Core Fit for life

A new radical evaluation of children's physical activity and its impact on mental health and wellbeing

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Authors:

Amanda Weston, Creator of Core Fit and managing director of Core Fit Unique, designed physical test assessments and supported research administration and literature search.

Gayle Whelan, project planning. Impactis Research Consultancy designed questionnaires with Amanda Weston, conducted research, research analysis and report writing.

Executive summary

Core Fit Unique programmes develop the participants' core strength, confidence and self-belief. The programme uses physiotherapy derived exercises, based around strength and balance. It was first conceived ten years ago and developed as a pilot physical activity intervention in primary schools in 2015. In excess of 1,700 participants have since taken part in a series of fun themed sessions, which aim to empower children, giving them the confidence to take responsibility for their own fitness and wellbeing whilst developing core strength, balance, flexibility and good posture.

On completion of the programme, children should accomplish a series of performance tests (such as squats, lunges, hamstring stretches and bridge positions) and to be able to continue these independently. The Core Fit programme is developed and delivered in a manner which is intended to provide the tools to sustain the use of the activities long after the conclusion of the programme.

This evaluation used a mixed methods approach to understand both objective and subjective outcomes of the programme on school-age participants. Data was gathered on physical performance assessments (successful completion of bridge, squats, lunges, hamstring stretch, balance and prone all fours) at baseline start of the Core Fit programme and at the end point on completion in 36 schools. Further detailed data was also captured in 21 schools using a range of methods, including the WEMWBS mental health and wellbeing survey and completion questionnaires which assessed enjoyment, knowledge gained from the sessions and activity levels since beginning Core Fit.

Core Fit was devised in response to evidence highlighting that many children and adults are insufficiently active to meet current guidelines: children should achieve at least 60 minutes' activity and up to several hours daily, as well as participate in vigorous intensity activities which strengthen muscle and bone. As physical activity patterns established during childhood are important in laying the foundation for activity habits in the future, this combined with the high burden and cost of musculoskeletal conditions in adulthood, formed the programme's development and unique delivery approach.

The literature in this area points to many benefits of engaging in regular physical activity with positive correlation evidenced between physical activity, fitness, and health-related quality of life while supporting social inclusion and positive mental health and wellbeing. Correspondingly, physical inactivity can result in many health-related conditions such as diabetes, asthma, metabolic conditions including insulin resistance, obesity, blood lipids and blood pressure as well as a greater risk of morbidity and reduced mortality. Levels of physical activity also impact upon the development of both muscles and bones and can affect bone density levels in adulthood. As balance and flexibility is also developed in childhood, this is a pertinent time to build lifelong physical activity habits. Further evidence demonstrates that engagement in physical activity can also positively affect cognitive functions as well as confidence levels and self-esteem. Further evidence points to a positive correlation between engagement in physical activity and improvements in school attendance, concentration, behaviour as well as school attainment.

In this evaluation, the Core Fit programme has delivered successful outcomes in both improvements in performance assessments, when comparing baseline with post programme results. Most children enjoyed the Core Fit programme, and wanted it to continue. They were able to accurately recall the main learning themes and understood they were responsible for their own fitness. Physical activity levels consistently increased in all schools since participants started the Core Fit programme. Perhaps the most remarkable finding was related to mental health and wellbeing, with statistically significant improvements reported consistently in schools across the county. WEMWBS average scores increased in all but one school by three points – a startling finding, with positive responses shifting from 'sometimes' to 'often' across the range of 14 questions. The greatest increases reported were related to making my own mind up, interested in other people, feeling loved, feeling useful, confident and feeling optimistic about the future; all of which lead to the conclusion that Core Fit significantly impacts on wellbeing.

Core strength is a natural positive reinforcement for all children and Core Fit shows that physical and mental impact was lasting. The Core Fit programme affected self-esteem, confidence and optimism and was successful in all schools, with consistent results irrespective of where the school was geographically. Anecdotal findings also point to success of the programme in typically non-sporty children who are considered the least active.

This evaluation has also found the Core Fit programme to have been cost effective; delivering a social investment on the return of over £33 for every £1 invested.

This evaluation demonstrates the enormous impact a physical activity intervention has upon not only activity levels but also the general wellbeing of participants. There is an urgent need to promote a more active lifestyle in all school children, regardless of their age and condition but particularly in the young: the school being the perfect setting for this. The objective should be focussed on fighting increase calorie expenditure and modern sedentary lifestyles through a programme of increased physical activity, while also ensuring that such physical activity is consistent and vigorous enough to improve physical fitness. With regular vigorous activity, the muscle mass will increase or at least be preserved, and this will in turn increase basal calorie consumption. Developing and building on core strength, balance, flexibility and posture helps prevent life-long health and mental conditions, increasing overall wellbeing and quality of life.

The effort required for such an improvement and for widespread adoption of this approach goes beyond the school participants themselves to involve their family, school and wider community, as demonstrated by the SROI ratio. An urgent need exists to roll this programme beyond the small cohorts so far evaluated as well as measuring the longer-term impact.


"Physical inactivity is a global pandemic, with far-reaching health, economic, environmental, and social consequences."
Kohl *et al.*, 2012, *The Lancet*

Background

Starting in 2007, Core Fit began as an intervention project delivering fun exercises, strength and balance training to primary school children. In 2015, this programme was developed further using physiotherapy principles with enhanced interventions and was rolled out to a range of primary schools across Cheshire. An evaluation of this pilot programme was funded by Cheshire East council and concluded that a further, more detailed assessment of the programme's impacts was warranted. Consequently, this report was commissioned to investigate the wider roll out of the programme to schools across Cheshire.

During this evaluation period, research was conducted in 36 Core Fit sessions, held in 21 schools involving around 1,700 children. The Core Fit programme was typically delivered to pupils in years five and six (age nine to 11) across the Cheshire area, in rural, semi-urban and urban schools. Some schools chose to offer Core Fit sessions to other year groups as well. Core Fit sessions were incorporated into the normal school day with all pupils participating, unless parents had expressly opted out. Participants with prohibited medical conditions were also excluded: the exclusion rate on these grounds was just two per cent. Sessions were around three-quarters of an hour long and typically took place in the school's hall or gym and usually were delivered over a half term per class (five or six sessions depending on the school).

School	Session	No	School	Session	No
Byley	Apr-16	10	Scholar Green	Nov-15	19
Calveley	Nov-16	19	Sound	Apr-16	30
Calveley	Jun-16	10	St Chads	Nov-16	19
Cledford	Jun-16	18	St Chads	Sep-16	19
Coppenhall	Nov-15	26	St Mary's	Jan-16	26
Edleston Road	Nov-15	30	The Oaks	Jun-16	29
Edleston Road	Apr-16	30	The Oaks	Sep-16	27
Edleston Road	Sep-15	30	Vine Tree	Jun-16	27
Gainsborough	Jun-16	29	Vine Tree	Jan-16	29
Gainsborough	Apr-16	31	Wharton	Jun-16	28
Gainsborough	Jan-16	31	Wharton	Sep-16	29
Haslington	Jun-16	11	Wheelock	Sep-16	29
Knutsford Manor Park	Apr-16	44	Wheelock	Jun-16	31
Mablins Lane	Apr-16	24	Wyche	Nov-16	23
Millfields	Jun-16	31	Wyche	Jun-16	19
Moulton	Nov-16	27	Wyche	Sep-16	20
Offley	Nov-16	23	Wyche	Jan-16	23
Offley	Jun-16	24			
Offley	Nov-16	23			

Figure 1 School sessions and participant numbers

The Core Fit programme

During the course of the evaluation, a total of 21 schools were involved in the research from across the Cheshire area: with 15 completing the WEMWBS and post programme questionnaires and all 21 schools completing the performance monitoring. Participants were asked to complete a WEMWBS survey (Appendix A WEMWBS) at the beginning and end of the Core Fit programme. In addition, participants were asked to complete an end of programme questionnaire, which covered subjective understanding of their experiences of Core Fit, current exercise levels, knowledge recall of the four learning themes and whether they had increased activity levels since beginning the programme. Children were also asked what types of activity they participated in outside the classroom, and how often. Not all children completed all surveys: class numbers may have differed at the start and end sessions. Therefore, the number of participants engaging in the research vary at survey points. For example, 644 participants completed pre-WEMWBS surveys, and 631 on completion of the programme. A total of 574 participants completed post completion surveys.

The research also involved analysis of performance assessments recorded at the beginning and end of the Core Fit programme, which assessed the number of children who could correctly perform an exercise movement. Data recorded included: squats, lunges (both left and right sides), balancing eyes closed on one leg for 15 and/or 30 seconds (both left and right sides), bridge with outstretched right leg, left arm and then left arm, right leg, hamstring stretch (both left and right sides) and prone all four tests.

Core Fit programme aims and objectives

The programme's aim is for participants to learn, apply and recall the main themes of balance, core strength, flexibility and posture. Success of the aims are measured using both subjective and objective outcomes:

Subjective

On completion of the Core Fit programme, participants should:

- Understand and report the main themes that to be fit and healthy they must look after their own strength, flexibility, balance and posture.
- Consider diet and water intake considering the amount and intensity of physical activity undertaken.
- Report that it is their own responsibility to look after their physical wellbeing in order to live life to the full and prevent injury, particularly future hip, knee, and back problems which may hinder their enjoyment of life or their sporting aspirations.
- Desire to continue with the exercises once the programme has been completed. Core Fit has been designed and delivered with participants' enjoyment in mind. Exercises are designed to be fun as well as physically beneficial by increasing participants' strength and flexibility, leading to lifelong engagement.
- Can identify lifestyle choices that will be beneficial to their health and wellbeing such as substituting sedentary activities with more active ones such as dog walking, running, cycling and playing active outdoor games.

Objective

Participants should be able to demonstrate correct posture for a number of exercises following completion of the Core Fit programme. These exercises will test and improve their core strength, balance, flexibility and posture. Measures of assessment include the ability to correctly:

- Perform a sit-to-stand movement with good hip alignment, i.e. squat.
- Perform a walking lunge with good hip knee and back alignment for four steps.
- Hold a one knee bend with correct hip, knee and foot alignment.
- Carry out full quads and calf length stretches and can hold a calf raise unassisted.
- Demonstrate correct hip knee foot alignment in a bridge position. Most participants should be able to do alternate leg off floor and hold alignment.
- Exhibit the standard form and flawless posture whilst on all fours to test alternate arm and leg stretches while displaying good hold with back and hip strength. Hold time should be equal bilaterally with 70 to 90 degrees of hamstring length and duration of this hold should steadily, but comfortably be increased.
- Demonstrate correct hip knee foot alignment in a bridge position. The majority of participants should be able to do alternate leg off floor and hold alignment.
- Exhibit the standard form and flawless posture whilst on all fours to test alternate arm and leg stretches displaying good hold with back and hip strength. Working towards increasing the duration of the hold which should be equal bilaterally with 70 to 90 degrees of hamstring length.

Not all participants will be able to perform all assessments perfectly; the goal is that they must attempt each exercise and be able to correct poor positioning and balance in themselves and others.

The aim of the programme is to develop the four themes of core strength, balance, flexibility and posture so that positions can be maintained for longer periods of time and that in doing so, exercise movements are balanced, easily flexible and are performed correctly.

Core Fit session structure

Overview:
The Core Fit programme offers fitness-led classes based on correct movement and physiotherapy-based exercises. These sessions can be delivered as a one-off or as a regular weekly part of the curriculum. Most often, they are delivered as an ongoing programme of weekly sessions lasting up to six weeks. Sessions can be taken either as a class or in smaller groups with pupils identified by the class teacher or session leader as benefitting from further coaching or strengthening. Whilst the impact of an individual session is beneficial, longer-term programmes deliver improved outcomes.

Sessions can be sports-specific exercises or related to children's individualised physical or individual needs. These personalised sessions have delivered on the objectives particularly well and in such cases the class sizes are typically limited to five. This would be difficult to reproduce for large populations.

The Core Fit programme begins with a launch session which includes an introduction to the activities and baseline measurements. Following the first session, a five to six-week package is delivered. These sessions are led by a qualified physical training instructor, sports therapist or physiotherapist. Classes are divided into groups of up to 15 children, with each group taking it in turns to either participate in the exercise learning methods or in assessing fellow pupils' positioning while offering peer review as appropriate. Groups participate in squats, lunges, small knee bends, balance stretches etc. followed by floor-based mat exercises which help build balance, core strength and flexibility. During the session, the trainer focuses on correct movement patterns and uses visual teaching aids and hands-on cueing to help participants grasp the concepts of each of the four learning themes. By design, the sessions are constructed with an element of fun, such as energetic cardiac work to music before the floor based exercises. This serves to engage with the children and maximize their participation.

Professional peer review is encouraged and focuses on the performance of activities, with a view to improving quality and achieving the set standards. During the programme, participants are encouraged to have ownership of their own fitness and health, with specific emphasis placed on good levels of activity for a healthy and balanced lifestyle. Supervised collaborative learning is an essential element with the children learning from each other through critical discussion and observation.

The exercises are structured along physiotherapy principles and are designed to encourage high impact with low-level effort. The Core Fit programme is inclusive of all participants' needs regardless

of individual circumstances or level of fitness. All Core Fit staff have a current enhanced DBS check and have received appropriate paediatric first aid training.

Sessions

The main Core Fit programme is delivered in a number of sessions, outlined below.

Session 1 - Introduction

The session begins with an introductory Power Point presentation, which outlines the programme including aims and objectives. In tone, it is aimed at engaging the young participants. The aims of this session are to give children an introduction to health and fitness, highlighting how this can be fun and incorporated into everyday life. Participants engage in discussion about the four main learning themes of the Core Fit programme:

- Balance (balance being proprioceptive balance, balance between left and right and front and back)
- Body core strength
- Flexibility and correct movement
- Posture.

Discussions cover the benefits of these different aims and some of the negative effects related to each if not considered in daily life. Emphasis is placed on the need to be healthy regardless of whether an individual is an active sportsperson or not: the need for baseline fitness for any activity in life starts with good balance, posture, movement, strength and flexibility.

Following the presentation and discussion, the class is split into groups of no more than 15, exercises are demonstrated and the class given the opportunity to practice some of the basic exercises. Baseline measurements of fitness and capacity are undertaken using a series of physiotherapy assessment exercises.

In subsequent sessions, the participants are encouraged to use correct movement, posture and balance in the class and beyond. Discussion in sessions is steered towards the implications of physical activity on their future health.

Session 2 - Strength

The session begins with a recap of the previous week and a brief discussion around the learning themes. A skeleton is used to highlight how the body and musculoskeletal system work and how specific positioning improves function as well as preventing detrition. The skeleton is used as a fun interactive learning tool and aids in understanding the impact of correct and incorrect posture.

The physical element of the session begins with an aerobic warm-up. This is set to music to engage participants, warming them up through stretching and increasing the heart rate. The focus of this session follows specific teaching of exercises which develop strength and balance in muscles, particularly the squat and the lunge positions.

Firstly, each exercise is demonstrated with emphasis on correct positioning and how this affects the body. Participants are then given the opportunity to practice this exercise with peer review which encourages self-awareness and critical review. Once correct positioning is achieved, the session focuses on stamina and strengthening. Rather than simple repetition, the exercises are incorporated into games where the activities become a part of a more structured play session.

For example, the squat is used as part of the "circle game" where children stay in the squat position while each class member takes it in turns to run a circle around the whole group before returning and continuing with their squat pose while the next pupil takes their turn. This continues until all participants have taken a turn to hold the squat position and complete one lap of the circle.

Other activities in the session include floor-based mat work allowing the children further opportunity to work on their strength. At the close of the session participants will complete a cool down session with stretching.

Session 3 - Flexibility

The session begins with a recollection of the previous weeks' learning and a brief discussion around the learning themes. The learning focuses on flexibility and the automatic nature of movement and the class discusses of the importance of flexibility. Some fun facts are demonstrated such as reflex points, with the patellar reflex being demonstrated or that by pushing someone, they will react back against you and no stretch will occur as the muscles will simply tighten to react to the force.

Discussion includes the need to maintain flexibility throughout life as it tends to wane with age. Further discussion progresses learning with focus on muscle growth, change and strengthening as exercise continues; demonstrations also show that muscles contract. How and why flexibility exercises should to be regularly incorporated into physical activity is also discussed in depth.

Following this, participants then warm up with two songs' worth of aerobic activity which builds up in intensity. The participants then work on squats in pairs with each partner watching and encouraging perfect positioning, increasing the amount of time participants can hold the squat is encouraged. Lunge work is also continued, building on previous weeks' learning.

Focus is given to developing quad stretches with the tutor highlighting the need to stretch correctly. On the floor, children practice and develop hamstring stretches, piriformis stretch, bridge holds, all fours, plank and typical yoga positions such as downward facing dog and triangular upside down.

Session 4 - Balance

The session begins with aerobic warm up to music as with previous weeks and includes discussion based around what has previously been learnt, reinforcing the four main learning themes. Other new positions are introduced around the session focus of balance. Positions are again perfected through repetition and critical praise, and are linked to prior learning and the programme's core themes.

In this session emphasis is placed on balance, with demonstrations of balance positions. Participants are encouraged to imitate positions with peer review and interaction. To conclude the session and adding a fun element to floor work, participants are encouraged to walk on all fours, and develop elements of yoga, as well as the plank and bridge positions.

Further sessions/Final session - Resilience

Further sessions begin with aerobic warm up to music as with previous weeks and include discussion based around a recap of previous work and reinforcing the four main learning themes. These sessions build on previous work by increasing the strength and endurance of holds. There is renewed focus and critical peer review on posture and correct positioning of each position. Participants are typically more comfortable in holding their pose and often the competition element begins to manifest in these sessions. The energy and competition is redirected at a group effort rather than individual competition and work continues developing resilience.

The final session (in a five/six-week programmes) provides a recap to reinforce the themes and encourage lifelong usage. Final assessments are gathered for the purposes of the Core Fit programme and include the twelve tests carried out during the first session. This helps evidence where improvements have been made from week one to final week.

Definition and measurement

The term **physical activity** refers to any bodily motion that requires greater than basal energy expenditure. Assessment of the physical activity performed by a person under natural and real conditions is extremely difficult, particularly in children/adolescents (Ruiz and Ortega, 2009).

Physical activity can be further defined as any bodily movement produced by skeletal muscles that require energy expenditure. The World Health Organization (2010) identified physical inactivity as the fourth leading risk factor for mortality causing an estimated 3.2 million deaths annually globally. By contrast, the physical fitness of a person is a factor closely linked to the level of physical activity and exercise performed. Physical activity is further defined as a behavioural concept that changes according to “leisure time” or “sports and exercise” (Sallis, Prochaska and Taylor, 2000). Physical activity is differentiated by four dimensions: frequency; intensity; duration; and type.

- Frequency is defined as how often the activity occurs, typically expressed as weekly.
- Intensity has been identified as the key dimension for possible dose-response relationships with either reduced or increased health risks for exercise-induced medical conditions (Haskell, 2001). Our review of literature did not distinguish between physical activity and exercise. With general leisure-time physical activity, exercise, or sports during or outside of school hours being referred to as physical activity (WHO., 2002). High volumes of television viewing (duration in hours) represented sedentary behaviour and were used as a proxy for low physical activity (Pearce, 2011; Voss and Rehfuess, 2012). This approach is consistent with previous validation that television viewing could be used to represent physical activity in population surveys (Priftis *et al.*, 2007; Healy *et al.*, 2011).
- Duration is defined as the length of the physical activity.

- Type refers to the complexity or nature of the physical activity and requires contextual clarification.

By contrast, physical fitness is defined as the ability of a person to perform activity and/or exercise, and represents an integrated measure of all the functions and structures involved in the practice of physical activity or exercises and can be classified in terms of duration, frequency, intensity and type. Physical activity and exercise performed are closely related to physical fitness.

Sport is a collective noun and usually refers to a range of activities, processes, social relationships and presumed physical, psychological and sociological outcomes. These activities include individual, partner and team sports; contact and non-contact sports; motor-driven or perceptually dominated sports; different emphases on strategy, chance and physical skills; and competitive, self-development and purely recreational activities. Clearly, there is a close relationship between physical education and sport, however, they are not synonymous. At the most superficial level, the distinction between the terms is simply that 'sport' refers to a range of activities and 'physical activity' refers to an area of the school curriculum concerned with physical activities and the development of physical competence.

More than 30 different methods of assessing the physical activity of a person have been reported in the literature, and they can be summarized under three categories:

1. Reference methods (such as direct observation, doubly labelled water, etc.);
2. Objective methods (heart rate monitoring, accelerometery, etc.);
3. Subjective methods (surveys, questionnaires, etc.).

Physical activity is often measured using self-reported questionnaires, interviews, accelerometery, pedometer, heart rate monitors, or direct observation.

Body Mass Index (BMI) is also used and is defined as a person's weight in kilograms (kg) divided by their height in metres squared. The National Institute of Health (NIH) now defines normal weight, overweight, and obesity according to BMI. A BMI z-score is a quantitative measure of the deviation of a specific BMI percentile from the mean of that population.

The fitness components of cardiorespiratory fitness (understood as the capacity to perform prolonged exercise involving the cardiovascular and respiratory systems), and muscular fitness (understood as the capacity to generate force) have been measured in a laboratory setting.

Muscular strength is the ability to resist repeated contractions over time or to maintain a maximal voluntary contraction for a prolonged period. Muscular endurance enables the body to carry out a maximal, dynamic contraction of a single muscle or muscle group in a brief period. Explosive strength, also referred to as power, has been analysed and measured as a component of fitness by laboratory tests or by field tests and have shown validity and reliability in children and adolescents (Artero *et al.*, 2011).

Wellbeing

In recent years, there has been increasing policy interest in wellbeing, and specifically the wellbeing of children and young people. Wellbeing is not the same as mental health, although the two are inter-dependant. Moreover, *The Good Childhood Report* (The Children's Society, 2016) identifies that those with higher subjective wellbeing have fewer mental health issues and have better life outcomes. The World Health Organisation (2004) in their summary report *Promoting Mental Health; Concepts emerging evidence and practice,* declared positive mental health to be the 'foundation for wellbeing and effective functioning for both the individual and the community', defining it as a state which allows individuals to realise their abilities, cope with the normal stresses of life, work productively and fruitfully, and make a contribution to their community.

In the ONS's Measuring National Wellbeing Programme (Carter, 2017) wellbeing refers to 'baskets' of indicators that together build up a picture of the quality of people's lives by combining measures of different domains (UNICEF, 2015; Carter, 2017). In other contexts, particularly in public health, wellbeing is often understood more narrowly as a contrasting concept to mental ill-health, with a focus on the experience of positive feelings and psychological wellbeing over a short timeframe.

Two common approaches exist in terms of measuring children's wellbeing. The first is to draw on objective social and economic indicators that are felt to contribute to children's wellbeing, such as levels of poverty, health and educational attainment. The alternative approach is to draw on self-reported data from the children themselves to evaluate various aspects of their lives. There is value in measuring both objective and subjective aspects of wellbeing.

A recent study indexing child wellbeing in the European Union (Bradshaw, Hoelscher and Richardson, 2007) demonstrates that the UK has the lowest wellbeing in Europe.

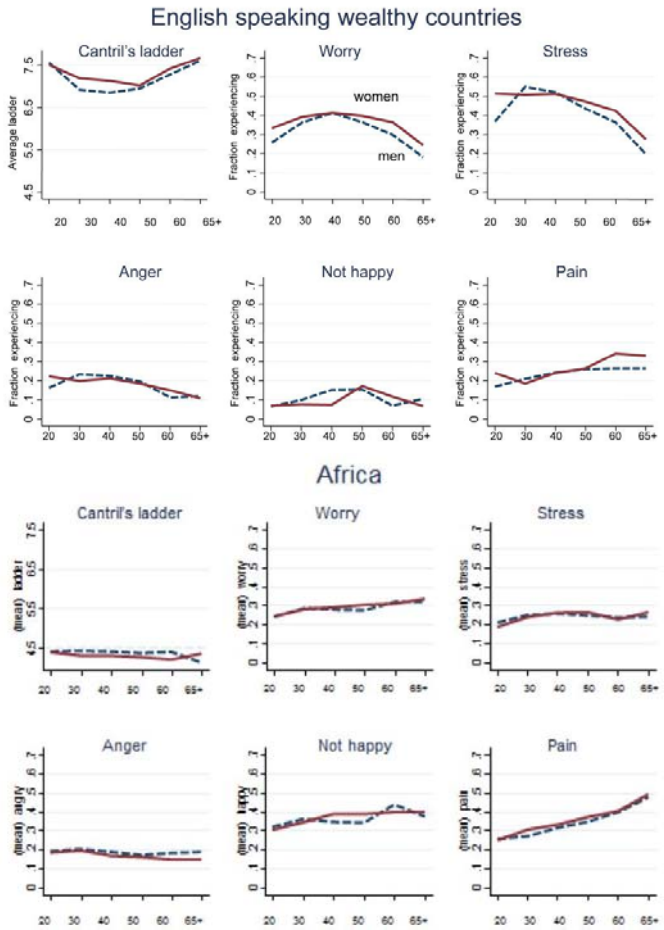


Figure 2 Life evaluation (Steptoe, 2015)

Clearly wellbeing is subjective, with multiple factors affecting perception.

For example Steptoe, Deaton and Stone (2017) evaluated various aspects that contribute to wellbeing in English speaking wealthy countries and in Africa.

The charts to the left plot the outcome scores for men and women in the two different cohorts.

~Consider the two "not happy" charts and the reasons these may be so different.

~ Or maybe Cantril's ladder (Cantril, 1965) which is a measure of satisfaction with life.

Evaluation methodology

This evaluation covers physical assessments from the majority of sessions run in schools between 2015 and 2017. Surveys and questionnaires were also conducted in classes run between June 2016 and Easter 2017.

This evaluation uses a mixed methods approach to evidence the impacts of the Core Fit programme on children, understanding who and how it affects them as well as the physical and emotional impact of engagement in the sessions. A combination of qualitative and quantitative methods was adopted to determine and asses the benefit, impacts and potential value of the programme on participants and their future health benefits. The methods allow for subjective and objective measurement of the outcomes and impacts that occur as a direct result of taking part in the Core Fit programme. These outcomes can be intangible and hard to measure, however, the employed methodology allows impact to be measured and valued where immediate and longitudinal results are not always possible. This evaluation also enables consideration of the wider impacts as understood as part of the literature review by measuring and accounting for improvements in wellbeing as well as physical assessment improvements and enjoyment of the Core Fit programme.

The research assesses what changes have occurred to participants, charting the potential impacts on fitness, mobility, as well as mental health, wellbeing and behaviour changes. The evaluation involved a series of strands, which are mapped out below:

Initially, a **scoping exercise** was undertaken by the principal researcher and project commissioner with the aim of identifying and clarifying what the evaluation would involve and what the analysis would measure and how. This scoping exercise took the form of meetings with the commissioner to set out the purpose, background, resources, activities and timescales for the evaluation.

As part of this evaluation, **subjective evidence** was gathered using the WEMWEBS tool both at baseline and at post programme (see Appendix A WEMWBS section).

Further **subjective evidence** was collected using the post course questionnaire developed as part of the pilot project.

The evaluation also gathered **objective evidence** in the form of an assessment based on participants' performance of set physical exercises, such as the squat.

To better understand the Core Fit programme and its outcomes, it is important to place the work in the context of the existing evidence base for increasing physical activity. An extremely broad systematic **literature review** was conducted to understand more about the links between physical activity and core fitness in children and potential outcomes related to educational attainment and health and wellbeing.

The literature review used known electronic databases (Medline, the Cochrane Library, and Embassy) that included a quantitative analysis (meta-analysis) and assessments using the Graphic Appraisal Tool for Epidemiology (GATE). Summary odds ratios (ORs) and confidence intervals (CIs) were used to express the results of the meta-analysis (forest plot) (Tacconelli, 2010). Published studies were identified that examined the associations between childhood physical activity and their health and wellbeing outcomes. The Centre for Reviews and Dissemination (CRD) guidelines (Moher *et al.*, 2009) for conducting systematic reviews were followed, in that: available research was identified; selected for inclusion; data examined and extracted (journal articles); data was assessed and described in terms of study quality; synthesized findings; and objectively assessed for relevance. Longitudinal and cross-sectional studies were included that investigated physical activity and its impacts in children and adolescents aged 0–18 years. Physical activity was documented by either interviews or self-administered questionnaires. The results also included several studies of school intervention programmes.

A **Social Return on Investment** calculation was also conducted assessing the cost effectiveness of the programme, determining the subjective social impacts of engagement with the Core Fit programme balanced with the initial investment.

Ethical considerations of the evaluation

This evaluation is funded by the Core Fit programme. Ethical approval was granted by the LJMU Research Ethics Committee for the pilot study (reference 16/ICC/001).

The Warwick Edinburgh Mental Wellbeing Scale (WEMWBS)

A need to understand and measure wellbeing led to the development of the Warwick Edinburgh Mental Wellbeing Scale (WEMWBS) by an expert panel drawing on current academic literature, qualitative research with focus groups, and psychometric testing of an existing scale (Putz et al., 2012) (**Error! Reference source not found.**).

WEMWBS has been validated for use in face-to-face interviews and showed good content validity:

- Monitoring wellbeing both nationally and locally (England, Scotland and Iceland are currently using the scale for these purposes).
- Evaluating projects and programme which could have an influence on mental wellbeing.
- Investigating the determinants of mental wellbeing.

WEMWBS uses a scale consisting of 14 items covering both hedonic and eudaimonia aspects of mental health including positive affect (feelings of optimism, cheerfulness, and relaxation), satisfying interpersonal relationships and positive functioning (energy, clear thinking, self-acceptance, personal development, competence and autonomy). It scores on a five-point Likert scale (none of the time, rarely, some of the time, often, all of the time).

According to a validation study (Tennant *et al.*, 2007), WEMWBS shows high levels of internal consistency and is reliable against accepted criteria. The assessment is short, standardised and meaningful to general population groups, and relatively unsusceptible to bias within populations. The scale is useful to the Core Fit programme as its positive focus enables objectivity in evaluating the wellbeing changes in participants over time. It is important to note that WEMWBS has been validated in older children, but not in primary school children. However, the research team felt it was important to use a well-tested assessment of wellbeing. Children experienced no difficulties in completing the questionnaire and response rates were excellent.

While WEMWBS is often used to evaluate individual programmes and interventions, it is useful to understand the national picture of wellbeing. The most recent large scale use of WEMWBS is in the *Health Survey for England 2015: Children's wellbeing* (Lifestyle Statistics, 2016).

WEMWBS scores, by equivalised household income and sex

Health Survey for England 2015: children aged 13-15

Mean score	Equivalised household income		
	Highest tertile	Middle tertile	Lowest tertile
Boys			
Mean	53.1	52.1	49.8
Standard error of the mean	0.66	0.81	0.82
Girls			
Mean	50.5	50.6	51.1
Standard error of the mean	0.89	0.91	0.83
All children			
Mean	51.7	51.3	50.5
Standard error of the mean	0.59	0.62	0.63

Source: Health Survey for England 2015, NHS Digital

We can see that this gives us a base line WEMWBS score in the range of 51.7 to 50.5

Figure 3 WEMBS average for UK 13-15

In Warwick's medical schools' practice-based user guide (Putz et al., 2012) it is suggested that it is impossible to be precise about how much change in WEMWBS is meaningful. The authors further recommend that the best estimate range for meaningful change ranges from three to eight points differences between before and after observation points. As a note of caution, the developers warn that differences between the scores of the same group of people at two points in time, as in the case of Core Fit before and after the programme, are more likely to be significant if the populations being compared are large and less likely if populations are small. The group sizes for the evaluation were small and as such may have depressed scores as a result.

NHS Digital (Lifestyle Statistics, 2016) data compares WEMWBS score in relation to BMI. They demonstrate that those with a greater BMI have a lower WEMWBS score. They can conclude that participants "whose BMI was in the normal range were more likely to have high or very high scores for feeling that the things they do were worthwhile than were those whose BMI indicated that they were overweight or obese". This is based on a deviation in WEMWBS score of 0.7.

Children's well-being, by BMI category

Health Survey for England 2015: children aged 13-15

Well-being measures	BMI category		
	Normal weight	Overweight	Obese
WEMWBS[2] mean scores	51.6	51.4	50.9
Standard error of the mean	0.40	0.72	0.66
Bases (unweighted)	*121*	*122*	*493*
Bases (weighted)	*105*	*110*	*474*

Source: Health Survey for England 2015, NHS Digital

Figure 4 BMI and WEMWBS

Post programme questionnaire

The post programme questionnaire was designed as part of the pilot project and consists of eight targeted questions designed primarily to evaluate the Core Fit programme. The questionnaire can be seen at Appendix B.

Performance assessments

The physical assessments consist of six exercises which are assessed on both sides of the body to ensure balance is recorded and measured. Participants should be able to hold the positions on either the left or right side equally for the same duration of time. Data was measured at the start of the programme (week one) and the final session (typically week five or six). Data sheets recorded each exercise and a percentage number of the class achieving the correct position and hold. In most cases, the tutor and researcher recorded data and conferred to ensure accuracy in their recordings. Where there were any uncertainties, participants were asked to repeat the position to verify data. Data recorded included: squats; lunges (both left and right sides); balancing eyes closed on one leg for 15 and/or 30 seconds (both left and right sides); bridge with outstretched right leg, left arm and then left arm, right leg; hamstring stretch (both left and right sides); and prone all four tests. As discussed above not all exercises were appropriate to each group of participants.

Current UK guidelines

The *Health Survey for England 2015: Children's wellbeing* (Lifestyle Statistics, 2016), shows that the majority of adults and many children across the UK are insufficiently active to meet the current recommendations. Research shows that there are clear and significant health inequalities in relation to physical inactivity according to income, gender, age, ethnicity and disability in the UK.

Physical education has been a statutory element of the National Curriculum in the UK from its start. More recently, the UK Government has announced a robust programme of activities based around *Start Active, Stay Active: A report on physical activity for health from the four home countries by the Chief Medical Officers* (Department of Health Physical Activity Health Improvement and Protection, 2011).

For those aged between five years and 18, this programme focuses on three recommendations:

- All children and young people should engage in moderate to vigorous intensity physical activity for at least 60 minutes and up to several hours every day.

- Vigorous intensity activities, including those that strengthen muscle and bone, should be incorporated at least three days a week.
- All children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods.

Many governing bodies and legislative entities around the world have set minimal physical activity targets that reflect a low level of physical activity. For example, the current recommendation of 60 minutes per day (UK, Canada, Australian, USA) are all uniform, however, they disagree on the level of intensity (U.S. Department of Health and Human Services, 2008; About Physical Activity, 2011; Department of Health Physical Activity Health Improvement and Protection, 2011; Australian Government Department of Health, 2013; Canadian Fitness and Lifestyle Research Institute, 2013). Other nations such as Germany (Graf *et al.*, 2014) recommend different durations. The evidence base for these decisions is strong from the point of view of needing physical exercise, however in terms of type and duration the evidence is weak and often contradictory.

In terms of an absolute target, these may appear to be quite intimidating, particularly for those who are somewhat inactive. More recently, there is an increasing shift towards identifying beneficial activity as well as guidance on time spent on activity.

From a behaviour modification perspective, having a target that seems out of reach may undermine physical activity participation. In terms of guidance per day, recent evidence would support this mechanism, however studies also show that in addition to aerobic activity, resistance training might have beneficial effects on the development of lean body mass, muscular strength and body fat, all of which might facilitate long-term participation in regular physical activity.

There is great evidence and emphasis placed on the importance of the role of schools in implementing programmes both of traditional athletics and enjoyable physical activities. The American Heart Association, for example, recently released new recommendations for the role schools should take in providing and promoting physical activity (Pate, 2006).

Considering these findings, it would seem appropriate to set minimal physical activity targets that reflect a low level of physical activity. In terms of an absolute target these may appear to be quite intimidating, particularly for children and youth who are very inactive.

There are many different approaches to what is the recommended amount of physical activity and exercise in children and adolescents. Experts advocate promotion of physical activity in children for health enhancements and to instil lifelong behavioural patterns which hopefully will result in fitter more active adults in the future (Sallis, Prochaska and Taylor, 2000; Twisk, 2001).

Alarmingly, the Health Survey for England, 2015 (Lifestyle Statistics, 2016) shows that among boys, the proportion meeting physical activity recommendations fell from 28% in 2008 to 21% in 2012. This rebounded somewhat by 2015, at 23%. This pattern is not seen among girls and there has been little statistically significant change in the proportion meeting physical activity recommendations over the period, with 19% in 2008 and 20% in 2015. Worldwide, this is repeated with evidence that children are not active enough for optimal health and wellness (Bates, 2006).

International comparisons

The UK is not alone in these issues; the Canadian Fitness and Lifestyle Research Institute (CFLRI) estimates that approximately 82% of youth are not active enough to meet international guidelines for optimal growth and development (Warburton, Nicol and Bredin, 2006; Canadian Fitness and Lifestyle Research Institute, 2013). Globally, various organisations over time have made differing recommendations. The below table (Figure 5 Comparison of physical activity recommendations) is by no means a comprehensive list of international comparisons, however, it does offer a comparison of the evolution of physical activity guidelines. Of particular note, is that some reports contain conflicting guidance, while others offer no meaningful guidance.

Organisation	Recommendations (in brief)
UK Department of Health Physical activity guidelines for children and young people (5-18 years of age) (Department of Health Physical Activity Health Improvement and Protection, 2011)	• All children and young people should engage in moderate to vigorous intensity physical activity for at least 60 minutes and up to several hours every day. • Vigorous intensity activities, including those that strengthen muscle and bone, should be incorporated at least three days a week. • All children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods.
Physical Activity Recommendations for Children and Young People (Australia) (Australian Government Department of Health, 2013)	• Children and young people should participate in at least 60 minutes (and up to several hours) of moderate-to vigorous-intensity physical activity every day. • Children and young people should not spend more than two hours a day using electronic media for entertainment. • The recommendations are intended to identify the minimum level of physical activity required for good health in children and young people aged from five to 18 years of age.
International Association for the Study of Obesity (IASO) (2002) (Saris *et al.*, 2003)	• Moderate intensity activity of approximately 45 to 60 minutes per day is required to prevent the transition to overweight or obesity in adults. • For children, more activity time is recommended. • A good approach for many individuals to obtain the recommended level of physical activity is to reduce sedentary behaviour by incorporating more incidental and leisure-time activity into the daily routine.
Physical Activity for Children: A Statement of Guidelines for Children Ages 5-12 (USA) (SHAPE-America, 2004)	• Children should accumulate at least 60 minutes, and up to several hours, of age-appropriate physical activity on all, or most days of the week. • Children should participate in several bouts of physical activity lasting 15 minutes or more each day.

	• Children should participate each day in a variety of age-appropriate physical activities designed to achieve optimal health, wellness, and fitness and performance benefits. • Extended periods (periods of two hours or more) of inactivity are discouraged for children, especially during the daytime hours.
Position Statement on Quality Daily Physical Education (Canada) (Canadian Association for Health, 1988)	• Quality daily physical education in every school is essential to successfully reverse the inactivity crisis afflicting Canadian children and youth. • All children and youth in Canada must receive physical education through compulsory Kindergarten to Grade 12. • All students must receive their physical education from teachers who are qualified to teach the subject. • The minimum acceptable criteria for the delivery of physical education are set out. • School must provide a minimum of 150 minutes of physical education class instruction and activity per week for every pupil.
Public Health Agency of Canada and the Canadian Society for Exercise Physiology (2002) (Tremblay, Shephard and Brawley, 2007)	• Inactive children and youth should increase the amount of time they currently spend being physically active by at least 30 minutes more per day and decrease the time they spend watching TV, playing computer games and surfing the Internet by at least 30 minutes per day. • The increase in physical activity should include a combination of moderate activity (such as brisk walking, skating and bike riding) with vigorous activity (such as running and playing soccer). • The guidelines recommend that inactive children and youth accumulate this increase in daily physical activity in periods of at least five to 10 minutes each. • Over several months, children and youth should try to accumulate at least 90 minutes more physical activity per day and decrease by at least 90 minutes per day the amount of time spent on non-active activities such as watching videos and sitting at a computer.
President's Active Award Standards (USA) (2003) (US Government, 1988)	• Youth (ages 6 to 17) must participate in 60 minutes of physical activity a day, for at least five days of the week, for a total of six weeks. Or • Youth (ages 6-17) must accumulate at least 13,000 steps/day (males) or 11,000 steps/day (females) for at least five days of the week, for a total of six weeks.
Dietary Guidelines for Americans (2005) (Saris *et al.*, 2003)	• Engage in regular physical activity and reduce sedentary activities to promote health, psychological wellbeing and a healthy body weight.

	• Children and adolescents should engage in at least 60 minutes of physical activity on most, preferably all, days of the week.
Dietary Reference Intakes for Energy, Carbohydrate, Fibre, Fat, Protein and Amino Acids (Macronutrients) (2002) (Institute of Medicine, 2005)	• For children and adults: 60 minutes of daily moderate intensity physical activity (e.g., walking/jogging at four to five miles per hour). • Additional activities required if leading a sedentary lifestyle.
The 10,000 steps challenge (UK) (2017) (Harvey, Eime and Payne, 2009)	• Setting yourself a target of walking 10,000 steps a day can be a fun way of increasing the amount of physical activity you do.
Recommended Amounts and Types of Physical Activity (UK) (2004) (Department of Health, 2004b)	• All young people should participate in physical activity of at least moderate intensity for one hour per day. This hour can be made up from a variety of activities across the day, including organised sport, play, walking or cycling to school, physical education or planned exercise.
Physical Activity and Health: A Report to the Surgeon General (USA) (1996) (Services, 1996)	• People of all ages should include a minimum of 30 minutes of physical activity of moderate intensity (such as brisk walking) on most, if not all, days of the week. It is also acknowledged that for most people, greater health benefits can be obtained by engaging in physical activity of more vigorous intensity or of longer duration.
Global Recommendations on Physical Activity for Health (WHO, 2010)	• Children and youth aged five to17 should accumulate at least 60 minutes of moderate-to vigorous-intensity physical activity daily. • Amounts of physical activity greater than 60 minutes provide additional health benefits. • Most of the daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least three times per week.
EU Physical Activity Guidelines Recommended Policy Actions in Support of Health Enhancing Physical Activity (2008) (EU Working Group Sport & Health, 2008)	• Everybody should practise a minimum of 30 minutes of daily physical activity

Figure 5 Comparison of physical activity recommendations

Literature review

Both the positive impacts of physical activity and the negative consequences of inactivity on the developing bodies and minds of young children are widely reported. There are a great many studies which highlight the holistic benefits of engaging children in habit-forming behaviours in childhood which have the potential to impact upon their future health and wellbeing, affecting their morbidity, life expectancy and overall general health and mental wellbeing (e.g. Miles, 2007; Cadenas-Sanchez *et al.*, 2012).

Schools seem ideally placed to offer both education and opportunity for children to form positive attitudes and behaviours regarding their bodies and physical activity. Schools are often used as centres for study. With physical activity and higher levels of aerobic fitness in children found to benefit brain structure, brain function, cognition, and school achievement (Chaddock-Heyman *et al.*, 2014) it seems the two go hand in hand.

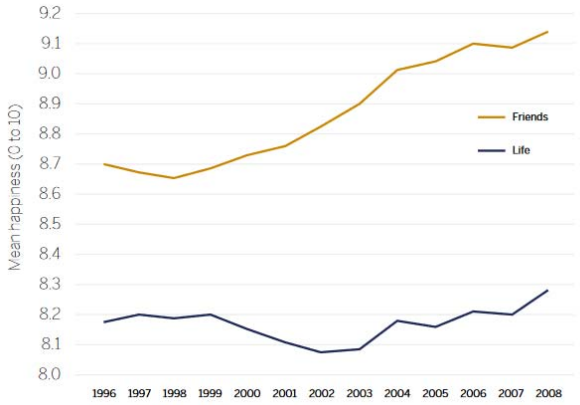
Bailey (2005) reports there are five main areas in which curricular physical activity can affect children's development through physical and mental health, lifestyle, affective, social (including crime reduction and reduction in truancy and disaffection) and cognitive improvements (Bailey, 2005; Bailey, 2006).

There are more than 30 different methods used for assessing the physical activity of a person, which can be summarised in three categories: reference methods (such as direct observation, doubly labelled water, etc.); objective methods (heart rate monitoring, accelerometery, etc.); and subjective methods (surveys, questionnaires, etc).

In discussing physical activity and its implications on health and wellbeing the existing literature is widespread. Initially, the review identified 28,841 studies, which when controlling for duplicates, resulted in a total of 21,841 articles: including 437 citations identified relating to cholesterol; 1,151 for depression; 2,504 for mental health; 2,505 for injury; 1,181 for bone density; 1,677 for blood pressure; 5,824 for obesity; 6,327 for mental health, 7,021 for depression and 1,677 for the metabolic syndrome. Whilst various reference and objective measures are used to provide a very accurate measure of physical activity, they are reported as very expensive and complicated, and it is therefore unfeasible to use them in larger population studies. Subjective methods are most commonly used in population studies because of their low cost and ease of use.

The Children's Society Household Survey

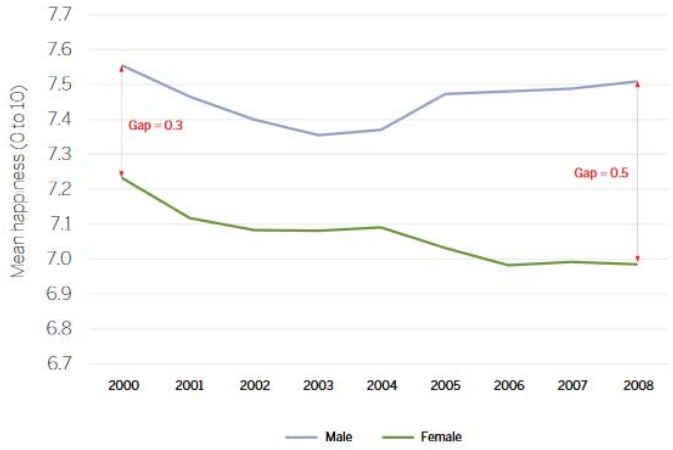
For many years, The Children's Society has monitored and reported on children's welfare and happiness. Ongoing since 2010, The Children's Society has conducted annual surveys in England with parents and children aged eight to 17. In these surveys, questions were asked relating to the wellbeing children and their parents. (The Children's Society, 2016).



The Children's Society has drawn on the data from British Household Panel Survey to demonstrate a significant increase in children's satisfaction with relationships with friends over this period, and a smaller increase in satisfaction with life as a whole.

Figure 6 Children's satisfaction over time

The surveys also offer a chance to collect data on children's wellbeing together with data on the household, such as income and occupation of the parents or carers. The survey covers 2,000 households in England, Scotland and Wales, and is socioeconomically representative of these countries.



However, The Children's Society also shows that the gender differences in satisfaction with appearance is growing.

Figure 7 Gender differences in satisfaction

Millennium Cohort Study (MCS)

(Further information is available from cls.ioe.ac.uk)

No literature review would be complete without mentioning the ground-breaking work of the MCS which is a longitudinal study following the lives of around 19,000 children born in the UK in 2000 to 2001.

The Millennium Cohort Study (MCS) is a multi-disciplinary research project following the lives of around 19,000 children born in the UK in 2000-01. The study has been tracking the Millennium children from early childhood into adulthood, collecting information on the children's siblings and parents. MCS's field of enquiry covers diverse topics such as: parenting; childcare; school choice; child behavior and cognitive development; child and parental health; parents' employment and education; income and poverty; housing, neighborhood and residential mobility; and social capital and ethnicity. The study is core funded by the Economic and Social Research Council (ESRC) and a consortium of Government departments.

Analyses of the MCS finds that children's mental health predicts their life satisfaction, mental disorder and other economic, health and social outcomes throughout the course of their lives (Patalay and Fitzsimons, 2016). Essentially what affects children can follow through into later life.

MCS has found that enjoyment of PE lessons positively correlated with increased child wellbeing. At age seven, while doing sport or exercise may not predict children's wellbeing, MCS highlighted that enjoyment of PE did. Children who reported liking PE 'a lot' had much higher odds of happiness than children who only liked it 'a little' or 'not at all'.

Similar results were also found for levels of worry, with enjoyment of physical education predicting a lack of worry among children (Chanfreau *et al.*, 2013). The authors add that there are many complex reasons for these increases, and may include quality of the school, the child's ability at sport, or the individual's generally positive outlook. However, it might also be suggested that making PE lessons playful and fun is both good for child wellbeing and may contribute to establishing positive reinforcing health behaviours for later in life.

While there is evidence supporting enjoyment of PE and wellbeing, the relationship between health behaviours and children's subjective wellbeing was not straightforward: participation in healthy behaviours that are good for health does not independently predict a young child's happiness and lack of worry. (Chanfreau *et al.*, 2013) reported that this is complex and requires a longer-term understanding. The authors hypothesise that establishing positive health behaviours early on in childhood may lead to the healthier outcomes in later life. They suggest subjects will exhibit normal BMI and fewer chronic health conditions, which may contribute to higher wellbeing at that life stage.

When specifically assessing diet and exercise behaviours, it is hypothesised that positive behaviour is linked with higher odds of happiness (Chanfreau *et al.*, 2013). However, MCS showed that there was

no difference, with children who regularly ate unhealthy snacks such as biscuits and cakes being just as likely to report being happy as their counterparts who did not report eating such snacks.

Further analysis of MCS found that as young people progress through secondary school, child wellbeing progressively declined (Chanfreau *et al.*, 2013). Similarly, analyses of the Gateshead Millennium Cohort Study (Parkinson, Pearce and Dale, 2011) found that changes in the amount of physical activity began to decline at age seven (Farooq *et al.*, 2017) while the amount of sedentary time was found to be high and increased non-linearly from seven years-old rising to 75% of waking hours by 15 years of age (Janssen *et al.*, 2016). This is further supported by Basterfield *et al.*, (2016) whose study found that children's perceived barriers to participation in sport changed over time and were unrelated to their weight. Barriers aged nine involved a physical environmental nature such as no suitable clubs, travel distance and being too young to participate; barriers at 12 years were interpersonal (boring) or not attended by their friends. The authors suggest that the decline in the amount of physical activity needs to be accounted for when considering interventions, which should to be tailored to the specific needs of the age group being targeted. Bronikowski *et al.*, (2016) suggest that the school setting is advantageous for physical activity interventions as children from all risk groups and parts of society attend school. Chanfreau *et al.*, (2013) state that the rationale for promoting healthy behaviours in childhood interventions should focus on the benefits for general health in childhood as well as general and subjective mental wellbeing into adulthood.

The MCS summarises that analyses of its data produces some clear and consistent messages about what predicts child wellbeing: children tend to have higher levels of wellbeing when they have good social relationships with family and friends, do things that they find enjoyable, and experience moderation in activities that are potentially harmful to health (Chanfreau *et al.*, 2013).

To date more than 600 articles have referenced this study alone and at the time of publication, six waves have been carried out when children were around the ages of nine months, three years, five years, seven years, 11 years and 14 years.

Benefits of physical activity

The links between physical activity, health related quality of life, and different pathologies such as diabetes (Jackson *et al.*, 2006; Tacconelli, 2010), obesity (Shoup *et al.*, 2008; Jalali-Farahani, Amiri and Chin, 2016; Yackobovitch-Gavan *et al.*, 2017), or cancer (Badr *et al.*, 2013; Braam *et al.*, 2016) have been largely studied in child and adolescent populations. Additionally, some studies have further analysed the relationship in healthy children and adolescents, suggesting a possible direct association between physical activity, fitness, and health-related quality of life (Iannotti *et al.*, 2009; Sánchez-López *et al.*, 2009; Morales *et al.*, 2013), as well as an inverse association between sedentary lifestyles and health related quality of life (Galán *et al.*, 2013).

Physical inactivity and low physical fitness are associated with metabolic risk factors such as insulin resistance, obesity, blood lipids and blood pressure in school-aged children (Andersen *et al.*, 2017). The closest association is found for aerobic fitness, but also physical activity and muscle strength are independently associated with clustering of metabolic risk factors. The relationship between physical activity, physical fitness and multiple metabolic risks is well known, however the association in moderately-to-highly active populations is not well established (Barbosa *et al.*, 2016).

A number of studies suggest that physical activity patterns established during childhood and youth are important in laying the foundation for activity habits in the future (Burney, Chinn and Rona, 1990; Nystad, Nafstad and Harris, 2001; Currie *et al.*, 2002; Owen *et al.*, 2010; Volgyi *et al.*, 2011; Papadopoulos *et al.*, 2012). At the same time, data suggest that physical inactivity is common amongst Canadian children and youth (Bates, 2006).The closest correlation is found with aerobic fitness, but evidence also concludes that physical activity and muscle strength are independently associated with clustering of metabolic risk factors.

Khatri *et al.*, (2001) was also able to demonstrate that aerobic fitness was related to cognitive function. Physical activity is often only considered in terms of sports; however, it is a great challenge to reach the least active children and prevent dropout from sports when they become adolescents (Anderson and Brice, 2011).

The numerous benefits of engaging in regular physical activity are well documented and apparent across a given lifespan. Particularly among older adults, lifelong physical activity is associated with many physical health benefits, including a significant reduction in risk for mortality, cardiovascular disease, stroke, and type 2 diabetes mellitus (Ahn *et al.*, 2004; Lukács *et al.*, 2013; Mutlu *et al.*, 2015). Cadenas-Sanchez *et al.*, (2012) demonstrated an inverse relationship between physical activity and development of chronic illnesses, and large scale longitudinal studies further evidenced the cumulative benefits of physical activity: for every additional 15 minutes of daily physical activity, the mortality risk is reduced by four per cent (Wen *et al.*, 2017). Moreover, it has been shown that physical activity in older adults is associated with a reduced risk of falls and faster recovery from functional limitations, thereby enabling older adults to increase the number of years of independent living (Elsawy and Higgins, 2010; Wen *et al.*, 2017).

Regular moderate intensity physical activity – such as walking, cycling, or participating in sports – has significant benefits for health; reducing the risk of cardiovascular diseases, diabetes, colon and breast cancer, as well as depression. Adequate levels of physical activity will decrease the risk of a hip or vertebral fracture and help control weight (Elsawy and Higgins, 2010; Chodzko-Zajko, 2014).

Quality of life

Quality of life and, more specifically, health-related quality of life, has been defined as the level of wellbeing derived from the evaluation that a person makes of diverse domains of their life, considering the impact these have on health status (Urzua, 2010). The Quality of Life assessment incorporates at early ages the perception of physical, psychological, and social wellbeing according to evolutionary development and individual differences, within a specific cultural context, and considers the ability to fully participate in the activities and the physical, social, and psychosocial functions appropriate to their age (Urzúa Morales *et al.*, 2013).

Children with undesirable lifestyles such as skipping breakfast, less participation in physical activity, longer television viewing, and later bedtime, were more likely to have poor health-related quality of life in domains of physical fitness, feelings, overall health, and quality of life (Chen *et al.*, 2005).

A survey of young people's participation in sport found that almost all children (98%) aged six to 16 had taken part in some extracurricular sporting activity in the previous year, with 96% indicating that they enjoyed sport in at least one context whether this was in or out of school (Mason, 1995).

Riley *et al.*, (2006) demonstrated that children with poor health-related quality of life were less likely to develop normally and mature into a healthy adult. Independent of physical activity levels, sedentary activities - especially those based on the use of electronic devices - were associated with an increased risk of obesity and a reduction in physical condition, self-esteem, and poor social behaviour (Ortega *et al.*, 2007; Tremblay *et al.*, 2011).

By contrast, numerous studies have shown a positive association between physical activity and fitness levels and physical, emotional, mental, and social health of children and adolescents (Andersen *et al.*, 2007; Ortega *et al.*, 2007; Colley *et al.*, 2011).

Social inclusion

Participation in physical activities has the potential to contribute to the process of inclusion, bringing together individuals from a variety of social and economic backgrounds in a shared interest. By the nature of these activities they are inherently valuable, offering a sense of belonging as well as providing opportunities for the development of valued capabilities and competencies. This will lead to increasing an individual's community capital, through extending social networks, and increasing community cohesion and civic pride. Physical activity has the potential to reach a substantial proportion of children and young people. In the UK, all school-aged pupils have a statutory right to a broad and balanced physical education curriculum, made up of a range of activity areas, based on games, gymnastics, dance, swimming, athletics and outdoor and adventurous activities (DfEd, 2013).

The benefits of physical education regarding social inclusion are reported in many publications. For example, Talbot, (2001) claims that physical education helps children to develop respect for the body — not only their own but others' as well. This understanding contributes towards the integrated development of the mind and body; develops an understanding of the role of aerobic and anaerobic physical activity in health; positively enhances self-confidence and self-esteem; and enhances social and cognitive development and academic achievement.

Metabolic syndrome

Metabolic syndrome has received considerable attention in recent years in both adults and children. The analysis found 17 articles examining metabolic syndrome and physical activity interventions. Of these studies, eight were observational in nature and seven cross-sectional. Many of the observational studies (Andersen *et al.*, 2004; Carnethon, Gulati and Greenland, 2005; Eiberg *et al.*, 2005; Yin *et al.*, 2005; Anderssen *et al.*, 2007; Kelishadi *et al.*, 2007; Ramírez-López *et al.*, 2017) examined large and heterogeneous samples, allowing generalised observation within a population. Of the cross-sectional studies, three employed self-reported measures of physical activity. In these, the reported relationship with the metabolic syndrome were either weak or modest in strength, and all were statistically non-significant. Alternatively, the studies using direct measured physical activity in an objective manner all reported a strong and significant relationship with the metabolic syndrome. Evaluation of these studies revealed clear dose-response relations. Comparison of the risk estimates in males and females suggests that the relationship between physical activity and fitness with metabolic syndrome is stronger in males. Based on this evidence the influence of age remains unclear.

A further nine experimental studies observed the effect of exercise interventions on changes in markers of the metabolic syndrome, predominantly in the form of fasting insulin and insulin resistance (Treuth *et al.*, 1998; Ferguson *et al.*, 1999; Carrel *et al.*, 2005; Lau *et al.*, 2006; Meyer *et al.*, 2006; Shaibi *et al.*, 2006; Bell *et al.*, 2007; Nassis *et al.*, 2017). These studies focused on an already overweight/obese sample and lacked a control group. Additionally, the number of participants included in these studies was modest. Half of the studies' exercise programmes were aerobic in nature whilst the remainder also included additional activities. The results were mixed, with the four interventions that focused on aerobic exercise observing significant improvements in at least one of the insulin variables examined. Only one intervention employed resistance or circuit training observed any meaningful improvements. None of the intervention studies systematically considered the influence of the dose, the intensity of exercise, or gender and age effects, on markers of the metabolic syndrome.

Obesity and overweight

The relationship between physical activity and fitness with obesity in school-age children and youth has been extensively studied. A total of 30 observational studies (24 cross-sectional, three prospective cohorts, two case-control, one mixed) were evaluated. Overweight and obesity were classified using age and gender-specific Body Mass Index (BMI) criteria in most of these observational studies. In terms of measuring the physical activity or sport participation self- or parental-reported tools were used.

Ekelund *et al.*, (2004), report on a multicentre study conducted on 1,292 European children (aged nine to 10 years) and Wittmeier, Mollard and Kriellaars, (2007) conducted a further study on 251 Canadian children (aged eight to 11 years), finding that the time devoted to moderate or vigorous physical activity was inversely related to the total amount of body fat measured as the sum of skinfolds. The majority of cross-sectional studies supported this association between physical activity and body fat and an inverse association between them was observed.

Various studies such as Ruiz and Ortega (2009) demonstrated that vigorous physical activity may play a leading role in the prevention of obesity in children and adolescents. Whilst Gutin *et al.*, (2005) noted that only vigorous physical activity was associated with a lower amount of body fat in North American adolescents (16 years), which agrees with the results reported in younger individuals (Abbott and Davies, 2003; Dencker *et al.*, 2006; Ruiz *et al.*, 2006). Dencker *et al.*, (2006) in a sample of Swedish children (aged eight to 11 years), and Butte *et al.*, (2005) in a sample of Hispanic children/adolescents living in the USA (aged four to 19 years), also noted a negative association between vigorous physical activity and body fat.

Most significantly was the European Youth Heart Study (Ruiz *et al.*, 2006) which demonstrated that children who performed vigorous activity for 40 minutes or longer each day had less body fat than those performing vigorous activity for a total of 10 to 18 minutes each day. Furthermore, Moliner-Urdiales *et al*.'s study (2009) involving Spanish adolescents aged 12.5 to 17.5 years showed that vigorous physical activity appears to have a greater effect on total and central fat than less intense physical activity, which agrees with the results of the previously discussed studies. Based on a joint assessment of the above reported studies, it may be concluded that adequate scientific evidence is available to state that an inverse relationship exists between physical activity level and body fat, and that this association is more consistent when vigorous (as compared to less intense, i.e. moderate) physical activity is performed.

The information from longitudinal studies that use objective measurement for the analysis of physical activity in children/adolescents is scarce but it is remarkably consistent. One systematic review (Jiménez-Pavón, Kelly and Reilly, 2010) suggests that an inverse relationship exists between physical activity levels at a given time in childhood and adipose deposits in the future over a follow-up time ranging from two to 15 years, highlighting the habitual nature of physical activity.

The anthropometric measurement of choice was BMI and was used in most studies with only two including the measurement of total body fat. Only four studies explored longitudinal relationship between physical activity measured by accelerometer and total body fat.

The following table highlights the main articles which discuss longitudinal observations of body fat, ranging from two to eight years' follow-up.

Study/year	Subject	Years follow-up	Measure	Outcome measure	Comment
(Moore *et al.*, 2003)	Boys 45 Girls 58 Age 4-11	8 (annual)	Total physical activity (counts/hour) (3-5 days including weekend)	BMI (kg/m2) Sum of 5 skinfolds test	Boys and girls High physical activity levels in childhood were associated with less fat contents in adolescence.
(Stevens *et al.*, 2004)	Boys 233 Girls 221 Age 6-8	2-3	Total physical activity (1 day)	BMI (kg/m2) Per cent fat Fat mass (kg) Fat-free mass (kg)	Boys and girls Total physical activity was inversely related to high values of BMI, fat mass, and fat-free mass (not with per cent fat).
(Janz, Burns and Levy, 2005)	Boys 176 Girls 202 Age 4-6	3	Total physical activity (counts/min) Moderate physical activity (min/day) Vigorous physical activity (min/day) 5-min periods of moderate physical activity 5-min periods of vigorous physical activity (3 days a week + 1 weekend)	Per cent fat measured with dual X-ray absorptiometry.	Boys' and girls' total physical activity, vigorous physical activity, and 5-min periods of vigorous physical activity were inversely related to per cent fat.
(Stevens *et al.*, 2007)	Girls 984 Age 12-14	2-3	Moderate to vigorous physical activity (min/day) Vigorous physical activity (min/day) (6 days including weekend)	BMI (kg/m2) Per cent body fat	Girls There was no association between the tested variables.

Figure 8 Longitudinal studies' observations of body fat

Three of the four studies noted an inverse relation between physical activity levels and future body fat. The results supported those found in cross-sectional studies, i.e. that vigorous, but not moderate, physical activity was associated with lower body fat levels three years later. No longitudinal studies have been found exploring the long-term effect of objectively measured physical activity on central fat in children or adolescents. Future research to study this subject in greater depth is needed. Longitudinal studies suggest that individuals with an unhealthy risk profile are less fit and active to begin with, and increased activity will improve their metabolic profile. Studies also

show that the amount and type of physical activity needed in childhood and adolescence remains a matter of debate.

Almost half of the exercise interventions that were aerobic in nature observed significant changes in measures of BMI, total fat, and/or abdominal fat in response to training. While only three of the 17 studies that employed other training, modalities observed significant improvements in measures of total fat, abdominal fat, or BMI in response to training. The data indicates that children who report relatively low levels of physical activity are significantly more likely to be overweight or obese than more active children of similar age and gender (Levin *et al.*, 2003; Mansikkaniemi *et al.*, 2012). Obesity in childhood cannot easily be reduced to a simple problem that can be solved, multiple factors such as; behaviour, gender, environment, economics, social and physiology all influence the individual energy balance. It is however, clear that changes in calorific intake (energy) and physical activity levels (output) are causally related to obesity. More research is needed to fully assess the impact of these lifestyle measures on obesity risk.

Insulin resistance

Insulin resistance is a very common and long appreciated corollary of obesity (Rabinowitz and Zierler, 1962; Reaven, Lithell and Landsberg, 1996). Insulin resistance syndrome is believed to be a precursor to Type II diabetes mellitus, in which the body does not use the insulin hormone it produces effectively.

Type II diabetes mellitus appears to be mediated by multiple physiological mechanisms that provoke insulin resistance syndrome. Insulin resistance is however, strongly associated with the risk factors that come with increased body fat (Lambert *et al.*, 2004). Type II diabetes mellitus is a complex metabolic disorder with genetic, social and behavioural risk factors. The prevalence is increasing worldwide, particularly in the western world.

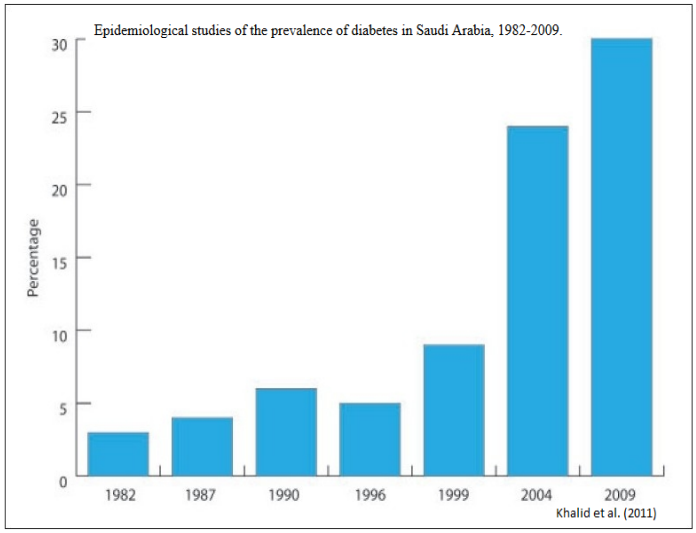


Figure 9 Diabetes mellitus prevalence

Further strong evidence exists correlating the link between overweight or obesity during childhood and the risk for type II diabetes mellitus (Pettitt *et al.*, 1993; McCance *et al.*, 1994; Hanley *et al.*, 2000).

In one Canadian study, (Lambert *et al.*, 2004) insulin resistance syndrome has been shown to be highly prevalent in youth as young as nine years of age due, at least part to obesity and overweight. Physical activity impacts on the risk for type II diabetes mellitus by affecting insulin sensitivity and glucose tolerance. Physical activity is correlated with lower fasting insulin and greater insulin

sensitivity in healthy children. Recent studies have demonstrated a positive relationship between physical activity and improvements in glucose tolerance (Schmitz *et al.*, 2002; Ahn *et al.*, 2004).

Blood lipids

Blood lipid profiles have a proven link with cardiovascular disease (CVD) in adults. More specifically, high levels of total cholesterol as well as high levels of LDL cholesterol with low levels of HDL cholesterol also are understood to increase the risk for CVD (Mansikkaniemi *et al.*, 2012).

There is a surprising scarcity on literature available discussing blood lipids in children and their relationship to children. A total of nine articles examining blood lipids and lipoproteins were evaluated. Only one of these studies, (Carnethon, Gulati and Greenland, 2005) was observational in nature. This study was cross-sectional and was conducted on a representative sample (n = 3,110) of 12-19-year-old American adolescents. It measured cardiorespiratory fitness using a submaximal treadmill test with results indicating that unfit girls (defined as the lowest 20%) were 1.89 times more likely to have hypercholesterolemia and 1.03 times more likely to have a low HDL-cholesterol by comparison to moderately and high fit girls. Unfit boys were 3.68 times more likely to have hypercholesterolemia and 1.25 times more likely to have a low HDL-cholesterol by comparison to moderately and high fit boys.

The remaining eight studies were experimental studies and examined the effect of exercise interventions on changes in blood lipids and lipoproteins. All these studies were limited to children and youth that already had high cholesterol levels or obesity (Hardin *et al.*, 1997; Ferguson *et al.*, 1999; Meyer *et al.*, 2006; Bell *et al.*, 2007; Heyman *et al.*, 2007; Lee and Park, 2017). The results of these core studies can best be described as mixed. Five of the studies used interventions based on aerobic exercise alone and observed significant improvements in at least one lipid/lipoprotein variable. The interventions that were based on resistance training and circuit training reported small and/or insignificant changes for all the lipid variables, and the effect sizes within these studies tended to be quite small. The interventions that produced significant changes were also based on the studies that employed the largest sample sizes. Of note is that the favourable interventions were based on elevated risk participants, implying that low volumes of moderate-to-vigorous exercise may be beneficial for youngsters at the greatest risk.

Physical activity has been proven to have a positive impact on blood lipid profiles in adults and is thought to have a similar effect in children (Tolfrey, Jones and Campbell, 2000; Eisenmann *et al.*, 2017). Cross-sectional studies have shown that increases in physical activity and energy expenditure are associated with higher levels of HDL-C (so-called “good” cholesterol) in children and adolescents of both sexes in a dose-related manner (Tolfrey, Jones and Campbell, 2000; Lambert *et al.*, 2004; Mansikkaniemi *et al.*, 2012).

Blood pressure

A total of 11 articles examining high blood pressure in children and physical activity were identified. Three of these studies were observational in nature (two cross-sectional, one prospective) (Nielsen and Andersen, 2003; Carnethon, Gulati and Greenland, 2005; Dasgupta *et al.*, 2006). Of these three studies, two measured cardiorespiratory fitness while the third relied on self-reported measures of

physical activity (Urzua, 2010). Within all three of these observational studies the relationship between physical activity or fitness with hypertension were weak in magnitude.

The remaining eight experimental studies examined the influence of exercise interventions on changes in blood pressure. These studies were limited to children and youth with high blood pressure or obesity (Hagberg *et al.*, 1984, 2017; Danforth *et al.*, 1990; Ewart, Young and Hagberg, 1998; Carnethon, Gulati and Greenland, 2005; Bell *et al.*, 2007). The interventions ranged from four to 25 weeks in duration, and focussed on increased exercise. Despite the small sample sizes of the studies, results were positive with reports of significant reductions in systolic blood pressure in response to increased aerobic exercise training. A further two studies also reported significant reductions in diastolic blood pressure. Due to the studies using similar levels of aerobic exercise in similar volumes and intensities and they found comparable reductions in blood pressure. However, the effects of the volume and intensity of exercise on blood pressure remain unclear.

Bone mineral density

The risk of developing symptomatic osteoporosis later in life is influenced by the level of peak bone mass that is attained in early adulthood (Kelly, Eisman and Sambrook, 1990; Krall and Dawson-Hughes, 1993; Harris *et al.*, 2000). While genetics, diet, environment and socioeconomic factors are considered key determinants of bone mineral density, physical activity patterns throughout life also plays a role (Kelly, Eisman and Sambrook, 1990; Krall and Dawson-Hughes, 1993; Harris *et al.*, 2000).

There are many observational studies in adults that have examined the relationship between physical activity and measures of bone mineral density such as the bone mineral content (MacKelvie *et al.*, 2003). However, there are no observational studies in the literature search that predict a low bone mineral density as a dichotomous outcome in relation to physical activity in children. A total of 11 experimental studies that examine the changes in bone mineral density in response to exercise training were found (Blimkie *et al.*, 1996; Morris *et al.*, 1997; Treuth *et al.*, 1998; Kontulainen *et al.*, 2002; Petit *et al.*, 2002; Linden *et al.*, 2006; MacKelvie, McKay, *et al.*, 2017; MacKelvie, Petit, *et al.*, 2017; McKay *et al.*, 2017; Nichols, Sanborn and Love, 2017). The physical activity programmes in these interventions characteristically consisted of moderate-to-high strain anaerobic activities such as impact resistance training, high impact weight bearing, and jumping. The results, although disputed, show that as little as 10 minutes of moderate-to-high impact activities performed on as few as two or three days of the week can have a modest effect on bone mineral density when combined with general weight bearing aerobic activities that are also beneficial for cardiovascular risk factors and obesity prevention.

Several studies have demonstrated that weight-bearing activity can produce significant increases in bone mineral density in children and youth (Välimäki *et al.*, 1994; Bass, 2000; Kemper *et al.*, 2017; McKay *et al.*, 2017; Neville *et al.*, 2017). Worthy of special note is a Canadian study (Dwyer *et al.*, 1983) which involved a school-based “jumping” programme as part of regular physical education classes that was able to demonstrate a bone mineral density increase of 4.5%.

Balance

The body's balance (vestibular) system helps us walk, run, and move without falling. Both balance and equilibrium help us stay upright and know where we are in relation to gravity. Balance is controlled through signals to the brain from the eyes, the inner ear, and the other sensory systems (skin, muscles, and joints) (American Speech-Hearing-Language Association, no date). While the vestibular system is the first to be developed among babies, young children have poor postural stability, which improves with maturation of brain structures controlling this function (Tringali, Wiener-Vacher and Bucci, 2017). One study (Assaiante and Amblard, 1995) suggests that it is not until seven years of age that children develop head–trunk coordination, allowing them to reach better postural stability.

Research has shown that exercise during formative years supports a stronger skeleton when measured in terms of bone density levels. However, bone density declines with age and this can combine with other factors such as osteoporosis to increase the chances of factures, particularly of the hip (Karlsson, 2004). The author adds that further studies suggest that in later life, exercise to improve muscle strength, coordination and balance can reduce the number of falls.

In sports, it is recognised that injury prevention programmes work to reduce injury by improving functional balance. For example, Steffen *et al.*, (2004) report that footballers participating in a FIFA 11+ injury prevention programme had significant improvements in functional balance with a 72% reduced injury risk in those who highly adhered to the prescribed exercises compared with those with less adherence. The authors suggest that this reduction is likely due to improved neuromuscular control, summarising that improved functional balance contributes to reduced injury risk. The result being improved players' technical football skills and physical development in general. While these are wholly relevant for football players, they can also be considered in the scheme of all sports and exercise programmes: that warm up and intervention programmes can prevent injury.

While exercise programmes in youth can support good balance and movement, our natural vestibular system can be affected by a number of factors. As we age, normal balance is dependent on many factors, including multiple systems of the body, as well as external and environmental factors (Webb-Schoenewald and Bailey, 2016), and for the body to be balanced, have equilibrium and a good centre of gravity, may take practise (Miller, 2012). Inactivity and 'unhealthy habits' can affect our equilibrium, and when combined with poor posture, can lead to imbalance and reliance on a particular side of the body. Ageing can also affect the body's vestibular system (Webb-Schoenewald and Bailey, 2016) due to a number of factors including impaired inner ear function as well as neurological and cardiovascular health. A number of health conditions can also affect the body's balance and equilibrium. For example, in stroke victims, balance is often affected as one side of the body is not as strong. In sufferers where balance was affected, the risk of falling while dressing was seven times more likely when compared to those who did experience balance problems.

Vestibular impairment can have detrimental effects on health through loss of balance and dizziness, which are risk factors for falls and injury. However, studies show that the effects of such impairment can be combatted through exercise, which help keep muscles strong in an effort to reduce the risk of

falls (Tait, 2012). Many exercise programmes, such as Core Fit, aim to improve strength and balance. This is further supported by studies which show that balance and resistance training can improve healthy older adults' balance and muscle strength (e.g. Lacroix *et al.*, 2017; English *et al*., 2010) which may have been reduced due to health or age-related conditions.

Exercise-based programmes have been found to improve specific factors associated with falls such as gait speed, cognitive function, and balance in a range of individuals having experienced cognitive impairment through stroke for example (Booth *et al.*, 1997; Liphysical activityrdo *et al.*, 2017). Research has shown that both yoga and tai chi have reported improvements in balance following strokes (Ćwiękała-Lewis, Gallek and Taylor-Piliae, 2017; Smith, Mross and Christopher, 2017). Pilates-inspired programmes have also found to be successful in improving dynamic balance, lower-extremity strength and aerobic resistance (Vieira *et al.*, 2017).

Circuit training has also been found beneficial to those having suffered a stroke, with moderate evidence reporting that circuit classes were more effective in enabling stroke sufferers to walk further, more independently, and faster and, in some cases, to balance more easily and confidently when compared with other types of post-stroke therapy (English *et al.*, 2010).

Flexibility

Flexibility can be defined as "the absolute range of movement in a joint or series of joints that is attainable in a momentary effort with the help of a partner or a piece of equipment" (Gummerson, 1990). Flexibility can be considered in terms of a specific joint or muscle, and not necessarily the whole body. Kurz (1991) describes two types of flexibility: dynamic, related to movement and static, non-moving such as holding a position or stretch. Gummerson (1990) states that there are many internal and external influences which affect flexibility. Internal may involve the type of joint, internal resistance, bony structures, elasticity of muscle tissues, tendons and skin, ability of the muscle to contract and relax, and body temperature. External factors may include age (children are more flexible than adults), gender, clothing, room temperature and water intake over the day.

It is also reported that flexibility is a predominant feature of motor adaptability – the capacity of the neuromuscular system to make fine adjustments in coordination (Greve, Hortobágyi and Bongers, 2017). These functions somewhat diminish with age, potentially due to motor flexibility being affected by a number of factors including deterioration in the size and number of muscle fibres, and impaired intracortical inhibition (cited in Greve, Hortobágyi and Bongers, 2017).

Results from longitudinal studies (Jürimäe *et al.*, 2007; Costa *et al.*, 2017) demonstrate substantial reduction in children's flexibility over the study period, which the authors suggest is related to increasing obesity levels over time along with changes in body size (body height and weight). Along with positive secular changes in growth patterns (leg, trunk and arm length and their respective ratios), the trend for taller, and heavier children may explain some of the modern day reported reduction in flexibility.

Studies do highlight that with intervention, healthy older adults can preserve motor flexibility during a goal-directed upper extremity reaching task (Greve, Hortobágyi and Bongers, 2017). Further, a

study on frailty in later life found that exercise was the medicine to reverse or mitigate frailty, preserve quality of life, and restore independent functioning in older adults at risk of frailty (Bray *et al.*, 2016).

Mental Health

Mental illness is a serious public health issue. (Biddle, 2008) certainly postulates that it is expected to account for 15% of the global burden of disease by 2020, which would make it the leading disease burden to health care systems worldwide. With this in mind, Whitelaw *et al.*, (2010) reported that the effects of physical activity on mental health in children is significantly under-evaluated compared to adult populations. Where children's mental health is reported the work is primarily focussed with depression, anxiety and self-esteem.

Rugbeer *et al.*, (2017) established that the frequency of exercise improved mental health outcomes, with a significant difference in mental health when that exercise was performed three times a week. A noteworthy difference was seen in the mental component comparing pre-and post-training twice a week and thrice a week.

Depression

There are vast amounts of studies on the topic of depression but only six studies specifically related to physical activity changes in children, and only three were observational studies (Brosnahan *et al.*, 2004; Haarasilta *et al.*, 2004; Tao *et al.*, 2007). These were cross-sectional in design, used self-reported measures of physical activity, and reported small links between physical activity and depression. Interestingly, within one study (Tao *et al.*, 2007) the relationship between physical activity and depression was more evident at a moderate intensity of physical activity than at a vigorous intensity of physical activity.

The three experimental studies examined changes in depression on aerobic exercise (Annesi, 2005; Goldfield *et al.*, 2007; Norris, Carroll and Cochrane, 2017a). The volume of exercise prescribed in these studies was a modest 60 to 90 minutes per week. These studies observed significant improvements in at least one depressive symptom measure in response to an eight to 12-week exercise programme. One of the studies included both high intensity and moderate intensity exercise programmes, with only the high intensity programme resulting in significant improvements in depression scores in comparison to the control group, which performed flexibility exercises (Norris, Carroll and Cochrane, 2017b).

Physical activity has been shown in older adults to be efficient in reducing clinical depressive symptoms in the short-term from those suffering depression or displaying depressive symptoms (Lee and Park, 2017).

Studies are limited using broad inclusion criteria that covers a broad spectrum of depression, from the very mild to the severe debilitating. Further studies often do not define the exact nature of the physical activity interventions in respect of frequency, intensity, duration and type. Where group based activities were used there is a lack of control around other factors such as the effects of social interaction.

Anxiety

Further studies (Martinez-Gonzalez, 2003; Department of Health, 2004a) found that active adults report fewer symptoms of anxiety than inactive adults. However, evidence for young people is considerably less than for adults. Larun *et al.*, (2006) in their meta-analysis considered sixteen studies with randomised trials with a total of 1,191 participants between 11 and 19 years of age. The studies included vigorous exercise interventions for children and young people up to the age of 20, with outcome measures for depression and anxiety. The authors concluded that whilst there appears to be a reduction in anxiety and depression scores for participants, the clinical diversity of participants, interventions and methods of measurement limit the ability to draw conclusions. The authors also saw little benefit in the altered intensity levels.

These findings are echoed by Wipfli, Rethorst and Landers (2008) who, in their review valuated exercise interventions as a treatment for anxiety. The report is critical of the studies based on lack of inclusion criteria for participants, and the broad nature of interventions. Little detail appeared to be available on the types of exercise included in the aerobic category. The authors were also cautious regarding bias as they identified an over reliance on self-reported outcome measures. Further comments were directed at the presence of statistical heterogeneity, along with the potential for significant heterogeneity in practice, meaning that the pooling of data may not have been appropriate.

In summary, physical activity interventions for young people have been shown to have a small beneficial effect for reduced anxiety. However, the evidence base is limited and in need of development.

Self-esteem

Self-esteem refers to the degree to which an individual values themselves; it is widely regarded as a key indicator of positive mental health and wellbeing (Duncan *et al.*, 2002; Parkinson, 2007).

Although good self-esteem is important in all children, obese children are at risk for having poor self-esteem and being rejected by peers. Numerous studies have brought attention to the fact that it is difficult to specifically link increases in physical activity with improved self-esteem (Sonstroem, 1984; Whitehead, 1995).

Gruber *et al.*, (1986) in their meta-analysis examining interventions in elementary school-aged children found evidence to support the concept that physical activity and a healthy self-concept are related and further that in some studies, evidence was demonstrated to support the finding that the relationship was more prominent when aerobic activities were used.

Due to the complex nature of self-esteem it would be extremely difficult to isolate the variable in the context of physical activity.

Self-harm

Morey *et al.*, (2017) in their paper examined the self-harm prevalence amongst adolescents aged 13–18 years in England. As the study is cross-sectional it only provides a snapshot of prevalence and

points to correlation rather than causation. However, with a prevalence estimate of 15.5% in the general population, its findings are of a significant note.

As can be seen in the table below reproduced from (Morey *et al.*, 2017b) those considering or undertaking self-harm have lower WEMWBS score.

	Number	*Mean WEMWBS Score*	*95% CI*	*Validation score*
Overall self-reported wellbeing	2000	45.6	45.2–46.0	48.8
Age specific self-reported wellbeing				
13	263	48.8	47.6–49.9	48.7
14	320	47.0	45.8–48.1	48.6
15	372	46.7	45.7–47.7	50.1
16	370	43.5	42.4–44.5	49.8
17	382	44.4	43.4–45.4	
18	293	43.8	42.7–44.9	
Age–sex specific self-reported wellbeing				
Male 13–15	437	48.8	47.9–49.7	N/A
Female 13–15	518	46.1	45.3–46.9	N/A
Male 16–18	520	45.3	44.4–46.2	N/A
Female 16–18	525	42.5	41.7–43.3	N/A
Self-reported self-harm				
Any	309	38.7	37.6–39.9	N/A
None	1691	46.8	46.3–47.3	N/A
Self-reported self-harm by type				
Cut on arms	235	37.9	36.6–39.2	N/A
Cut elsewhere	170	37.4	35.9–38.9	N/A
Self-battery	163	38.1	36.5–39.6	N/A
Burnt	68	37.0	34.4–39.7	N/A
Pills or overdose	89	36.7	34.3–39.0	N/A
Something else	24	38.8	34.7–43.0	N/A
None	1691	46.8	46.3–47.3	N/A

Self-harm was associated with a significantly lower wellbeing score, with mean scores of 38.7 (ever self-harmed) and 46.8 (never self-harmed).

Clearly there is merit in the link between mental health and WEMWBS

Figure 10 Self-harm prevalence in 13-18 year olds

Later life

Aging is a complex and inevitable process, which leads to a decline in the body's physiological system and physical capacity (Manini and Pahor, 2009a). The process of aging may increase the occurrence of chronic diseases and conditions such as hypertension, cardiovascular disease, diabetes, cancer and osteoporosis (McKevith, 2005).

There is compelling scientific evidence worldwide, which suggests that a structured exercise programme can improve the physiological functioning, health-related quality of life and functional ability of older persons (Baker, Atlantis and Fiatarone Singh, 2007; Peri *et al.*, 2008; Manini and Pahor, 2009b; Vagetti *et al.*, 2014).

More recently, physical activity and exercise have been shown to improve quality of life in older adults with neurodegenerative diseases (Advocat *et al.*, 2013) and depressive disorders (Mura and Carta, 2013). Exercise has further been associated with better quality of life in the elderly with major depressive disorders living in the community (Patten *et al.*, 2013), and there is strong evidence that physical training improved daily living performance in frail elderlies who were long-term institutionalized (Weening-Dijksterhuis *et al.*, 2011). In the context of Core Fit, it has been shown that children with either high aerobic fitness or with high level of physical activity at 10 years old tended to be more active at six years compared with those with low fitness or low activity, and that

these children who were both fit and active at 10 years of age had a more favourable activity and fitness profile at six years compared with children who were unfit and sedentary (de Souza *et al.*, 2014).

Cognitive function

Kirk-Sanchez and McGough (2013) demonstrated that exercise preserves the functioning of the aging brain while Seifert *et al.*, (2010) showed that physical activity increases brain-derived neurotrophic factors in the hippocampus.

Mura *et al.*, (2014) postulated that brain derived neurotrophic factors may be important mediators in reducing cognitive decline, which effects a persons' autonomy. In all, 12 trials met our inclusion criteria involving a total of 754 participants. It was clear from these trials that the risk of bias was high and reporting was poor in some bias domains. In comparing differences between aerobic exercises to any other active intervention and no activity, there was no measurable benefit from aerobic exercise in improved cognitive function. Analysing only the subgroup of trials in which cardiorespiratory fitness improved in the aerobic exercise group showed that this improvement did not coincide with improvements in any cognitive domains assessed. Our subgroup analyses of aerobic exercise versus flexibility or balance interventions also showed no benefit of aerobic exercise in any cognitive domain.

Some studies do highlight that physical activity does show improvement in some areas of cognition, however, these invariably there were issues with many of these studies - some showed bias, others poor reporting or lack objective measures (Etnier and Landers, 1997; Colcombe and Kramer, 2003; van Uffelen *et al.*, 2007; Smith *et al.*, 2010; Andersen *et al.*, 2017).

It is worth noting that all the trials focussed on increased physical activity in an older adult population. There were no studies identified which looked at cognitive function in older adults with consideration to their physical activity in earlier life.

There exists the evidence that possible subgroups have provided promising results (Schut *et al.*, 2001; Podewils *et al.*, 2005; Etnier *et al.*, 2007). However, other factors which might influence the relationship include: age (Christensen and Mackinnon, 1993), frequency of cognitive episodes (Hultsch, Hammer and Small, 1993; Hultsch *et al.*, 1999), social network (Crooks *et al.*, 2008) and adherence to a Mediterranean diet (Panagiotakos *et al.*, 2007). Further, Åberg *et al.*, (2009) has demonstrated that aerobic fitness has a relationship with cognitive function.

ADHD and learning disorders

In a small number of studies, the effects of physical activity on specific abnormalities in cognitive and behavioural dysfunctions in children and youth have been studied. Brown (1982) investigated a regular jogging programme over 10 to 22 weeks and found a reduced need for stimulant medication in children with ADHD. Some uncertainty was identified about the duration of the benefit following the physical intervention.

A further study (MacMahon and Gross, 1987) was able to demonstrate that a programme of regular aerobic exertion over an extended time of 20 weeks led to an increase in physical fitness and an improvement in self-esteem.

Behaviour

Exercise interventions have also been found beneficial for children with a range of learning disabilities, those with behavioural diagnoses and autism spectrum disorders (ASD). Research shows that children specifically with ASD experience impairments in postural control which can affect the development of motor and social skills. A review of current literature (Lim, Partridge and Girdler, 2017) revealed that there were sensorimotor and multiple sensory processing deficits in those diagnosed on the spectrum. Further studies looking at impacts of intervention/support programmes which combine physical and mental activities in children with ASD reported improved cognitive ability (Lee *et al.*, 2017). Specifically, balance training programmes also improved balance and postural control (Cheldavi *et al.*, 2014).

In their study, Pontifex *et al.*, (2013) indicated that single bouts of moderately intense aerobic exercise may have positive implications on neurocognitive function and inhibitory control in children with ADHD. Verret *et al.*, (2010) add that structured physical activity programmes may have clinical relevance in the functional adaptation of children diagnosed with hyperactivity disorders. A further study (Lee *et al.*, 2017) assessing the benefits of therapeutic interventional exercise for the treatment of physiological and behavioural abnormalities as well as psychiatric disorder in children with Autistic Fragile X syndrome found that physical exercise was often clinically used and recommended further research to determine the exact beneficial effects of such interventions.

Further research conducted into relaxation and alternative therapies such as yoga exercises were also found to be complementary to behavioural interventions for children with ADHD (Chou and Huang, 2017). Specifically, as yoga exercise typically involves a variety of poses, deep breathing, concentration, and mental and physical relaxation, this can positively regulate mental states (Zipkin, 1985), promoting self-control, attention and concentration, self-efficacy, body awareness, and stress reduction (Peck *et al.*, 2005).

In a review of literature on intervention programmes for handicapped children, techniques involving progressive muscle relaxation, isometrics, yoga, movement exercises, massage, guided fantasy and imagery, meditation, concentration, suggestion, music, breathing control, self-relaxation, and biofeedback training were all found to have successful results in decreasing hyperactivity and impulsivity, improvements in academic achievement, increased attention span, as well as improved communication and interpersonal relationships (Zipkin, 1985).

Further work has found that physical exercise can also decrease repetitive behaviours in autistic children and improve cognitive function across the life-span (Anderson-Hanley Kimberly Tureck Robyn schneiderman, 2011). Participation in recreational activities also positively influenced the stress and quality of life of adults with ASD (García-Villamisar and Dattilo, 2010). However, it is widely recognised further detailed research needs to be conducted in this field (Dillon *et al.*, 2017).

Aerobic exercise in children with behavioural diagnoses prior to learning in school has also been found to improve academic responding in young children with ASD (Oriel *et al.*, 2011). Further studies show that vigorous or strenuous exercise is associated with decreases in stereotypic (self-stimulatory) behaviours, hyperactivity, aggression, self-injury, and destructiveness (Petrus *et al.*, 2008).

Academic achievement

There have to date been no studies that demonstrated the impairment of intellectual tasks from physical activity with Kirkendall (1986) able to demonstrate no detrimental achievement.

However, the majority of studies (e.g. Shephard *et al.*, 1969) show that physical activity does not increase basic intelligence, but was able to show an improvement in academic performance.

The benefits of physical activity go beyond health and wellbeing. While controlled trials are lacking there exists a body of evidence that document relationships between physical activity and enhanced academic performance (Tremblay, Inman and Willms, 2000; Dwyer *et al.*, 2001; Lindner, 2002; California Department of Education, 2004). Of these studies Dwyer *et al.*, (2001) was able to demonstrate from a cohort of almost 8,000 children aged between seven and 15 years old, that there is a correlation between self-reported physical activity and academic performance.

Delinquency

Again, there is little research in this field, however an interesting study (Segrave, 1983) was able to demonstrate that delinquency rates were statistically lower in the athletic population when compared to the broader peer group.

Overview

Despite the significant physical and mental health benefits, engagement in regular physical activity decreases with age (Rütten and Abu-Omar, 2004; Davis and Fox, 2007).

There is a great deal of strong and consistent evidence based on experimental studies which show that participating in as little as two or three hours' moderate-to-vigorously intense physical activity per week resulted in improved health outcomes. Evidence from observational studies further demonstrates a relationship between physical activity and health, with differences in health risk between the least active (or fit) and the second least active (or fit) groups. Most of the health outcomes documented, particularly for obese and the cardio-metabolic health measures, responded almost exclusively to aerobic exercise interventions. It is also likely that most of the activity that was captured in the observational studies was aerobic in nature.

There is a lack of long-term data to establish how these interventions translate into longer term health benefits.

Interventions for promoting physical activity among older adults can be categorised as individual-level approaches or through environmental approaches. While some factors, such as enjoyment, predict both initiation and maintenance of physical activity in adults, other factors, such as outcome

expectations and action-planning, are more strongly associated with physical activity initiation than maintenance.

Life long

Opportunities to be physically active tend to decrease with age and recent lifestyle changes have reinforced this phenomenon. The human body, because of regular physical activity, undergoes morphological and functional change, which can prevent or even delay the appearance of illnesses and improve capacity for physical effort. Current evidence is sufficient to show that those who live a physically active life gain health benefits. Chief among the aims of the Core Fit programme is to improve the long-term health outcomes. This aim is supported by a study (Resaland *et al.*, 2011a) which shows promising results with structural changes in physical activity in school. The team succeeded in implementing an intervention that included 60 minutes of daily physical activity. The children from the intervention school improved aerobic fitness by almost 10%. However, more importantly; they found the largest improvement in the least active children, which typically are the children with the poorest health. While this is positive according to data from the European Youth Heart Study, a 15% increase in aerobic fitness may decrease the risk of clustered CVD risk to less than one third in the least fit children (Andersen *et al.*, 2007).

While Hills, Andersen and Byrne (2011) also demonstrated that the closest association is found for aerobic fitness, physical activity and muscle strength were independently associated with clustering of metabolic risk factors.

Various studies have supported the approach that physical activity patterns established during childhood and youth are important in laying the foundation for activity habits in the future (Malina, 1996; Beunen *et al.*, 1997; Kemper *et al.*, 2001; McMurray *et al.*, 2003; Telama and Yang, 2013).

Economic impact

The economic impact of increasing wellbeing scores is particularly hard to determine as there is a distinct lack of data in the age group of participants in the Core Fit programme. There is also a lack of data in terms of spend per illness or even by service, and a lack of comparison data with the tools and organisations gathering data undergoing many revisions.

According to the *Mental Health Services Monthly Statistics: Final February, Provisional March 2017* (NHS, 2017) there were 314,252 referrals active at any point during February for people aged under 19, of which 42,729 were new referrals. Of the 1,157,027 in contact with mental health services at the end of February 240,020 (21%) were aged under 19. Compared with March 2016 928,348 people were aged 19 or over and 223,680 (24%) were aged under 19.

This increase is further supported by the NHS-Confederation (2017) which shows health expenditure (medical services, health research, central and other health services) per capita in England has risen from £1,868 in 2010/11 to £2,057 in 2014/15. At the same time as this nine per cent rise in cost per capita, NHS England (2016) report in the year to April 2016, the budget for mental health trusts was projected to rise just 0.3% in absolute terms. According to the NHS England business plan for

2016/2017 (ibid), the cost of these mental health contacts to the national economy is estimated at £105 billion a year roughly the cost of the entire NHS. This £105 billion does not take any account of the physical health costs.

Healthy lives are priceless, and each of us is uniquely valuable. We know that a value be placed on the cost of a life. According to the Work Foundation (Global Alliance for Work, 2016) employees suffering from bone and joint pain cost the EU's economies 240bn euros (£200bn) each year.

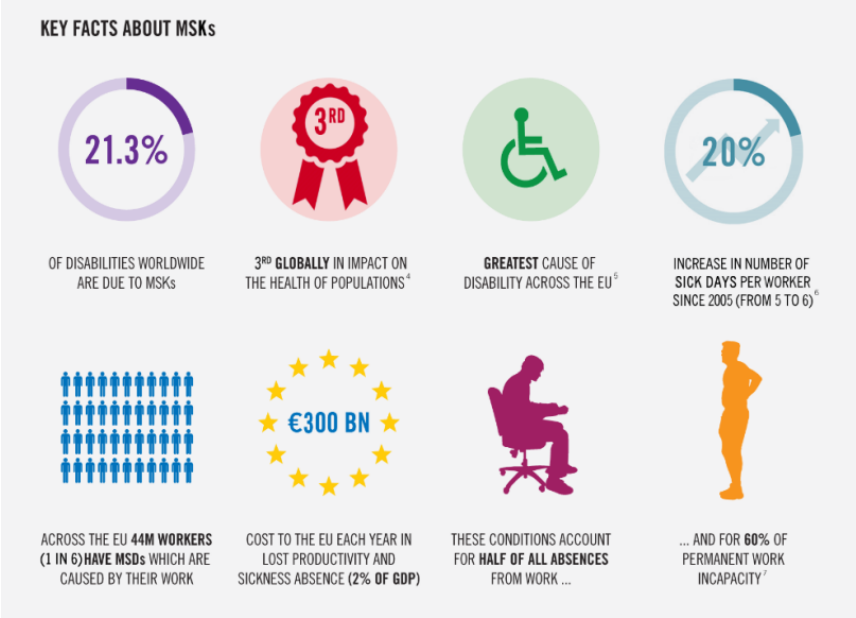


Figure 11 Key facts for musculoskeletal conditions

In 2016, according to the ONS (Jenkins, 2017) the overall sickness absence rate (which can be interpreted as the proportion of working hours lost due to sickness or injury) in the UK was 1.9%.

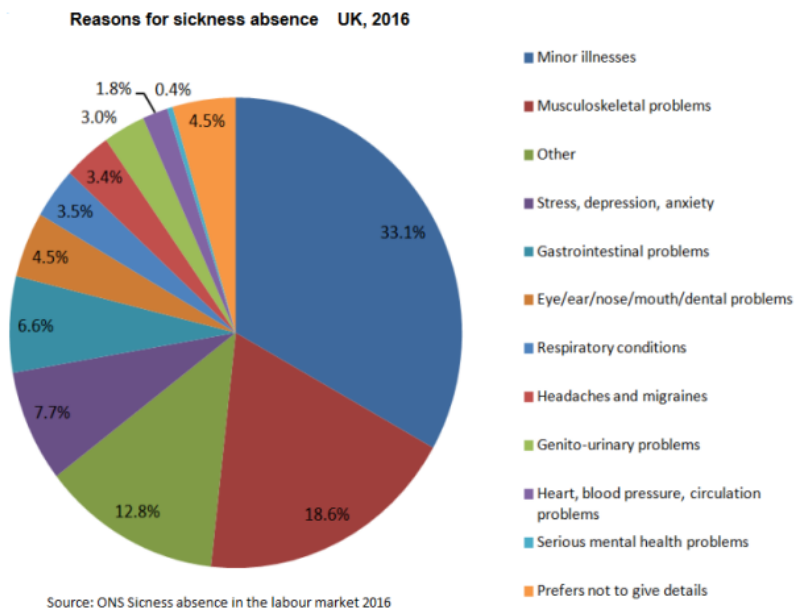


Figure 12 UK lost sick days

We can see from **Error! Reference source not found.** that minor illnesses were the most common reason for sickness absence in 2016. This was followed by musculoskeletal problems (including back pain, neck and upper limb problems) at 30.8 million days (22.4% of the overall days lost). In addition, other days lost due to mental health issues (including stress,

depression, anxiety and more serious conditions such as manic depression and schizophrenia) accounted for in 15.8 million days lost (11.5%).

Why start with children?

When considering exercise, most adults imagine working out in the gym, running on a treadmill, or high impact sweating. For children, however exercise means playing and being active.

There are numerous publications and policy documents that provide lists of positive aspects of physical activity. For example, Talbot (2001) claims that physical education linked to their activity helps children to develop respect for the body—their own and others; and contributes towards the integrated development of mind and body; develops an understanding of the role of aerobic and anaerobic physical activity in health; positively enhances self-confidence and self-esteem; and enhances social and cognitive development and academic achievement.

Forming good habits for future

Physical activity has been associated with a lowered risk of cardiovascular disease and an increased life expectancy. Its importance cannot be overstated; however, sometimes the value in children sometimes needs to be justified. In the formative years of primary school (age five to 11) children tend to be in a stage of development where they form ideas that will guide them through life, thinking is very literal and they are easily influenced.

It is clear that young children enjoy active play (Boreham and Riddoch, 2001), however, this changes over time into more organised club-based team sporting as part of PE or group activities such as swimming, football, rugby and hockey. Childcare and education setting may be the ideal places to promote physical activity and the early development of healthy behaviours (Bower *et al.*, 2008).

It is suggested that sport provides opportunities to meet and communicate with other people; to take different social roles; to learn particular social skills (such as tolerance and respect for others); to adjust to team/collective objectives (such as cooperation and cohesion); and that it provides experience of emotions that are not available in the rest of life (Svoboda, 1994).

For most children, the majority of their daily physical activity is accumulated in a very sporadic manner, and the latest evidence suggests that this sporadic pattern of activity may not be as beneficial as sustained bouts of activity that last in excess of five minutes in length (Bell *et al.*, 2007).

Moderate intensity activity in children and youth has been defined in a variety of ways, depending on the method chosen to measure physical activity. Most of observational studies have focused on measuring moderate-to-vigorous intensity physical activity. The relationship between overall physical activity and obesity do not appear to be as strong or consistent as those between moderate-to-vigorous intensity activity and obesity. Additionally, the intervention studies included within this systematic review are almost entirely made up of studies with at least a moderate intensity. Therefore, we can say that while moderate and vigorous intensity activities are associated

with many health benefits, the same is not true for low intensity activity. Inferior quality activity may not offer as many benefits as focused moderate exercise.

Evidence exists that biological carry-over effects continues into adulthood; whereby active children are more likely to become more active (healthy) adults. Childhood obesity may be a precursor for a range of adverse health effects in adulthood, while higher bone masses in young people reduce the risk of osteoporosis in old age. Finally, there may be a behavioural carry-over into adulthood. However, supporting evidence for this assertion is weak (Boreham and Riddoch, 2001). These findings are particularly important as children are increasingly becoming sedentary, physically inactive, and unfit (Chaddock-Heyman *et al.*, 2014).

These effects are not limited to the physical and an active lifestyle during childhood is beneficial to physical, cognitive, and brain health (Chaddock-Heyman *et al.*, 2014). Chaddock-Heyman *et al.*, (2014) further found that children who were fitter than their peers were found to have larger brain volumes in the basal ganglia and hippocampus, which relate to superior performance on tasks of cognitive control and memory, respectively. These fitter children also demonstrated superior brain function during tasks of cognitive control, better scores on tests of academic achievement, and higher performance on real-world tasks such as crossing the street task.

Aside from exercise and lifestyle choices, established healthy behaviours learnt in childhood carry through into adulthood and include better eating habits and decreased likelihood of smoking (Shilton, 2001).

Physical environment

The physical constraints of the human world have increasingly being recognised as a mediator of physical activity levels in not only in children but in adults as well (McKenzie *et al.*, 1996a; Welk, 1999; Spence and Lee, 2003; Steptoe, Deaton and Stone, 2017).

There are many factors that make schools unique and key as an environment in which health promotion can be targeted towards children:

- Children spend a significant amount of time in the school environment, 168 days on average each academic year in the UK.
- All children are required to attend school and the vast majority attend a mainstream school.
- Teachers and other school staff have the potential to exert a considerable amount of physical activity on the children (Biddle and Armstrong, 1992; McKenzie *et al.*, 1996b).
- Equipment and facilities already exist to support physical activity (McKenzie *et al.*, 1996b).

These factors, amongst others have led to a plethora of school-based physical activity interventions globally. In some cases, these interventions have been large, structured, randomised controlled trials while others have been implemented on a much smaller, less formal scale. Many have shown significant benefits to the participants.

Other intervention programmes

The results of school-based interventions have been mixed, particularly older intervention studies (e.g. Tell and Vellar, 1988 and McKenzie *et al.*, 1996) have clearly shown short-term increases in physical activity, and few have objectively demonstrated a sustained long-term effect. This does not suggest that school-based physical activity programmes are not effective, rather that issues with research design, measurement and evaluation have been a challenge.

One more recent study (Resaland *et al.*, 2011b) showed promising results with structural changes in physical activity in school. The authors succeeded in implementing an intervention including 60 minutes' daily physical activity. The children from the intervention school improved aerobic fitness almost 10%, but even more importantly, they found the largest improvement in the least active children, which were the children with the poorest health.

There are many school-based physical activity programmes that have been shown to be effective in increasing physical activity but their relative efficiency compared to other school-based programmes is unknown. The need for a benchmark is clear in order to provide a cost comparison. It is important to consider these programmes on a like-for-like basis especially factoring socio-economic backgrounds, other factors such as ethnic origin and even host nation play a large part. Outcomes are significantly harder to compare and are included here if judged to have met their outcomes.

Ready for Recess

The programme is designed to increase students' physical activity in two elementary schools in the USA. Ready for Recess cost £19,178.19 for the two schools in the first year of implementation. Physical activity increased by 1.8 metabolic equivalent hours per day per student. Approximately £0.27 was spent on Ready for Recess to produce an additional metabolic equivalent hour per student per school day in the 2008-2009 school year. The programme is anticipated to be more cost-effective if implemented for a longer time and on a larger scale largely due to economies of scale (Wang *et al.*, 2017).

Physical Activity 4 Everyone

An Australian intervention which was a multi-component intervention implemented in secondary schools located in low-income communities. Cost effectiveness was assessed using both the physical activity and weight status trial outcomes. The trial was implemented in 10 Australian secondary schools (five interventions: five control) and consisted of the intervention schools receiving seven physical activity promotion strategies and six additional strategies that supported school implementation of the intervention components. Costs associated with physical activity strategies, and intervention implementation strategies within the five intervention schools were estimated and compared to the costs of usual physical activity practices of schools in the control group. The total cost of implementing the intervention was estimated from a societal perspective, based on the number of enrolled students in the target grade at the start of the intervention (Grade 7, n = 837). The economic analysis outcomes were cost and incremental cost effectiveness ratios for the

following: minutes of moderate-to-vigorous physical activity per day gained, metabolic equivalent hours gained per person/day; BMI unit avoided; and 10% reduction in BMI z-score.

The intervention cost £191,787.96 over 24 months, or £229.02 per student in the intervention group. This resulted in a cost effectiveness ratio of £32.55 per additional minute of moderate-to-vigorous physical activity per day, £ 0.58 per metabolic equivalent hour gained per person per day, £818.41 per BMI unit avoided, and £327.25 per 10% reduction in BMI z-score (Sutherland *et al.*, 2016).

Results

The Core Fit evaluation used two subjective measures - WEMWBS and post programme questionnaires - to evaluate outcomes of the programme. This was combined with a performance assessment to evaluate the results.

WEMWBS Results

A total of 1,275 WEWBS questionnaires were completed during the evaluation period: 644 at the start and 631 following completion of the programme. Sample size at each school is statistically small, particularly for use with WEMWBS, which has been proven difficult to influence in such small class sizes.

	Number		**Number**	
Count of school responses to WEMWBS	**Pre**	**Post**	**Pre**	**Post**
Byley	16	17	50.88	53.00
Calveley	36	37	55.94	55.76
Cledford	46	49	51.20	53.71
Haslington	12	8	50.50	52.75
Moulton	50	48	54.62	58.42
Offley	155	135	51.17	54.64
St Chads	94	86	51.76	54.81
The Oaks	50	61	50.06	53.56
Vine Tree	24	21	50.50	55.00
Wharton	26	26	49.85	54.12
Wheelock	51	60	52.18	56.38
Wyche	84	83	55.12	56.02
Grand total number of responses	**644**	**631**	**52.20**	**55.11**

Figure 13 WEMWBS responses

From the analyses (Figure 13 WEMWBS responses) we can see that the average score for participants prior to the programme is 52.2 - greater than that found in the range of the most recent Children's Wellbeing Survey (NHS Digital 2016). It is therefore all the more surprising to see the impact of the programme having increased the WEMWEB score by three whole points by the completion of the programme to a post programme value of 55.1. It would be poor to assume that this whole increase was due entirely to the Core Fit strategy, there is however clear evidence across the sample that the score has increased.

To put this three-point increase in context by comparison NHS digital draw conclusions around the BMI and WEMWBS score with a difference of 0.7.

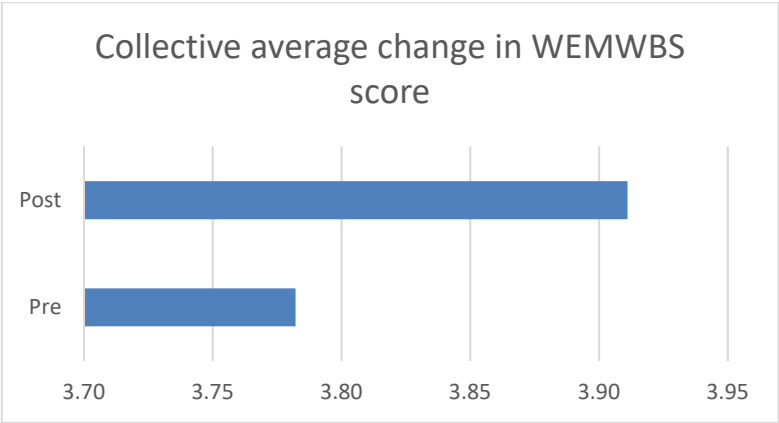


Figure 14 Change in WEMWBS score

When looking at specific WEMWBS questions (Figure 15 WEMWBS response by question), the average survey responses show that the greatest increases reported were related to making my own mind up (an increase of 0.29), interested in other people (0.28), feeling loved (0.27), feeling useful (0.27), confident (0.25) and feeling optimistic about the future (0.20). Clearly in the majority of questions we can say that on average, the response increased by 0.2 per question. This illustrates a clear increase across the board.

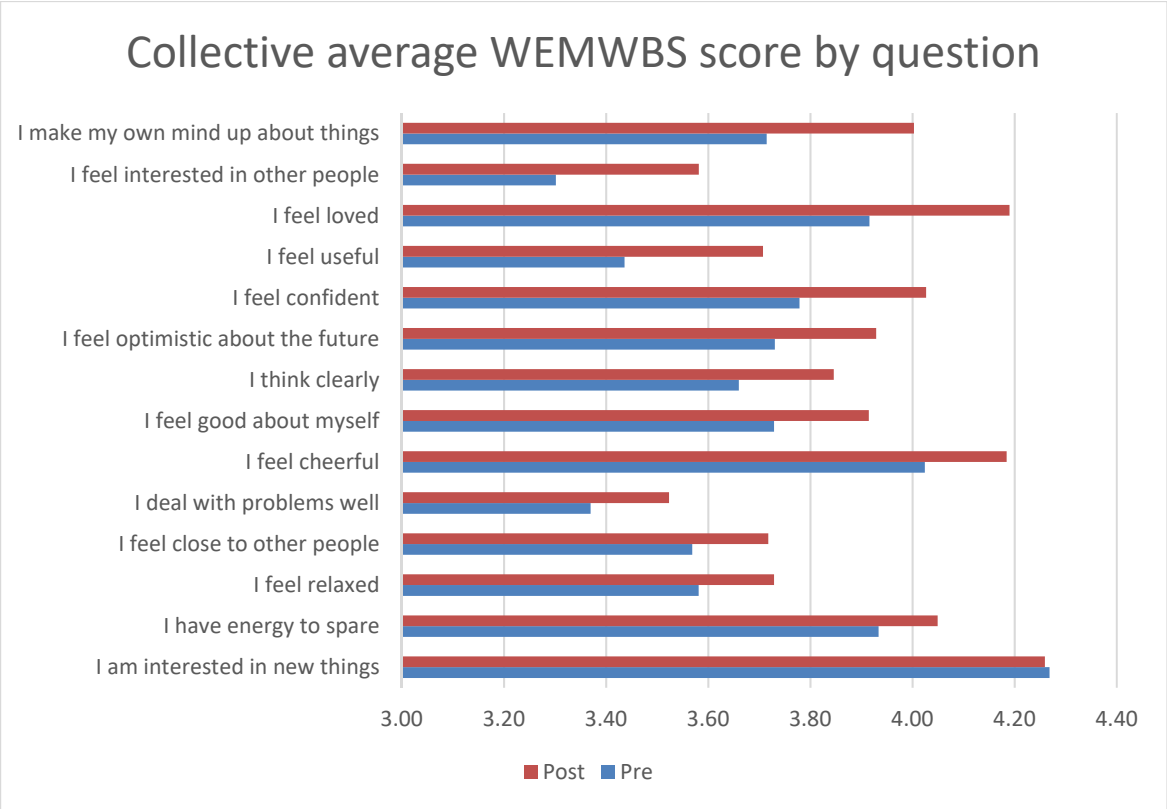
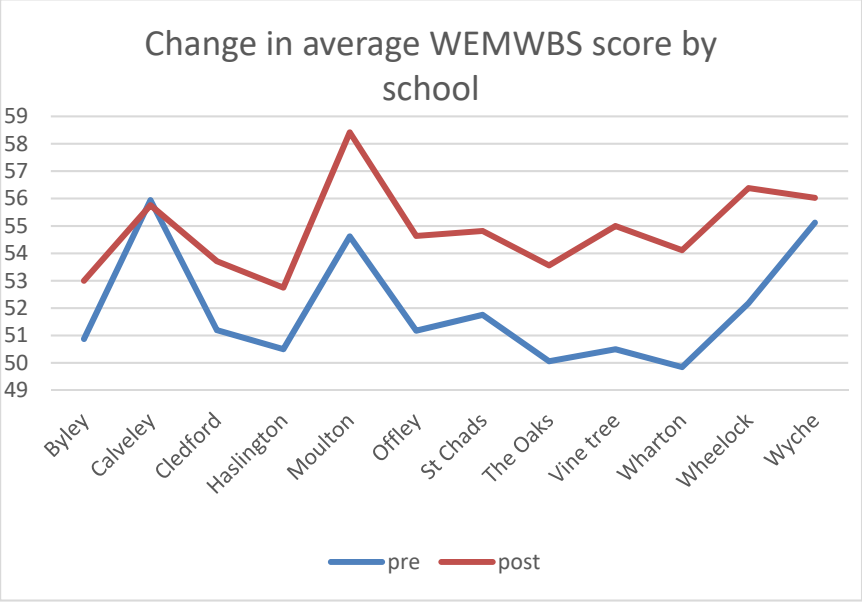


Figure 15 WEMWBS response by question

Overall, the shift in question response was from 'sometimes' to 'often' following completion of the programme. This strongly correlates to an overall improvement in general wellbeing as measured with WEMWBS.

The stand out contrast is the response to "I am interested in new things", this could be due to multiple factors such as engagement not taking in the participants, but this would not fit with the other responses it is more likely that either the activities were not "new" to the participants or that the participants were unaware that they had learnt something new.



Note the consistent changes from school to school

Figure 16 Change in average WEMWBS score by school

When considering the change by school, there is clear evidence of a paradigm shift in pre-to post average WEMWBS score with a very similar shift in all schools. The anomaly being Calveley's results with a -0.19 change; an insignificant amount suggesting that there were potentially other influences at work here or that the programme was delivered in a different manner at this location. Calveley was also the test pilot for the Core Fit programme at its conception in 2007. At start point, Calveley's WEMWBS score was also higher than most other school's finishing score, suggesting that the residual effect may be in part due to continuation of the Core Fit programme in the school over a ten-year period.

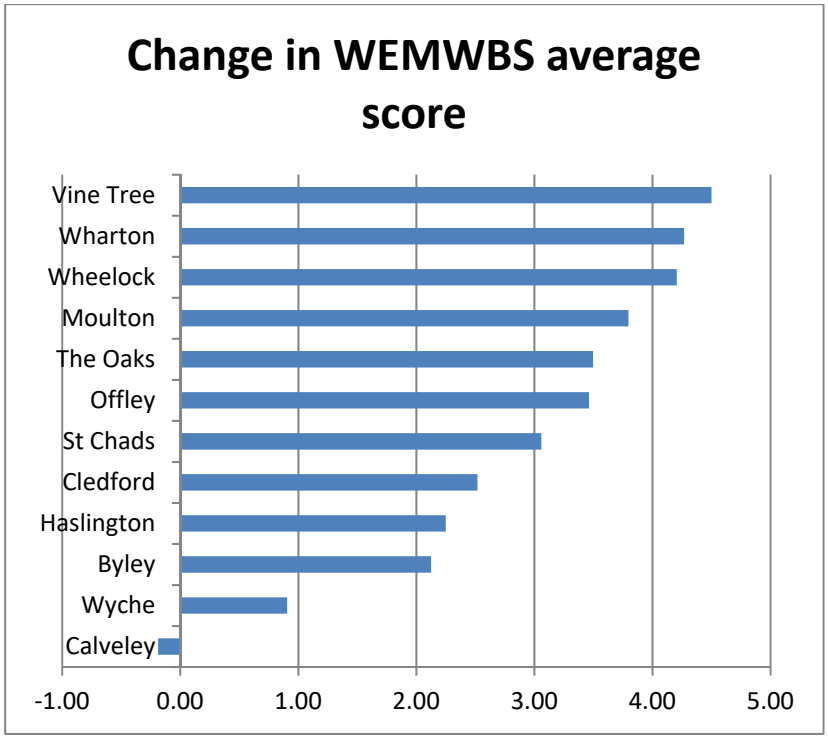


Figure 17 Change in WEMWBS average score

The greatest changes in WEMWBS post compared to pre-results were seen among Vine Tree (4.5 score increase), Wharton (4.27), Wheelock (4.21) and Moulton (3.80).

Calveley is the stand out anomaly in these results, as the school had previously undertaken the Core Fit programme the change was less pronounced.

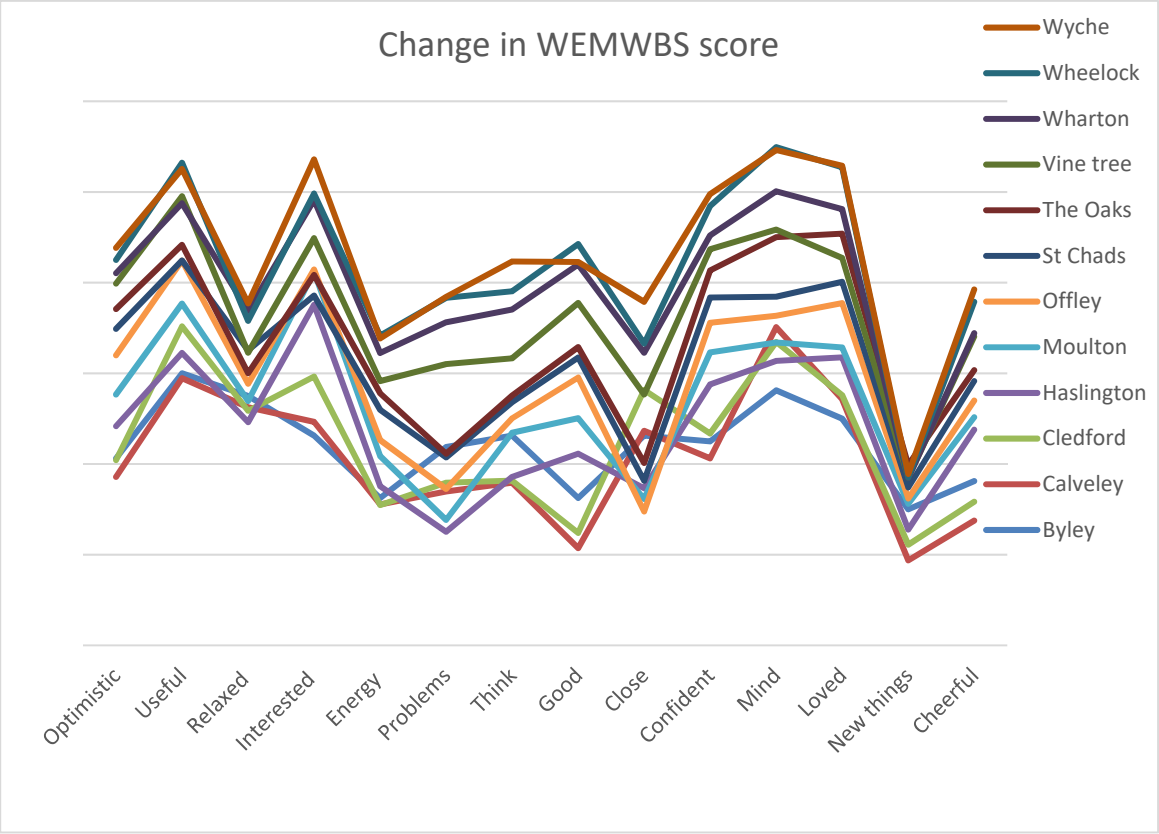


Figure 18 Change in WEMWBS scores by question and school

When we continue to examine and consider the change in WEMWBS by question it is clear to see that there is a repeatable change occurring due to the repetitive nature of the increase across the range. Key areas of repeatable change are those of the mind. This repeatable change is clear evidence that Core Fit has increased the "mind" factor and contributed to a positive effect on wellbeing.

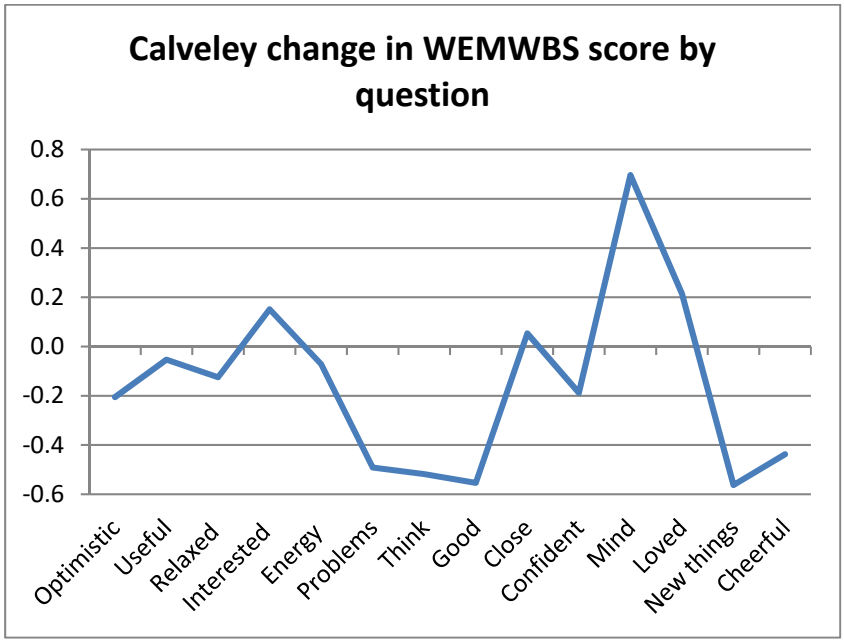


Figure 19 Calveley change in WEMWBS score by question

This is even true for the "anomaly" of Calveley whose mind score has also increased, obviously combating other external factors.

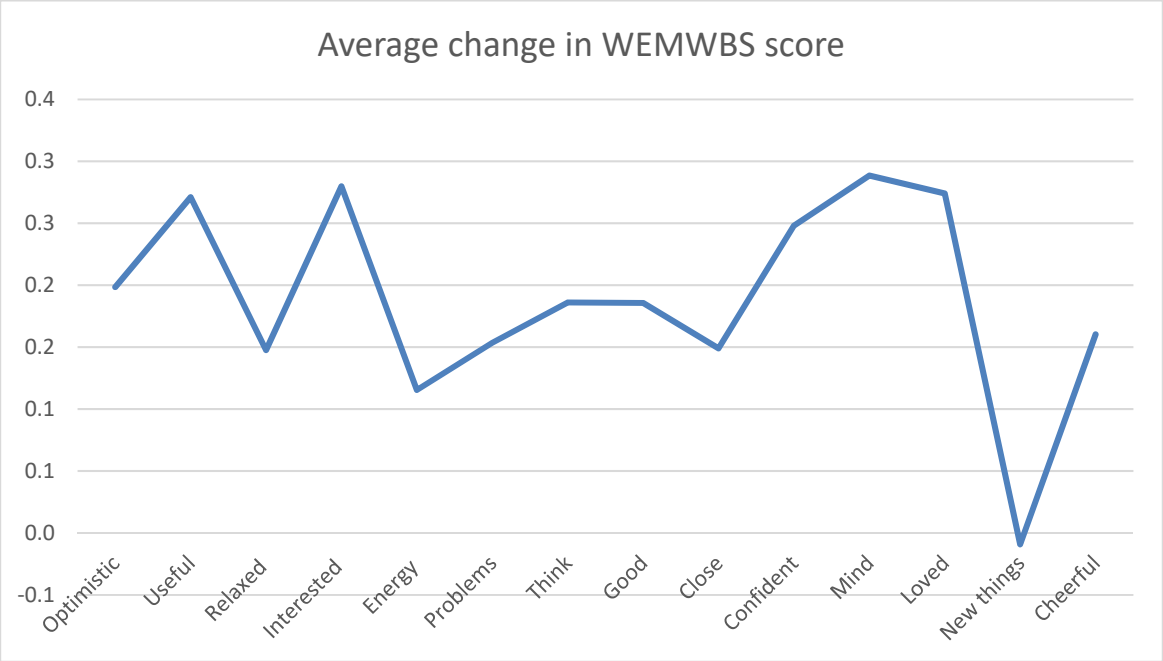


Figure 20 Average change in WEMWBS score

By plotting the average change by question in WEMWBS score we can isolate the greatest impact that the Core Fit programme has had. In this evaluation “mind” is clearly demonstrated as the largest element of the WEMWBS that has been positively affected. As previously discussed the “New things” has had the least impact.

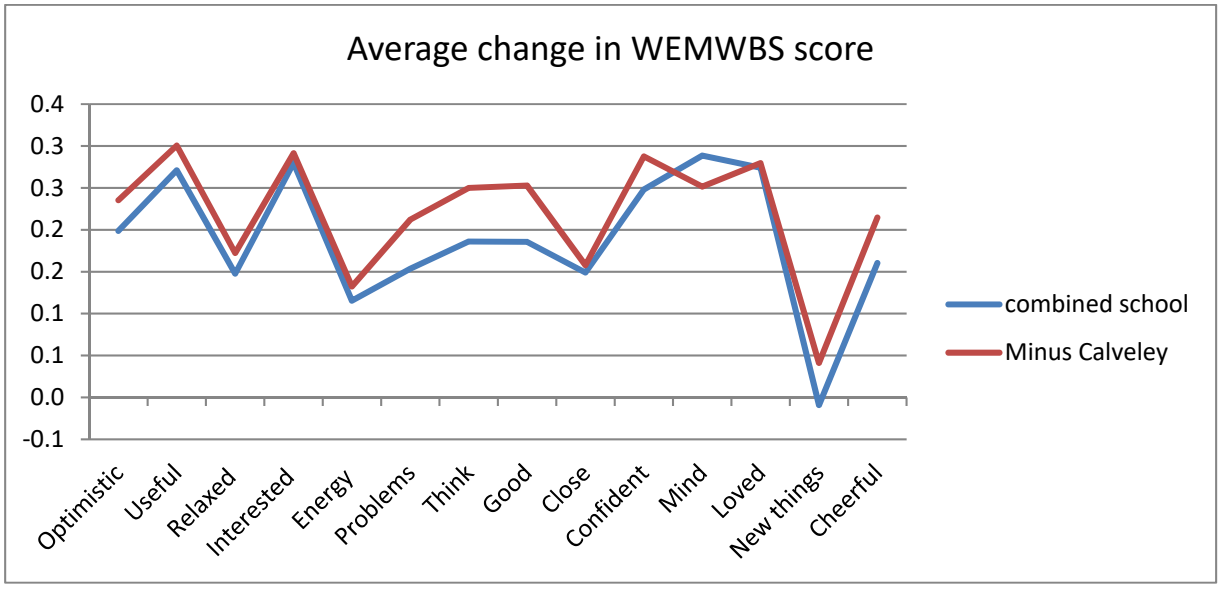


Figure 21 Average change in WEMWBS score

When considering the overall average change by question (Figure 21 Average change in WEMWBS score) this pattern becomes much clearer where we can see significant statistical change around the key areas that the Core Fit programme has greatest impact. If we strip the Calveley data from this set, we can then appreciate the difference this anomaly has in altering the trend line.

Statistical power

The power of a study is the likelihood that it will distinguish an effect of a certain size from pure luck or happenstance. The effect size is a quantitative measure of the strength of a phenomenon, in the case of this evaluation the benchmarked improvement in post programme WEMWBS score of three is a large increase.

With such a large change in WEMWBS score we can see that the confidence in the power based on our sample size supports the hypothesis that the Core Fit programme increases wellbeing.

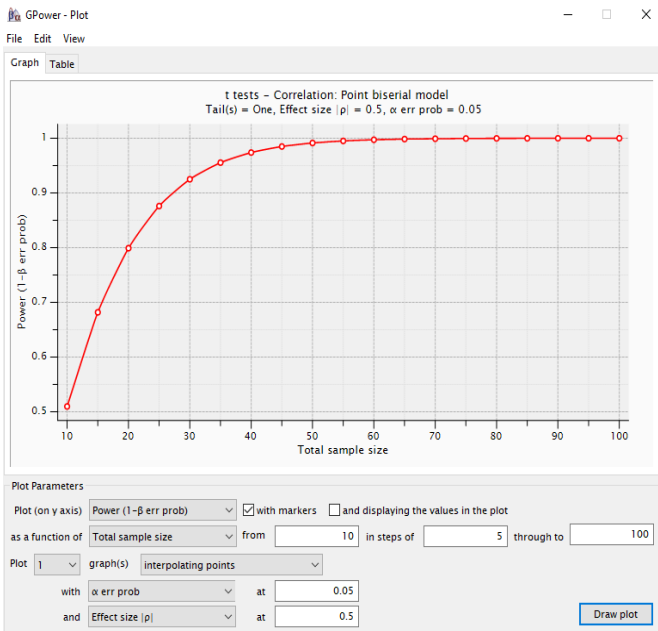


Figure 22 Statistical power curve

Post questionnaires

Count of school responses to Core Fit post survey	
Byley	11
Calveley	24
Cledford	38
Gainsborough	40
Haslington	8
Millfields	29
Moulton	27
Offley	138
St Chads	46
The Oaks	45
Vine tree	21
Wharton	20
Wheelock	60
Worleston	9
Wyche	58
Grand Total	574

Figure 23 Count of post programme activity

At the end of their last Core Fit session, participants were asked to complete a questionnaire. This resulted in a total of 574 completed surveys.

Not all questions were completed on all responses where appropriate these have been recorded as a negative response.

In terms of feedback on the programme (Figure 24 Core Fit enjoyment) we can clearly see that the majority in every school enjoyed the programme as this is a key to lifelong commitment this is extremely pertinent.

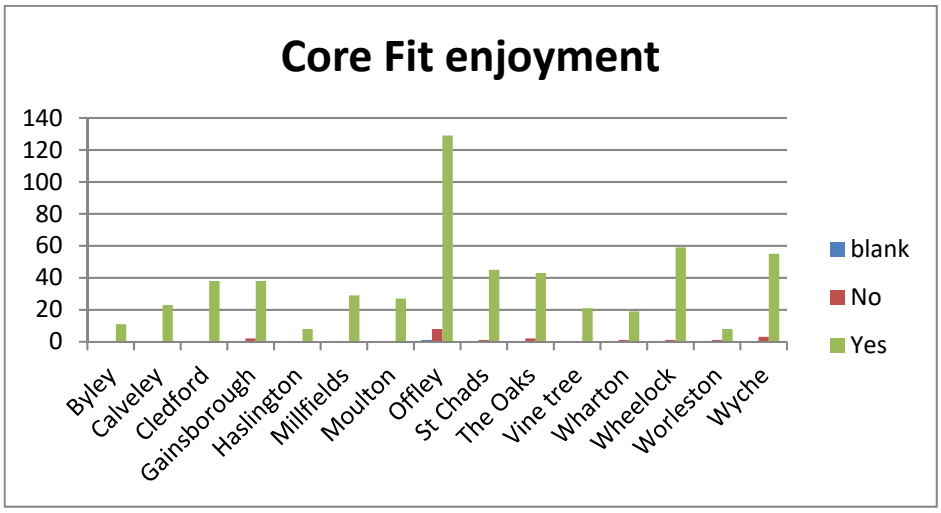
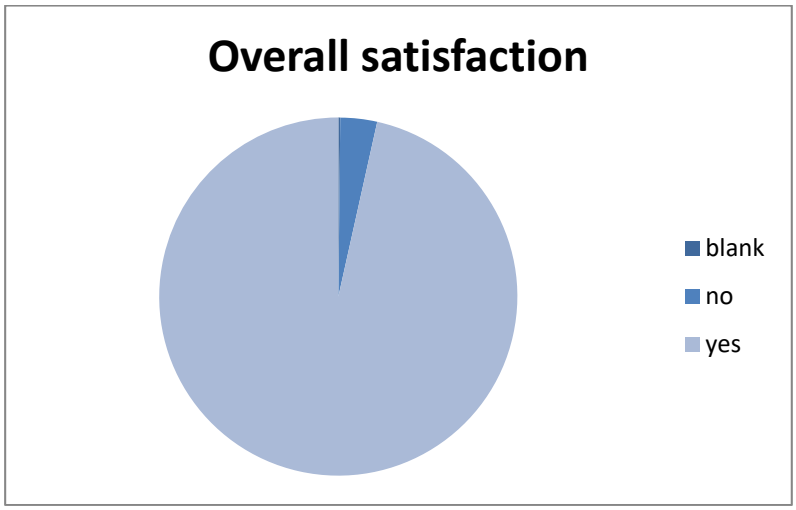


Figure 24 Core Fit enjoyment

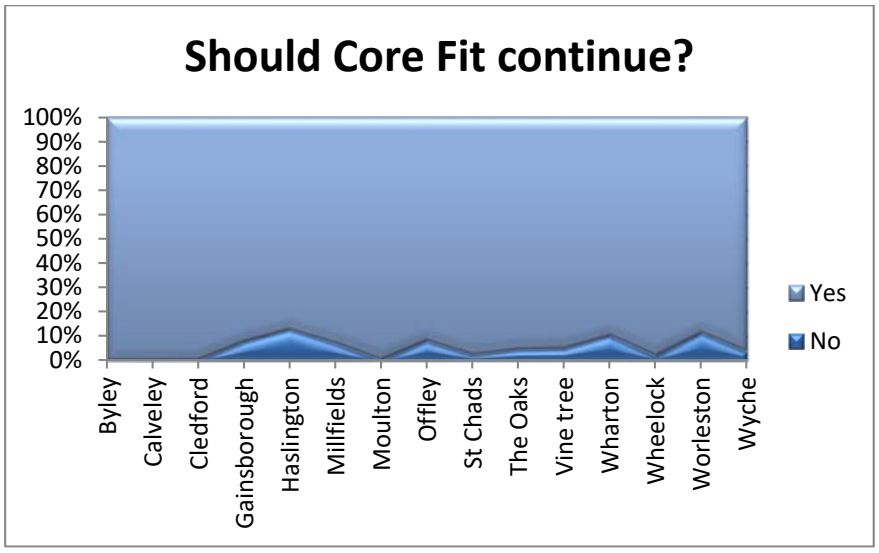
Translated across the whole cohort for this wave of the Core Fit project we can see overwhelmingly that the participants enjoyed the programme.



Interestingly, only one response was returned as a blank with other questions on the survey answered.

Figure 25 Overall satisfaction

Of course, the question next become if the participants enjoyed the Core Fit programme would they want to continue. Figure 26 Should Core Fit continue? clearly shows with a landslide that the participants would like the programme to continue. With such small sample sizes individuals make a significant difference for example in Worleston there were only eight participants (Figure 24 Core Fit enjoyment).



Interestingly only one response was returned as a blank with other questions on the survey answered.

Figure 26 Should Core Fit continue?

A key goal of the Core Fit programme is the participants' ability to recall the four themes of the programme (Figure 27 Those able to recall the Core Fit): core strength, balance, flexibility and Posture and with 53% able to recall all four aims there was a degree of success. Put into context, only 17% were unable to recall any aims at all. There remain two caveats on this value: the first being that any response that was left blank was recorded as being unable to recall the aims, and the

second that in the case of the Haslington dataset, eight out of nine participants did not respond to this question. This response needs to be placed into context of the school in that the class in this school was specifically for children with additional educational needs.

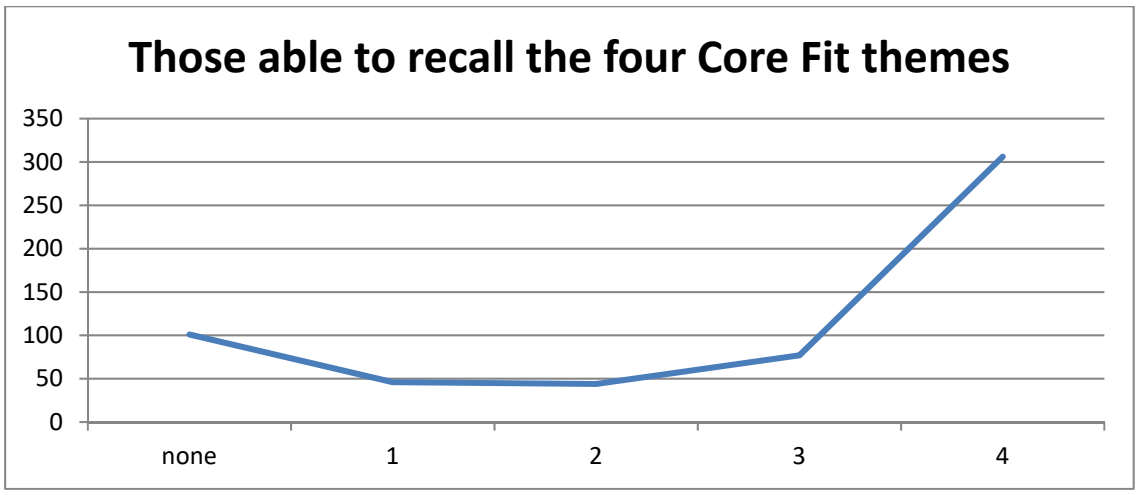


Figure 27 Those able to recall the Core Fit themes

By a vast majority, participants were positive that they are healthy. This participant viewpoint tells us more about wellbeing than it does about their actual health. With self-body image view having a huge effect on wellbeing.

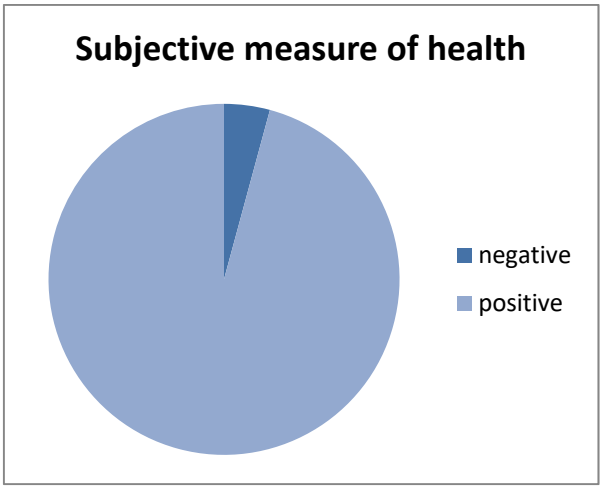


Figure 29 Subjective measure of health

Participants were also asked to self-report the amount of physical activity they under take on a regular basis (Figure 30 Frequency of exercise). A huge 77% reported that they undertake physical activity more than 3 times a week and 58% meet the current UK guidelines of daily physical activity. This is very positive as habitual physical activity has many benefits for general health and is a core goal of the Core Fit programme. While exercise intensity is unclear, it is certainly positive that the participants welcome increased physical activity.

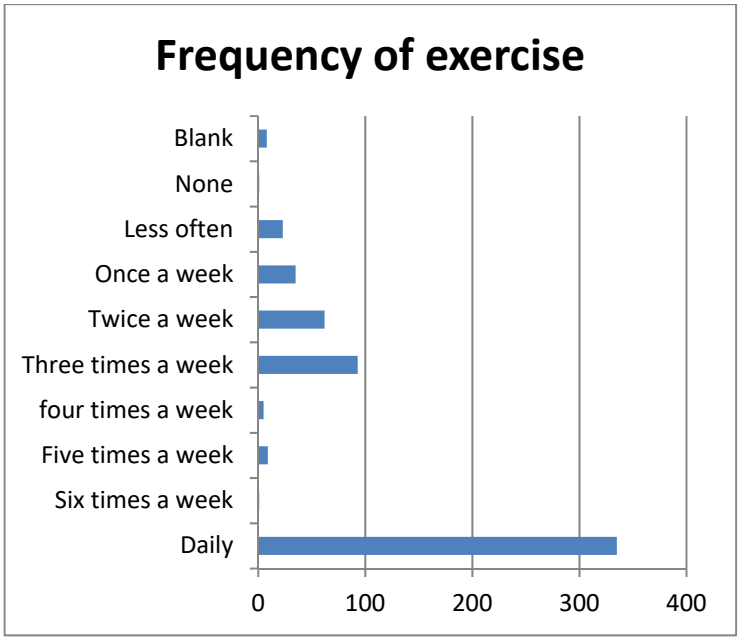
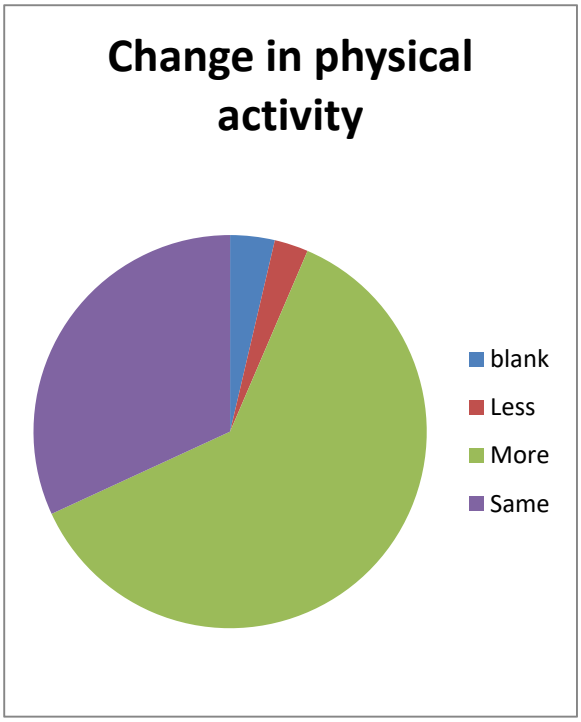


Figure 30 Frequency of exercise

When we now consider the change in physical activity undertaken (

Figure 28 Change in physical activity) we can see that the clear majority, some 62%, undertake more exercise than before the Core Fit programme.

It is worthy of note that for this question more blank responses were returned than any other question; more so than all other questions put together. This may have more to do with impulsivity in the young sample groups than any other factor as it was the last question to be answered.



A total of 58% of those who now undertook more exercise since participating in the Core Fit programme now did daily physical activity compared to those who do less exercise now where only 37% undertook daily exercise.

Figure 28 Change in physical activity

'When we consider the children, who undertook daily physical activity and consider their activity as part of a peer group, we have some variation but in the main a consistent census. This uniformity shows a moderating factor exerting external pressure on the children. With small sample sizes, it remains unclear as to the ability to reproduce this result.

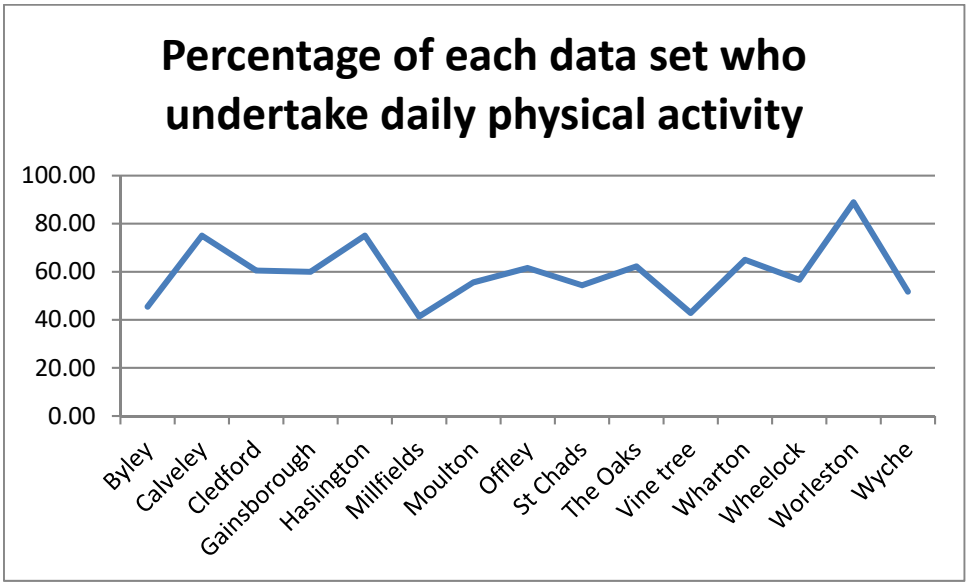


Figure 29 Percentage of each school who undertake daily exercise

If we revisit the change in physical activity data and consider each cohort's results we can see that consistently there is an increase in physical activity. We have a striking anomaly in this data set in that Byley as a cohort left this question blank.

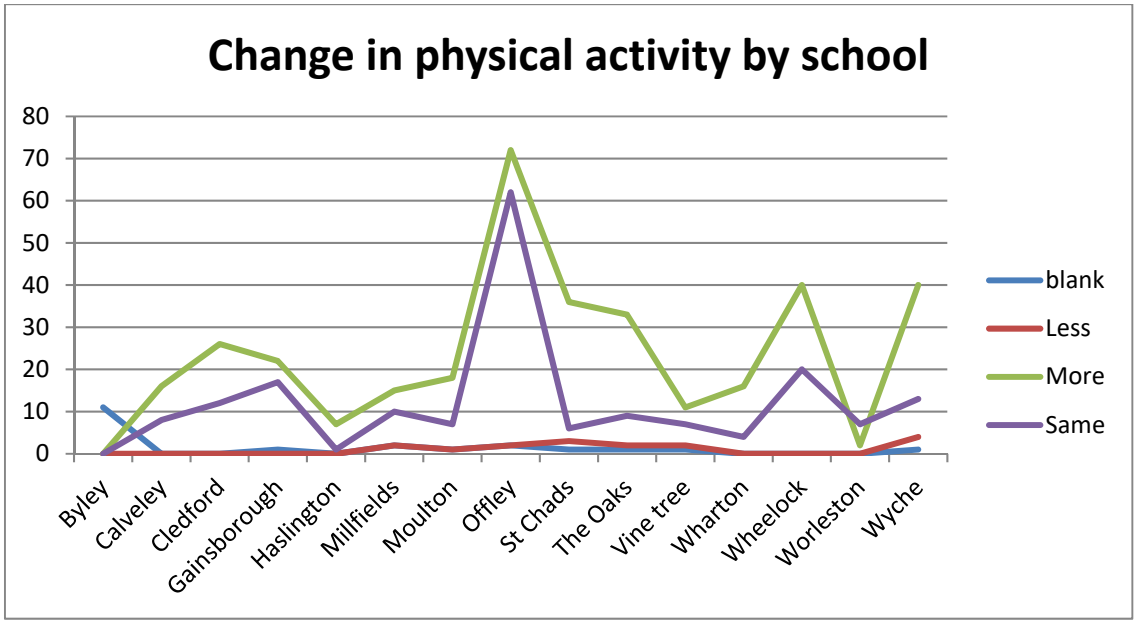


Figure 30 Change in physical activity by school

Physical assessments

Participants' performance of the exercises was measured during the initial session and again at the end. Not all groups were assessed in all exercises. Physical performance tests were carried out in 35 Core Fit groups, ran in 21 schools from across the Cheshire region. Results show that a greater percentage of the cohorts could correctly perform the exercise following the Core Fit programme Figure 31 Average percentage change before and after Core Fit.

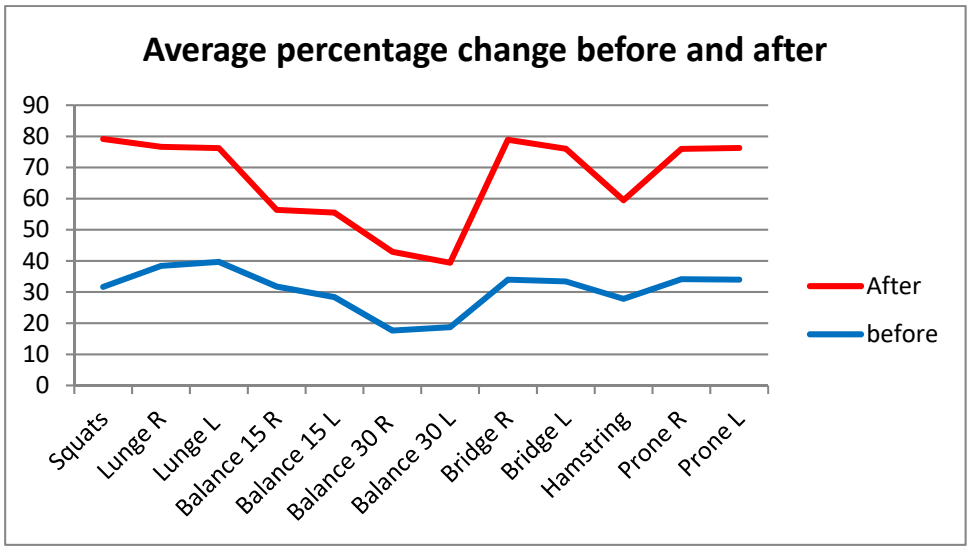


Figure 31 Average percentage change before and after Core Fit#

We can see that all activities show an increase in the percentage that were able to correctly perform the exercise (Figure 32 Average percentage performance change). We can further say that on average each exercise improved by 34%.

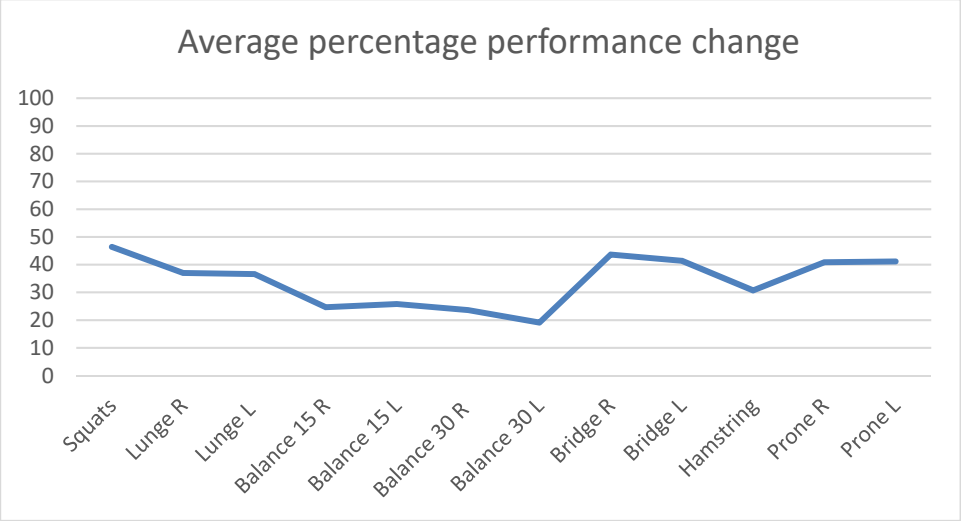
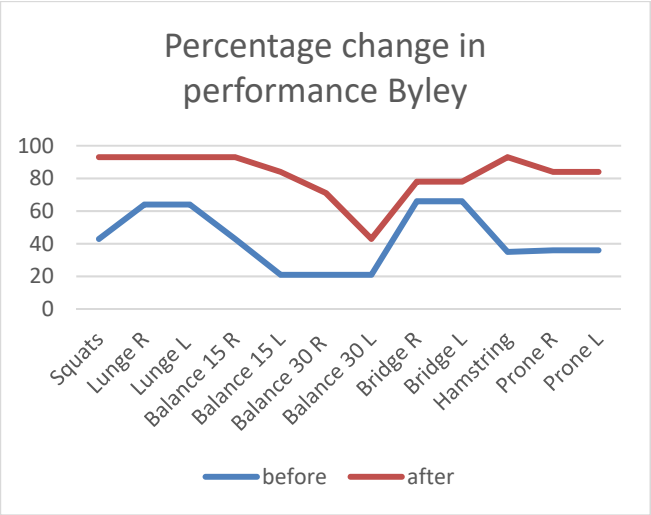


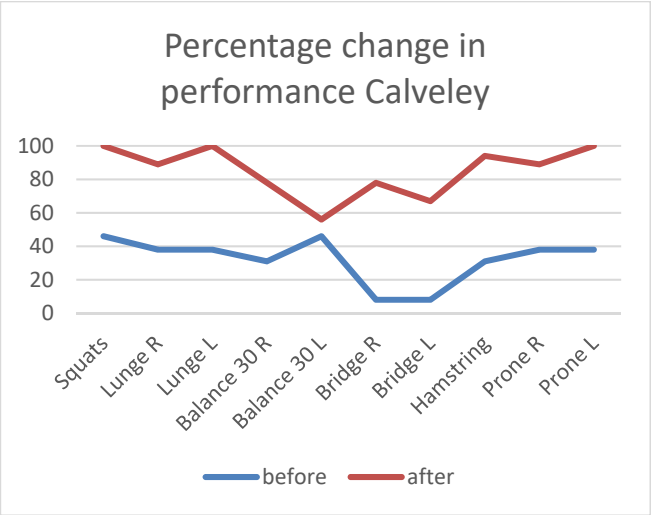
Figure 32 Average percentage performance change

Due to the nature of data recording, trends are difficult to spot across the programme for a specific exercise. What is clear is that there is an improvement in performance for a recorded exercise.



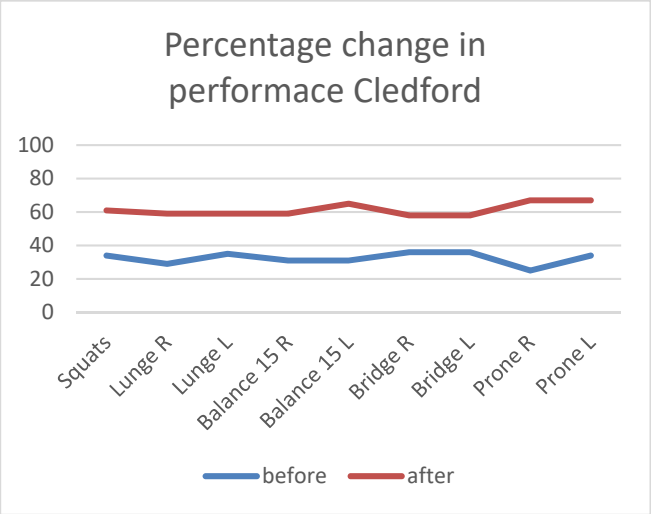
Byley is consistent in improvement with the exception of bridge.

With average improvement is 39%.



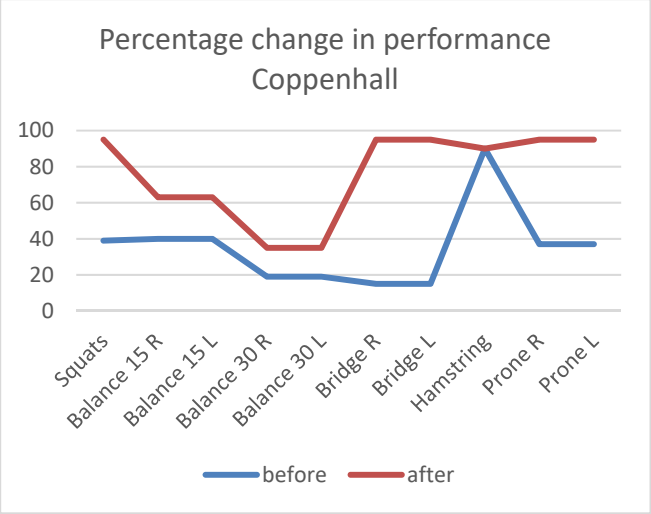
Calveley is consistent in improvement with the exception of balance.

With average improvement is 53%.



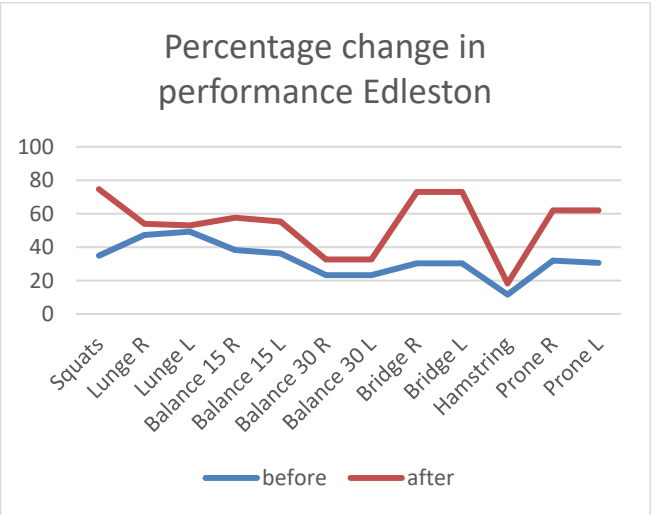
Cledford is consistent across all exercises measured.

With average improvement is 29%.



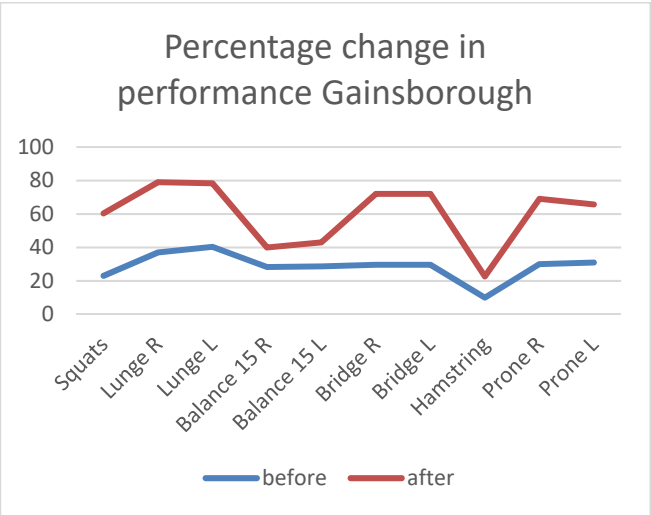
Coppenhall shows clear improvement particularly in bridge.

With average improvement is 32%.



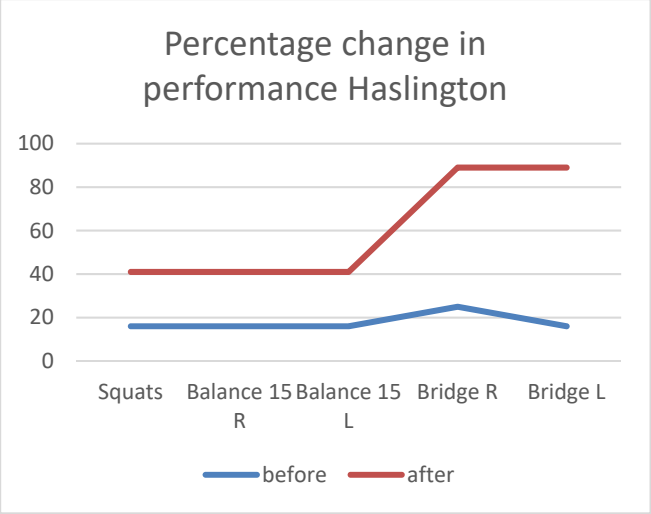
Edleston shows inconsistent improvement across the range of exercises.

With average improvement is 21%.



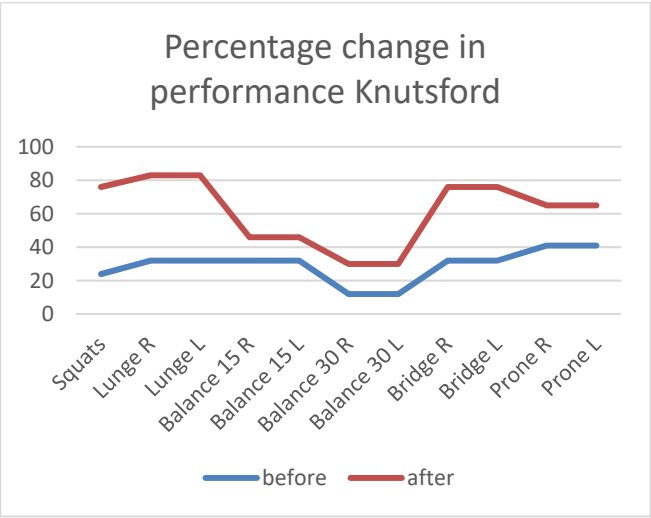
Gainsborough is consistent across all exercises measured.

With average improvement is 33%.



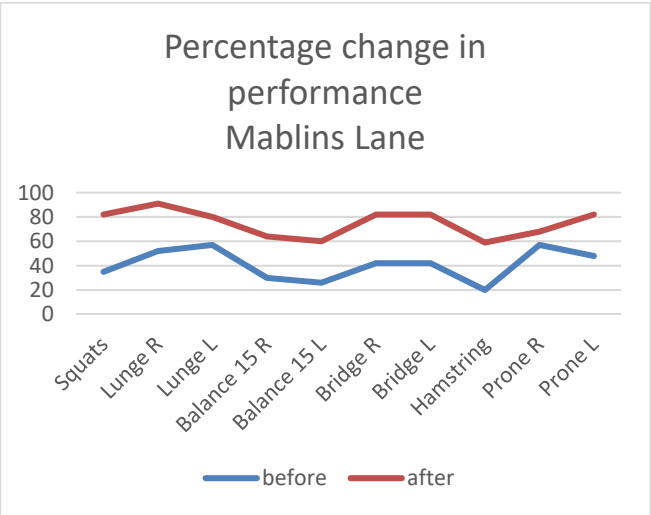
Haslington shows consistent improvement across the range of exercises, with marked increase in bridge. The lack of exercise is attributed to the special educational needs of participants.

With average improvement is 42%.



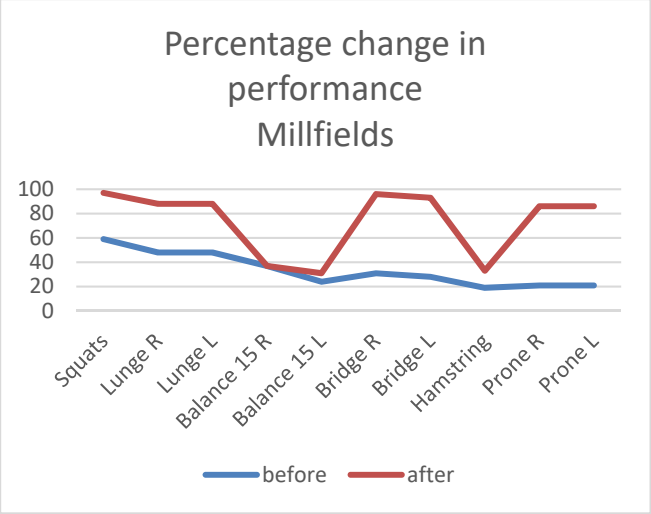
Knutsford shows improvement across the range of exercises.

With average improvement is 32%.



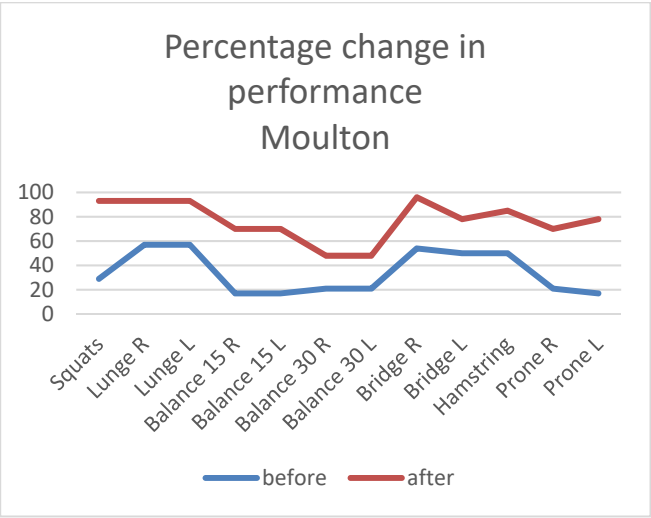
Mablins Lane shows inconsistent improvement across the range of exercises.

With average improvement is 34%.



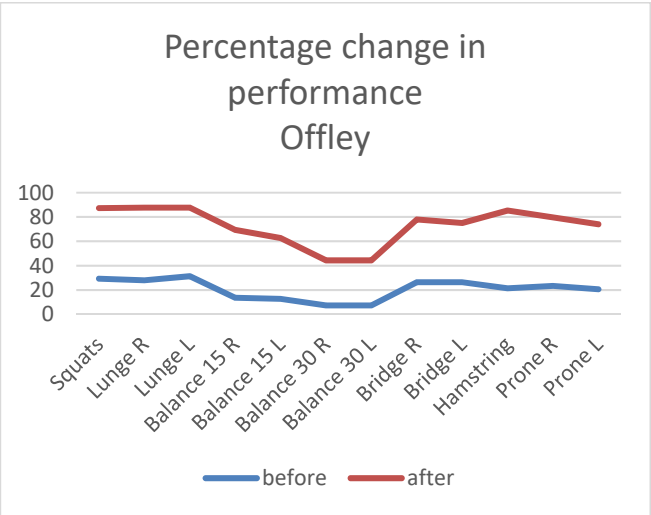
Millfields shows improvement across the range of exercises with the exception of the balance elements

With average improvement is 40%.



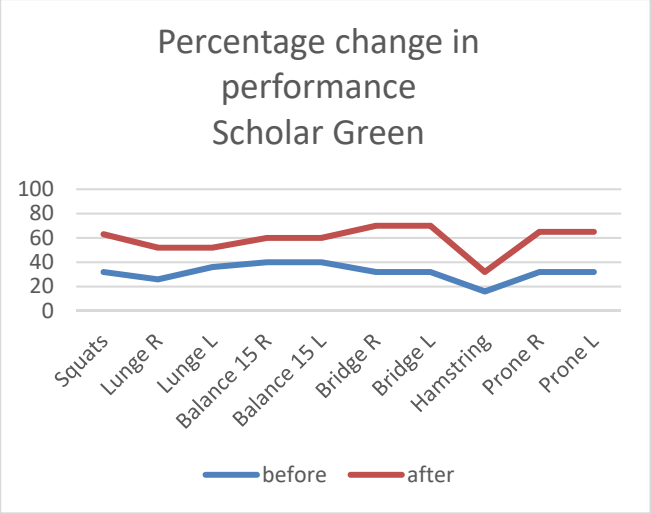
Moulton shows consistent improvement across the range of exercises.

With average improvement is 43%.



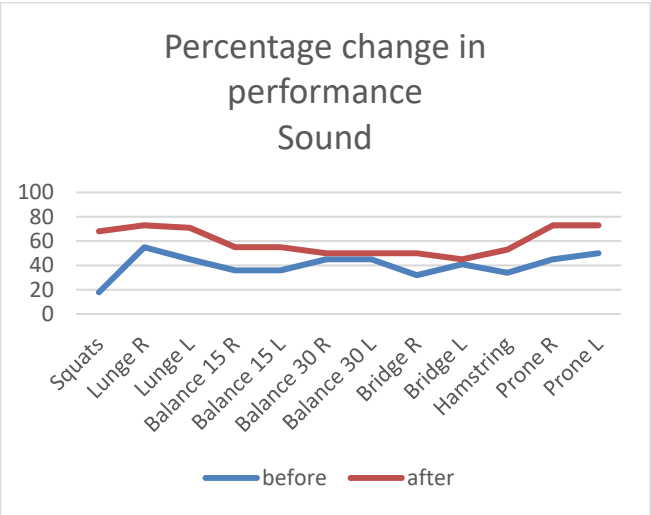
Offley shows consistent improvement across the range of exercises.

With average improvement is 52%.



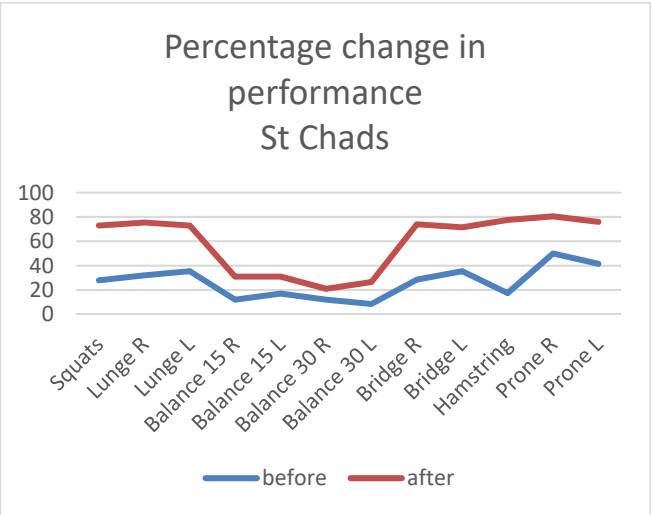
Scholar Green shows consistent improvement across the range of exercises.

With average improvement is 27%.



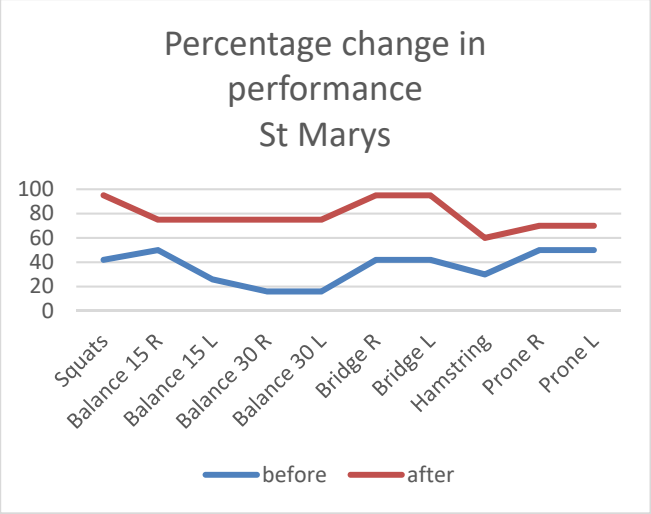
Sound shows consistent improvement across the range of exercises.

Sound shows the lowest increase of the cohort with average improvement is 20%.



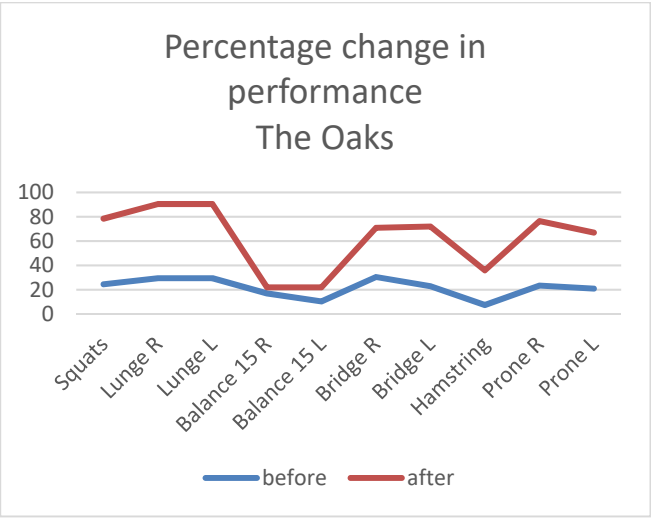
St Chads shows consistent improvement across the range of exercises.

With average improvement is 30%.



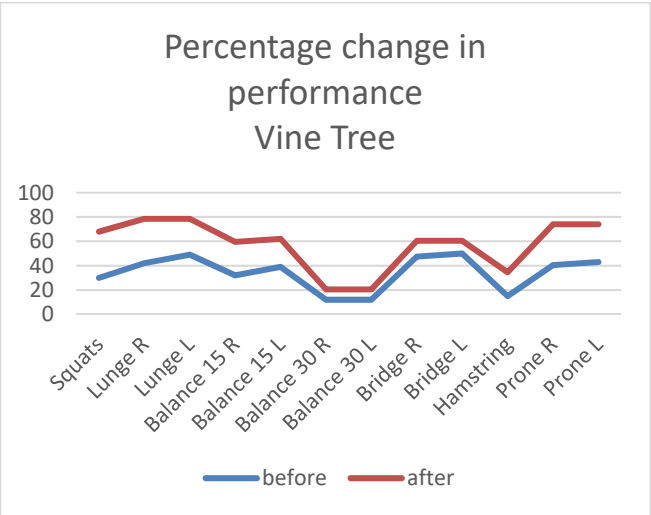
St Marys shows consistent improvement across the range of exercises.

With average improvement is 42%.



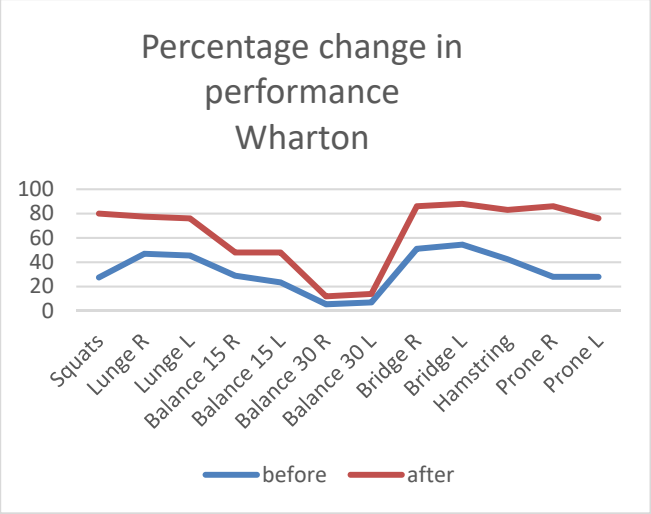
The Oaks shows improvement across the range of exercises. With Large improvements in Squats and Lunge

With average improvement is 41%.



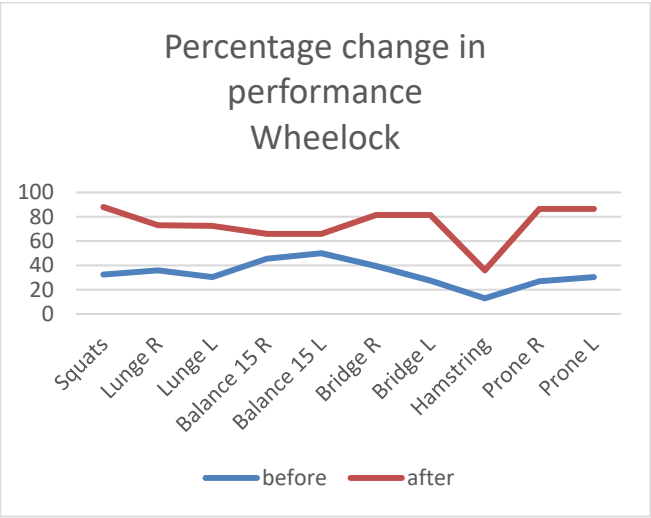
Vine Tree shows consistent improvement across the range of exercises.

With average improvement is 23%.



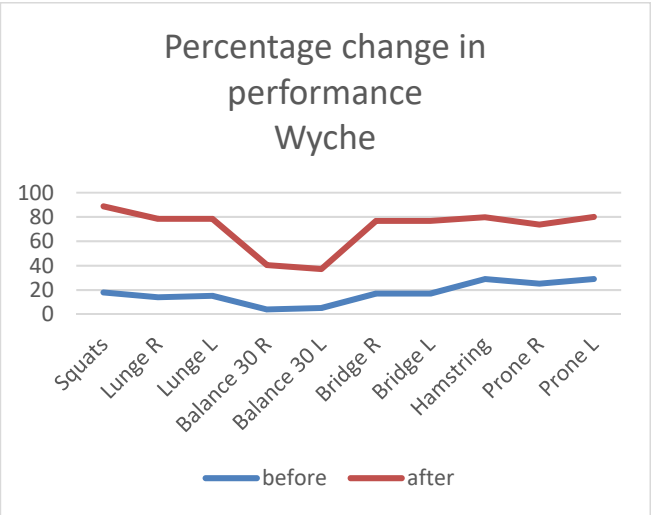
Wharton shows consistent improvement across the range of exercises with only a small improvement in Balance. This may be due to the lower starting point

With average improvement is 32%.



Wheelock shows consistent improvement across the range of exercises.

With average improvement is 41%.



Wyche shows consistent improvement across the range of exercises.

With average improvement is 31%.

With small sample sizes, trends are difficult to see, however, there does appear to be a correlation in terms of balance. If the starting point is low, then the increase in performance is modest. Larger data sets would be required to confirm this finding.

We can also see (Figure 33 Average change as an expression of whole) that the performance improvement is consistent across the range of exercises.

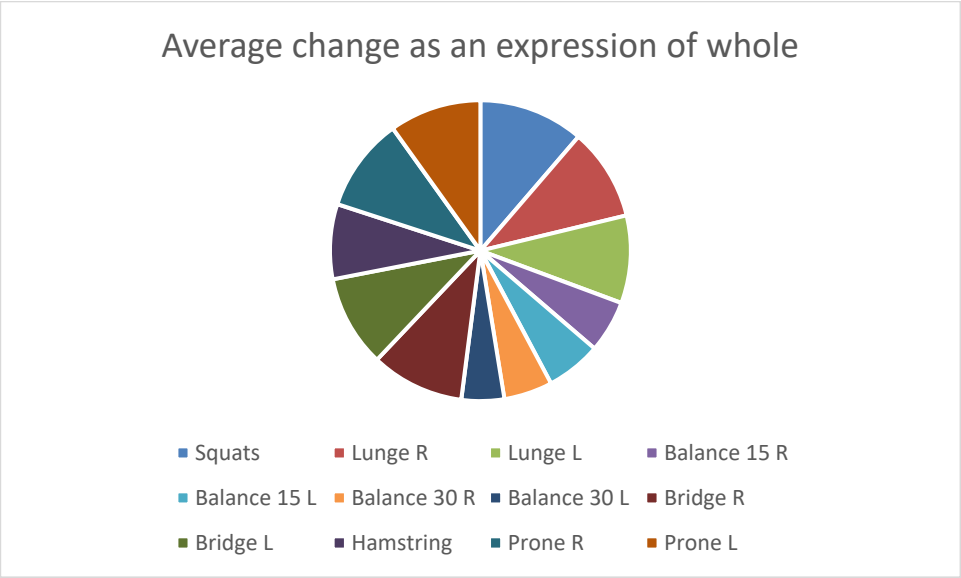


Figure 33 Average change as an expression of whole

Social Return on Investment (SROI)

Social Return on Investment is a measurement framework intended to assist organisations with placing a value on the social and economic outcomes they create. SROI is a framework for the monetisation of the value created by an organisation's activities and the contributions that made that outcome possible. It is also the story of the change affected from the organisation's activities, told from the point of view of the stakeholders. An SROI will encompass various outcomes capturing both social, economic and environmental factors that are derived from direct engagement with stakeholders who determine which outcomes are relevant.

In broad terms, there are two types of SROI:

- Evaluative SROI: conducted retrospectively and are based on outcomes that have already taken place.
- Forecast SROI: undertaken in order to predict how much social value will be created if given activities meet intended outcomes.

A forecast SROI can be useful at the planning stage of a project, while a retrospective evaluative SROI is particularly beneficial in identifying and evaluating unintended consequences.

SROI was developed from social accounting and cost benefit analysis, and shares commonality with other outcomes-based approaches. However, SROI is distinct from other approaches in that it places a monetary value on outcomes, so that they can be added up and compared with the investment made. The analysis allows a ratio of benefits to costs to be calculated, however, an SROI is much more than a simple figure and allows us to see the story of the change and to make decisions based upon the outcomes.

The SROI is a recommended tool by the Cabinet for the Third Sector and further information is available in their guidance *A guide to Social Return on Investment* (Nicholls *et al.*, 2009).

The SROI prudently, recognises that there will be in many cases, an ongoing cost of provision associated with the long-term gains as reported by stakeholders. However, it balances this investment with reported outcomes and the potential social return thus allows a basis for comparison of cost effectiveness.

Stakeholders

The SROI begins with the identification of stakeholders - the people/organisations/groups that will either have an input or an output in the programme. The following chart highlights all the identified stakeholders:

The purpose of the SROI is to evaluate the outcomes as an expression of the inputs. To this we examine the all inputs applied by all stake holders. As most of these stakeholders in the Core Fit Programme are affected by outcomes rather than inputs it is relatively clear that the two inputs are time from the participants, and money (for simplicity) from Core Fit. Having established the inputs, we now proceed to identifying the key thematic areas of change for each stakeholder.

Stakeholder	Thematic area
Participants	Increased physical activity
	Quality of life
	Balance/core strength/flexibility/posture
	Mental health
	Academic performance
	New Skills
	Delinquency rate
	Wellbeing
Core Fit Unique	Improved activity levels in children
Cheshire councils	Mental health
NHS England	Mental health
Police and crime	Delinquency rate
DfE/school	Academic performance

From this we can now map the both the intended and unintended changes. As with many social intervention programmes, the changes can, and indeed, do impact in multiple areas.

For example, as discussed above, participants' increased wellbeing will lead to a reduction in the delinquent behaviour of the participants. Whilst this is of significant merit in terms of the police and crime, it is also a significant impact for participants. Therefore, multiple changes can, and does, impact upon multiple stakeholders; in this case the change is only used once to prevent double counting. Double counting is avoided by examining the outputs and attributing the change to the stakeholder that is impacted to the largest extent. Change is drawn from the evidence presented as discussed elsewhere in this report.

Stakeholder	Thematic	Change
Participants	Increased physical activity	Lower BMI
		Improved Life expectancy
		less GP visits
		Reduced risk of Metabolic syndrome
	Quality of life	Improved quality of life
	Balance/core strength/flexibility/posture	Increased knowledge
	Mental health	Reduced anxiety
		Reduced depression
		Increased life expectancy
		Reduced self-harm
	Academic performance	Improved behaviour
		Increased attainment
	New Skills	New exercise skills
		Lifestyle skills (metabolic based)
	Delinquency rate	Reduced delinquency
	Wellbeing	Independent thought
		Increased confidence
		Increased happiness
		Optimistic
		Relaxed
Core Fit Unique	Improved activity levels in children	Meet aims and objectives
Cheshire councils	Mental health	As above
NHS England	Mental health	As Above
Police and crime	Delinquency rate	As Above
DfE/school	Academic performance	As Above

Proxy values

For the purposes of this analysis, which has been undertaken at an individual and not population level, the measures that it has been possible to apply to NHS cost savings are those that are able to be strictly evidenced and monetised. This in no way represents the real value or cost savings that are being achieved through the programme. So, for each of our changes we have identified likely proxies.

Stakeholder	Thematic	Change	Proxy
Participants	Increased physical activity	Lower BMI	Obesity cost to NHS per year
		Improved Life expectancy	Premature mortality costs (particularly related to mental health)
		less GP visits	Cost of routine GP visit
		Reduced risk of Metabolic syndrome	hospital admissions/visits diabetes detection (routine)
	Quality of life	Improved quality of life	Life satisfaction
	Balance/core strength/flexibility/posture	Increased knowledge	Replace knowledge
	Mental health	Reduced anxiety	NHS reference cost first contact
		Reduced depression	NHS reference cost first contact
		Increased life expectancy	Accounted for above
		Reduced self-harm	NHS reference cost first contact
	Academic performance	Improved behaviour	Cost of antisocial behaviour
		Increased attainment	Life increase in one minor increase in life time attainment.
	New Skills	Lifestyle skills	Replacement course
		Exercise skills	Replacement course
	Delinquency rate	Reduced	Cost of delinquency
	Wellbeing	Independent thought	functional independence
		Increased confidence	Increased confidence
		Increased happiness	cost of wellbeing course
		Optimistic	Cost of Positive Psychology short course, module Hope, Optimism and Resilience
		Relaxed	cost of spa day
Core fit unique	Improved activity levels in children	Meet aims and objectives	

Cheshire councils	Mental health	As above
NHS England	Mental health	As Above
Police and crime	Delinquency rate	As Above
DfE/school	Academic performance	As Above

In some instances, the cost can be captured completely by the proxy. For example, the average cost of a GP appointment in the UK is £36 and in terms of saving appointments this can be considered an absolute. In other circumstances such as the evidenced benefits in terms of reduced anxiety, a likely proxy would be an initiation appointment with Child and Adolescent Mental Health Services.

To assess how much influence this has had on the final value that has been calculated a sensitivity analysis is carried out and the results recorded. By doing this the value of the benefits can be expressed within defined limits.

It is necessary to discount the values generated by each of the financial proxies to account for deadweight, displacement, attribution and drop-off. This is conducted by applying a number of sensitivity variations.

Proxy	Value of proxy (£)	Quantity (no)	Value (£)
Obesity cost to NHS per year	304.87	870	33,164.80
Premature mortality costs (particularly related to mental health)	1305.05	650	105,998.98
Cost of routine GP Visit	36	795	3,577.95
Hospital admissions/visits diabetes detection (routine)	1569.8	870	170,0659.41
Life satisfaction	499.38	1500	93,633.75
Replace knowledge	35.99	795	3,576.96
NHS reference cost first contact	162.85	650	26,454.06
NHS reference cost first contact	251.78	650	40,900.23
NHS reference cost first contact	162.85	234	9,520.74
Cost of antisocial behaviour	230	1500	43,125.00
Life increase in one minor increase in	6000	1500	1,125,000.00

life time attainment.			
Replacement course	18.75	1500	3,515.63
Replacement course	7,057.01	1500	1,323,198.38
Cost of delinquency	8,000	316	315,701.56
Functional independence	1,400	489	85,648.66
Increased confidence	2,625	474	155,658.41
Cost of wellbeing course	800	428	42,761.69
Cost of Positive Psychology Short Course, module Hope, Optimism and Resilience	195	449	10,952.46
Cost of spa day	1680	473	99,270.60

Sensitivity

Various assumptions have been made in the course of preparing this analysis and the detailed tables of calculations below demonstrate the areas of sensitivity, briefly the reasoning for the sensitivity and the adjustment made.

Sensitivity	Description	Reason	Adjustment
Deadweight	What would have happened without the activity?	Sample size and impact level	50%
Displacement	What activity did you displace?	Retention and impact based on responses	50%
Attribution	Who else contributed to the change?	Large area of impact multiple vectors	50%
Drop off	Does the outcome drop off in future years?	Absence of longitudinal data	100%

To the greatest extent possible, assumptions have been validated through case study evidence and literature comparison. However, for some estimates, assumptions have been made during the review, and some relate to the interpretation of information arising from other research work and statistical analysis referenced in this work. In order to assess the extent to which these assumptions are material, potentially key assumptions have been identified. Each has been subject to variation within what appears to be a reasonable range, and the effect on the total valued outcomes under the study has been recast. The sensitivities include adjustments due to the demonstrable success rate for interventions, rather than adjusting numerous individual assumptions within the profiles, this analysis considers the impact of interventions across multiple measures.

Deadweight

Deadweight is the measure of how much of the outcome would have occurred in the absence of the intervention. Deadweight of 50% has been assumed by considering that if the programme had not been in existence a number of individuals might have increased their physical activity of their own or due to other influences. In terms of the wellbeing aspects, again deadweight of 50% has been applied to reflect the fact that a multitude of other factors could be impacting upon the impact reported by Core Fit participants. As the there is a degree of certainty about the levels of deadweight that have been applied to these outcomes, further data on the longer-term impacts and wider data collection of mitigating factors would help refine deadweight. For example, a study compared with a control group would enable us to refine the level of impact on wellbeing.

Displacement

Displacement applies when one outcome is achieved but at the expense of another outcome, or another stakeholder is adversely affected. In relation to this programme, displacement could have arisen as a result of participants ceasing to take part in another activity or at the expense of another area of the curriculum. In terms of the impact beyond the intervention it is extremely difficult to quantify the displacement with the available data. A pragmatic approach has been taken in the case of the majority of outcomes. To this end, a displacement sensitivity of 50% has been applied to most outcomes.

Attribution

The recorded changes might have occurred regardless of the activity; other factors might have contributed to the changes or another activity might have affected the Core Fit outcomes. In considering the extent to which other factors have affected these, it is important to be pragmatic about the benefits provided by the activity. Particularly in the case of the Core Fit programme outcomes related to wellbeing, and given that there are so many potential other influences, it is necessary to recognise that the value Core Fit creates may also be affected by other factors. To that end, this SROI methodology takes this into account when calculating the SROI. In relation to specific physical activity-related outcomes, attribution has been calculated by considering two factors. As part of the programme, all individuals were asked to identify the amount of time spent each week taking part in physical activities and the nature of those activities. There was a wide range in variation of participants' reported levels of physical activity, but this allowed us to set the attribution sensitivity for related outcomes at 50%. In regard to the wellbeing outcomes it is significantly more

challenging to examine all the impacts on participant wellbeing, and this was assessed on an individual outcome basis.

Duration and drop-off

It is clear that some outcomes will last longer than others and may also be dependent on whether the activity is continuing or not. The health benefits of walking, for example, will endure for a very limited time if physical activity ceases. Considering this, the duration of impact was set at a year, even though most wellbeing gains formed will last much longer. However, in the absence of longitudinal data for the Core Fit programme, this analysis has set all durations at the one-year point. Consideration has also been given to Hillsdon *et al.*, (2012) who reported there is evidence that referral to an exercise programme works and has effect if the programme lasts but is dependent on long-term support. Outcomes which will continue to have a value in future years cannot be expected to maintain the same level of value for each continuing year. Further study would allow examination of the longer-term benefits and would likely increase duration of impact for the Core fit programme, however, this is outside the scope of this report.

Limitations

Within this SROI there are multiple changes and outcomes identified for multiple stakeholders; however, each has only been afforded one cost measure to avoid the possibility of duplicate entry. As already identified, this study does not contain any longitudinal data and all changes have been evaluated as benefiting during the programme.

In calculating the SROI for the Core Fit programme, it has been necessary to make certain assumptions or to use data which is not subject to universal agreement. This project is preventative in nature and therefore it is extremely difficult to measure all the outcomes. This SROI has only included what can be measured. There are additional subjective outcomes as per the experience section as well as long-term outcomes which could be included in the next SROI report.

Materiality considerations

At all stages of the SROI process, judgements are made to understand and translate information. In some cases, the information is clear and little explanation is needed while others require additional information. The SROI methodology requires complete clarity and transparency in approach in order to eliminate misinterpretation. By applying concepts of materiality explanation is offered for interpretation of information.

SROI Conclusion

The Core Fit programme delivers change across a range of areas, with further evidence and data capture particularly of a longitudinal nature the SROI would be significantly different. From the information supplied by the participants, the responses from stakeholders the SROI evaluation has found that for every **£1 invested into Core Fit, a value of £33.57** is created. It is recognised that regular physical activity has a significant impact on the length and quality of life. Physical activity can improve health and increase mortality. In the scope of this analysis it has not been possible to measure and value of the long-term health benefits of Core Fit which are experienced over a period of years.

Quality adjusted life-years

Quality adjusted life-years (QALY) are a way of measuring both the quality and quantity of life. QALY is a way to account life expectancy and the quality of life that will be experienced during these years. Quality of life encompasses a range of factors, and is not simply condition based. There a variety of ways in which it can be measured and the recommended approach is EQ-5D19Y (specifically developed for use in children) (Euroqol, 2017). This allows individuals to describe their experiences in relation to defined dimensions of health which include: mobility; ability to live independently; capacity to enjoy a 'normal' life; degree of pain and discomfort; and, anxiety and depression.

These principles are applied to measure the quality of life or state of health. One year of perfect health equates to one QALY whereas a year of life in a health state which scores only half of the value established for perfect health will be the equivalent of 0.5 QALs. The approach is used to express the benefits gained from different interventions in a 'standardised' way and is used extensively to allocate resources.

In the case of the Core Fit programme, it is unclear without further evaluation what its impact upon QALY is. However, Sun *et al.* (2014) concluded in their evaluation, that a significant graded relationship between greater physical activity level and higher QALY was evident. Relative to the 'inactive' group, median QALY over two years were significantly higher for the 'meeting guidelines' (0.112, 95% CI: 0.067–0.157) and 'insufficiently active' (0.058, 95% CI: 0.028–0.088) groups, controlling for socioeconomic and health factors. The authors further demonstrate that moving someone from an inactive to active group resulted in a saving of greater than £2000 over two years' terms of QALY, clearly suggesting that in the case of Core Fit with a 58% increase in participants' physical activity, the return on this alone is greater than the initial investment made in the Core Fit programme. Our analysis supports further evaluation in a larger sample population to properly determine the impacts of the programme on QALY.

If everyone in England was sufficiently active, then every year this would prevent:

- 36,815 deaths from all causes
- 12,061 emergency hospital admissions for coronary heart disease
- 6,735 breast cancer cases
- 4,719 colorectal cancer cases
- 294,730 people living with diabetes

(Lee *et al.*, 2012)

Health Economic Assessment Tool (HEAT).

The Health Economic Assessment Tool (HEAT) is designed and validated by the World Health Organisation (Kahlmeier *et al.*, 2014). The tool was developed to address a perceived deficit and designed to enable economic assessment of the health benefits of walking or cycling by estimating the value of reduced mortality that results from specified amounts of walking or cycling. In the case of Core Fit, the HEAT tool could be used based on this being a lower impact monitoring tool and may produce similar relevant costs.

Physical activity has beneficial effects on many aspects of morbidity as discussed earlier in this report. From a public health point of view, these benefits materialise more rapidly than reductions in mortality. As we have seen, the current evidence on morbidity, particularly for walking and for cycling, is more limited than that on mortality.

Including the impact of morbidity in an economic appraisal leads to greater uncertainty, and therefore, WHO recommends that for the time being, focus should only be on all-cause mortality for HEAT for walking and for cycling. It should be noted that this method is likely to produce conservative estimates, since it does not account for disease-related benefits. The distinction between walking and cycling being one of intensity, also of note, is that data used to validate the tool is drawn from adults and as such extrapolation for the participants' age group has a degree of variance. This is largely based on the lack of evidence base for the chronic health effects of physical activity on young people. HEAT is not a recommended tool for this population due to these limitations.

If we use the data discussed above that physical activity has increased in 61% of Core Fit participants, and at the recommended minimal guideline levels, using HEAT, mortality reduction for this population could be as great as four per cent. While this is promising, as discussed, the limitations of both the data and the tool mean this can only be taken as a discussion point and has not been included in any cost benefit analysis. There is however, scope to incorporate this as a future area of study.

Discussion

We postulate from our findings that the Core Fit programme, as described in this evaluation, has demonstrated a far-reaching radical impact on physical health and mental wellbeing in children. The key and novel finding of this study was the large effect a physical intervention has upon the wellbeing of participants; by all comparisons a three-point increase in such a small cohort is vast.

Following a full review of the literature many key themes can be drawn, including:

- The majority of interventions resulted in some improvements in knowledge and attitudes related to physical activity in children.
- The impact and outcomes of interventions on physical activity levels varies considerably between studies. Many of these, particularly those focused on primary school-age children, demonstrate some success in increasing physical activity modified physical education classes. Some studies also showed increases in out-of-school physical activity.
- School-based physical education appears to be effective in increasing levels of physical activity and improving physical fitness.
- School-based interventions that target physical education classes can positively impact physical activity levels in children.
- Interventions that revolve around physical activity provide the strongest evidence of influencing these behaviours.

Our study has demonstrated a contrary trend to most studies in that it demonstrates a marked improvement in knowledge and attitudes to physical exercise in children with an increased uptake of some form of physical activity which clearly impacts on the influencing of other behaviours and self-belief. This Core Fit study uniquely shows consistent performance indicators and success is universal in all types of child and backgrounds, but most markedly in troubled families children we saw the greatest success.

The Core Fit study suggests that with core strengthening, carried out in the correct way, the impacts on individuals is wide ranging. While schools typically work on PE, gym work and sports, there are little targeted core strengthening work. This research and the literature shows that there are both emotional and physical benefits of such work, and the fun element of the Core Fit programme ensures that all participants are engaged and enthused. The Core Fit programme empowers self-esteem and belief in children. Self-esteem, one feature of wellbeing, is often highly resistant to change, and that most programmes designed to raise self-esteem fail (Swann, 1996). This desire to have high self-esteem is associated with self-enhancement bias (Sedikides and Gregg, 2008) meaning that people see themselves more positively than they actually are. As evidenced by WEMWBS results, participants reporting improvements in feeling better about themselves and thus they exhibit greater self-esteem.

Further research has shown that most people think have a distorted view of themselves that is often more generous in terms of their own character, e.g. they are funnier, more logical, more popular, better looking, nicer, more trustworthy, wiser and more intelligent than other people (Preuss and Alicke, 2009). Individuals with high self-esteem experience more happiness, optimism,

and motivation than those with low self-esteem, as well as less depression, anxiety, and negative mood (Pyszczynski *et al.*, 2004).

There is a note of caution sounded by Stone et al (1998) and Lister-Sharp (1999), both of whom warn that studies based on self-reported measures may be subject to bias and problems with recall. Stone et al (1998) also note that the collection of school studies is limited for several age groups and that special attention is needed with respect to programmes targeted at girls in particular (Whitehead, 1995). Future programmes could consider the differing groups within the cohorts such as gender. In line with the current guidance more effort and focus needs to be directed at the main learning aims than simply at fitness, and Core Fit appears to fulfil this niche. Core strength makes one feel positive about oneself. Feeling physically fit and strong translates into feeling positive about our bodies which in turn has an impact upon mental wellbeing. Participants' wellbeing is significantly higher post activity and further work is needed to evidence the increase in physical fitness and would further be beneficial in also establishing the fitness benefits of the programme.

Overall, participants performed all exercises to the required standard, although they did find balance work the most difficult, suggesting this is mainly left out of mainstream PE and sports in schools, and an obvious key area for future development. Core strength and feeling physically fit and strong translates into feeling positive about our bodies which in turn has a positive impact upon mental wellbeing. Participants' wellbeing is significantly higher post activity and further work is needed to evidence the increase in physical fitness and would further be beneficial in also establishing the fitness benefits of the programme.

In achieving lifelong fitness, many factors can act as impedance or indeed an inducement:

- Geographical limitations: the availability of a specific activity is strongly determined by geographical conditions, for example those living in an urban environment are going to struggle partaking in regular mountain climbing. Similarly, those who enjoy open air swimming are going to need a lake. Some of these issues can be overcome with special provision or with modern technology. To continue the example virtual technology could be used to recreate the hill walking experience or an open-air swimming pool could recreate the lake.
- Socio-economical limitations: the economic conditions of participants can represent a strong limiting factor to many self-organised activities as these are often related to relatively prohibitive costs. This is not just an issue for individuals but also nations, in these times of austerity pressure on budgets providing resources may not be the top priority. Thankfully, in the UK at least, prevention is a key priority. This restriction in resources at all levels might mean that some activities are only open to those with relatively disposable incomes.
- Cultural limitations: access to self-organised activities also depends partly on awareness of the value of physical activity for body and mind. Other activities may be culturally frowned upon. Steps may need to be taken to modify or adapt provision. For example, the segregation of male and female participants.

Anecdotal evidence of the Core Fit programme shows that participants also reported raised levels of confidence which instilled positive behaviour and inspired them to take free and easily accessible forms of fitness outside of the class. The sessions supported them to improve their strength emotionally and physically independently and in some cases engaging other members of the family to work with them. This also anecdotally carried forward into other areas of the participants' development and school life.

In line with the national curriculum (DfEd, 2013) the Core Fit Programme aims to ensure that all pupils:

- Develop competence to excel in a broad range of physical activities
- Are physically active for sustained periods of time
- Engage in competitive sports and activities
- Lead healthy, active lives.

With national guidelines suggesting regular daily activity, should Core Fit be part of the daily school life? Indeed, the Core Fit programme could be used to satisfy the National Curriculum target to develop flexibility, strength, technique, control and balance (DfEd, 2013). What benefits can be derived from the introduction of a daily programme? One study (Müller *et al.*, 2016) found that by increasing school-based exercise units, children maintained a lower BMI over a four-year period. This has the potential to reduce and event prevent many chronic health conditions in later life, along with reducing incidence of mental health and decreasing an expected burden on health services in dealing with the consequences of such illness.

The SROI conducted in this evaluation of Core Fit delivered in schoolchildren found that the programme was cost-effective, returning £33.57 for everyone pound invested. This evaluation has not included assessment of QALYs or used the HEAT economic tools, however, there is merit in these being used in further research to understand more fully the enormous impact the programme has on participants.

Strengths and limitations

This report would not be complete without considering the limitations of the programme. Chiefly, the small sample sizes involved, combined with some gaps in data make comparison difficult particularly in the performance assessments. The Core Fit programme is centred on equipping key knowledge in participants to continue the training and advice on their own: longitudinal studies would be an opportunity to evidence this anticipated finding. The core themes of balance, core strength, flexibility and posture are centric to the development of the programme and the information is readily retained as is evidenced by the post programme questionnaire.

Having children complete the self-judgment WEMWBS gave some particularly insightful responses. While the tool has not been validated in this age group, participants were able to easily understand and record their answers accordingly. In addition, the open-ended nature of the interview questions

for the post questionnaire survey meant participants were able to raise issues that were salient to them and not previously considered by the researchers.

The sample, however, was relatively small compared to national numbers and drawn from a single county. No account was taken of the socioeconomic nature of the area and when compared to the UK average the region is statistically more financially fluid than most. In addition, due to small cohort sizes there was little analysis in comparisons between schools. However, Core Fit did attend more affluent rural-based primary schools, but also specialist behavioural schools, and inner-city equivalent primary schools in Crewe - the social inequality of these schools in Crewe were reflective off the worst levels of deprivation, social injustice and troubled families in the area. Therefore, despite sample sizes, the best results came from the troubled family children and this postulates an interesting outcome that should be discussed and evaluated and evidenced further.

Similarly, as we do not have data on a control group and as such we are not able to draw conclusions verse the general population. Thus, further work is needed to establish the generalizability of findings and to explore, for example, the gender gap.

The unique delivery and a great strength of the Core Fit programme is in bringing enjoyment into everyday physical activity leading to enhanced impacts, mainly affecting positive wellbeing. It is maybe this enjoyment that is allowing participants to improve their levels of confidence which also supports increased wellbeing.

Conclusions

The Core Fit programme offers an insight into the impact of positively-structured core strength exercise working on the correct technique, along with instilling positive attitudes towards exercise and themselves, and ultimately core strength should be a part of the daily curriculum and structure for the child's future.

In any assessment of the responsiveness to habitual exercise in a health context, there is a wide range of issues that need to be addressed to provide science-based recommendations for use in evidence-informed health care delivery. Issues regarding responsiveness include characteristics of the exercise regimen or dose as well as characteristics of the response or effect.

In addition to the improved physical fitness, increased physical activity has been proven to improve mental health, wellbeing and even social/economic outcomes. The effort required for such an improvement goes beyond the individuals themselves to involve also their family, school and community. With the need to target children in the habit-forming years, schools provide a favourable setting for performing vigorous physical activity. Core Fit empowers participants in some cases, to challenge the family positively to engage in activity.

Physical activity during childhood and adolescence is thought to positively affect many factors related to the risk for chronic disease later in life. While conclusive evidence is still lacking, potential benefits have been observed in some short-term cross-sectional studies and in controlled interventions involving children engaged in specific physical training programmes. There is also evidence, in some cases, to suggest that these benefits track into adulthood, thereby reducing chronic disease morbidity and mortality. Potential health benefits of physical activity include reduced risks of obesity, cardiovascular disease, diabetes and osteoporosis. Physical activity may also result in enhanced academic performance and psychosocial benefits.

As well as fitness, children need to be able to recall the underpinning knowledge that not only is physical activity importance, but they need understand their own capabilities and the need for good movement throughout their life course to prevent injury and back pain.

In terms of overall benefit of regular physical activity, as we have highlighted, that poor health and wellbeing currently account for 46.6 million lost sick days in the UK in 2016. While not longitudinally explored, it is clear that an increased wellbeing reduces sick days (Mytton, Panter and Ogilvie, 2016), thus Core Fit has the potential to reduce the number of sick days for participants in future years.

The SROI conducted as part of this evaluation also supports the cost effectiveness of the programme, returning £33 for every £1 input in the programme. This further adds weight to the wider impact of the programme and supports the holistic effect of the programme on individuals.

Recommendations

The Core Fit programme suggests that all children require correctly taught core strengthening. We recommend core enhancing activity should be offered in all primary and secondary schools. This will allow continuity of enhanced physical and mental wellbeing, creating positive impacts that resonate but in school and their future life.

Core Fit is not the silver bullet to society's problems, however, core strengthening and resilience training does have significant impact on the mental and physical attitudes of the younger generation. This evaluation has assessed the radical approach used by the Core Fit programme using a range of mixed methods. Through detailed examination of the available literature and in-depth analysis of the Core Fit programme, the multiple benefits that regular physical activity confers to children has been explored. In addition, it examines methods to assess or measure physical activity levels in schools, both subjectively and objectively while considering the impact economically, socially and environmentally. Based on this comprehensive synthesis of relevant literature and the research conducted, the following recommendations have emerged:

1. Development of self-reporting instruments to be used to assess physical activity as a component of the data collection. These types of instruments represent a straightforward, cost-effective means of gathering reliable and valid information on the physical activity levels of children and youth in school and, depending on the instrument, outside of school as well. Core Fit has found WEMWBS to be particularly useful.
2. All schools should introduce core strengthening techniques which are taught correctly and reinforced on a regular basis.
3. Self-reported and objective measures should be used in combination to optimise and enrich the quality of the data. Positive comments independently from children should be taken into account as some of the children's comments indicated life transformation.
4. Strategies should be developed to better evaluate and disseminate promising practices in school-based physical activity interventions.

Physical activity is a pattern of complex behaviour that is influenced by multiple parameters. Many of these can be influenced and can indeed change. Core Fit was able to achieve this, however, given that the programme was developed and based around physiotherapy and counselling techniques, if similar work is replicated, it should follow the same guidelines as non-structured exercise can be damaging. There is also acknowledged that change may also be required not only at the governmental, schooling and individual levels, however, more efforts need to be made on a cultural scale if children are to achieve the current recommendations for physical activity and to achieve their potential both emotionally and physically.

As physical education is a required part of the curriculum, offering fun, healthy and appealing physical activity in schools will create an interest that is not always evident in typical sports and gym sessions. It is therefore important to evaluate whether increased and/or improved physical education may result in improved health and health behaviour among children and young people. Not only is Core Fit positively increasing the amount of physical activity in participants, it is improving health outcomes though targeted education which is having a significant impact on the wellbeing of participants. Core strengthening delivers positive mental attitude Interventions.

Next Steps

The initial findings suggest that the proposition of Core Fit needs to be expanded to greater numbers of participants in larger cohorts and with wider geographical scope. These initial findings would suggest that there is merit in the Core Fit programme, however due to the limited cohort sizes and relatively small sample sizes, further study in a wide and more diverse group is required. There is merit in exploring in greater details the Core Fit effect on wellbeing as well observing this longitudinally. It would also be beneficial to study a control group to compare impacts of this group with one experiencing only typical school-based physical education.

There may be other groups that could significantly benefit from the Core Fit Programme; research to date is focused on primary school children. With the enormous potential to impact on wellbeing and its link to health there is merit exploring the possibilities in other groups, including secondary and high schools.

Interest in school-based physical activity interventions is currently high profile, in large part due to the trend towards physical inactivity, and reducing obesity in children. There is a great deal of research being conducted globally which evidences the variety of school-based physical activity and health promotion interventions. Ultimately, these research activities will allow promising and best practices for promoting physical activity in schools to be elucidated. Despite the limitations, clearly the benefits of the Core Fit programme are apparent, and the wellbeing gains are evident.

Future evaluation should consider the reworking of the post activity questionnaire in order to provide better data capture, which would further support longitudinal follow-up of both participants, their reported impacts and the cost effectiveness of the programme over time. During the study, it became apparent that the current methods used to record statistical information were not compatible with the information required for an SROI study which measures changes and impact on individuals rather than services provided for individuals.

To determine the true effect of the Core Fit Programme on children, further research is required that utilises more in-depth and specific question(s) to assess outcomes a control group may also be useful in evaluation across peer groups.

Further work could also be undertaken to monitor the long-term impact of the programme. For example, how would the questionnaire responses defer after 12 months, two or even 10 years?

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Appendix A WEMWBS

Please tick (*√*) the box that best describes your experience of each over the **last 2 weeks**

STATEMENT	Never	Rarely	Some times	Often	All the time
I feel optimistic about the future	1	2	3	4	5
I feel useful	1	2	3	4	5
I feel relaxed	1	2	3	4	5
I feel interested in other people	1	2	3	4	5
I have energy to physical activity	1	2	3	4	5
I deal with problems well	1	2	3	4	5
I think clearly	1	2	3	4	5
I feel good about myself	1	2	3	4	5
I feel close to other people	1	2	3	4	5
I feel confident	1	2	3	4	5
I make my own mind up about things	1	2	3	4	5
I feel loved	1	2	3	4	5
I am interested in new things	1	2	3	4	5
I feel cheerful	1	2	3	4	5

Appendix B Performance questionnaire

1) Have you enjoyed Core Fit sessions? Would you like to carry them on in school?

_____

2) What four important things do you need to stay fit and healthy?

_____

3) Do you think you are healthy?

_____

4) Who is responsible for your own health?

_____

5) What type of exercise did you do before Core Fit started in your school (please list)?

_____

6) What type of exercise do you do now (e.g. walking, running etc)?

_____

7) How often do you exercise (please circle your answer)?

Every day Three times a week Twice a week Once a week Less often

_____

8) Has this amount changed in the last two months (please circle the answer)?

More Less Same

_____