4. When asked at the end of this block why they were returning the missions, those children who did still return their missions said that it was to help them get healthy.

PASS: summary findings

- Information from the focus groups was merged to see how they compared on different themes (see **Table 6**).

- PASS was successful in increasing physical activity awareness and self-efficacy in children. For some children this increased physical activity; for others this may have given them the confidence to try new activities in the future.

- A key part of PASS was encouraging the parents to take part in the missions with their children. If parents did take part then children were more likely to be active and complete the missions.

- Rewards were used as an incentive for children to return their missions. Initially this was the children's principal reason for returning their missions. However, by the end of block 4 the major motivating factor was intrinsic - they were returning the missions because they 'got them active'. Some children got bored with missions so different incentives may be needed.

- Future recommendations for PASS include making the missions more personalised and interactive. Further research is needed to determine the appropriate length of PASS, and to ascertain whether PASS can be delivered via the internet and to children of different ages.

Glossary

Accelerometer A device that detects and quantifies movement (physical activity)

Adolescence Transition from childhood to adulthood. Usually occurs between the ages of 11 and 16 years

Aerobic exercise Physical activity or exercise that predominantly uses aerobic energy metabolism. Light and moderate intensity physical activity is predominantly aerobic

Aerobic fitness The ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity. In children aerobic fitness is usually expressed as measured or estimated peak oxygen uptake (VO2peak)

All-cause mortality Death from any cause

Atherosclerosis A progressive disease that leads to hardening and thickening of the walls of arteries and narrowing of these vessels

Baseline The data collected prior to the start of the intervention

Blood pressure The lowest and highest blood pressure recordings in the arteries

Body composition The relative proportions of fat and lean (non-fat) body mass

Body mass index (BMI) Weight in kilograms divided by height in metres squared. A crude measure of obesity

Bone mineral content The amount of mineral at a particular skeletal site

Bone mineral density Determined by dividing the bone mineral content by the area of the scanned region

Bone-strengthening activity Activities designed to promote bone strengthening via impact or tension force on the bones which promotes bone growth and strength

Cancer A set of diseases characterised by unregulated cell growth leading to invasion of surrounding tissues and spread to other parts of the body

Cardiovascular system; Cardiovascular disease The circulatory system comprising the heart and blood vessels; any disease which impacts this system

Cardiorespiratory fitness See Aerobic fitness

Carotid artery A major artery (right and left) in the neck supplying blood to the brain

Carotid intima-media thickness The thickness of the walls of the carotid artery – used to detect the presence and track the progression of atherosclerosis

Children 2-11 year olds (in this project: 9-11years)

Competence The ability to accomplish the achievement demands of a particular skill or group of skills

Coronary heart disease Diseases of the heart caused by a build up of atherosclerotic plaque in the coronary arteries

Developmentally-appropriate Experiences provided for children based on their individual, unique developmental levels

Diabetes (diabetes mellitus) A disease in which the body doesn't produce or properly use insulin, which regulates blood sugar levels

Dual energy x-ray absorptiometry A device used to measure body composition and bone mineral density

Duration The length of time in which an activity or exercise is performed (expressed in minutes)

Echocardiography A method of studying the heart's structure and function by analyzing sound waves.

Energy expenditure The amount of energy, measured in calories, that a person uses.

Exercise Planned bouts of physical activity usually pursued for personal health and fitness goals

Fat-free mass Total body mass minus fat mass

Frequency The number of sessions of physical activity over a fixed period

Fundamental Movement Skills Basic movements that involve the combination of movement patterns of two or more body segments. Categories of skills include stability, locomotor and object-control (manipulative) movements

Habitual physical activity The day-to-day regular physical activity undertaken

Health A combination of the absence of illness, the ability to cope with everyday activities, physical fitness and a high quality of life

Hypertension A chronic increase in blood pressure

Insulin resistance A loss of sensitivity to the effects of insulin

Intensity Characteristic of a physical activity that represents how "hard" it is performed by a person e.g. light, moderate or vigorous

Lean mass The mass of the body minus the fat

Left chamber of the heart (LV mass) This left side of the heart pumps blood flow to the whole body.

Lifestyle activity Activities that are performed as part of everyday life, such as walking.

Locomotor skills Movements in which the body is propelled from one point to another e.g. jumping

Maturation The process of growth and developmental changes leading to biological maturity

Mission A task which children were asked to complete as part of the PASS intervention

Moderate physical activity Physical activity which uses large muscle groups at an intensity at least equivalent to brisk walking

Moderate-to-vigorous physical activity Any physical activity above moderate physical activity levels

Obesity A severe excess of body fatness with increased health consequences

Object-control skills Movements in which force is imparted to or received from objects e.g. throwing

Osteoporosis A condition characterised by generalised skeletal fragility, leading to fractures with minimal trauma

Peak VO2 The peak value for oxygen consumption consumed by an individual while performing an activity

Percent body fat total weight of fat mass divided by total body mass

Perceived competence An individuals judgement of his/her abilities in a particular attribute (e.g. skills)

Perceived body attractiveness Self-perceptions of attractive physique, ability to maintain an attractive body, confidence in appearance

Perceived physical condition Self-perceptions of condition, stamina, fitness, ability to maintain exercise, confidence in an exercise setting

Perceived physical self-worth General feelings of pride, satisfaction, happiness and confidence in the physical self

Perceived physical strength Self-perceptions of strength, muscle development, confidence in situations requiring strength

Perceived sports competence Self-perceptions of athletic ability, ability to learn sport, confidence in sport

Physical activity "Any force exerted by skeletal muscle that results in energy expenditure above resting level"

Physical inactivity The state of doing no or very little activity (being sedentary)

Prepubertal Children who have not yet entered puberty

Puberty The beginning of the development of sexual maturity

Process assessment An observational approach to skill assessment, focusing on technical aspects of movement

Proficiency Reaching a level of skill competence which represents mastery of the skill; necessary for the associated benefits of skill competence

Sedentary behaviour See physical inactivity, includes watching TV or computer use

Self-efficacy Confidence in one's ability to perform a specific task

Self-esteem The awareness of good in one's self

Social cognitive theory A psychological theory which states that behaviour is a result of interactions between the environment, the individual and the behaviour

Sport Leisure time activity that is planned, structured and competitive.

Total physical activity The sum of all physical activity performed above sedentary levels, irrespective of intensity

Trunk fat Fat mass in the upper torso (excluding the limbs). Excess fat is linked to cardiovascular disease

Vigorous physical activity Activity of an intensity that induces a fast heart beat; a large increase in breathing (conversation is difficult or broken) and sweating

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