Creating Active Schools (CAS):

Investigating Sustained Implementation and Long-Term (Cost)-Effectiveness on Children's Physical Activity in Multi-Ethnic and Socioeconomically Challenged Communities in Bradford

Protocol - version: 1.1 - **Date:** 12th February 2026

Corresponding authors:
Professor Andy Daly-Smith (Co–Principal Investigator)
Professor of Physical Activity and Child Health and Associate Research Director
Institute for Health and Social Care Research
University of Bradford, Richmond Road, Bradford, BD71DP
E-mail - A.Daly-Smith@bradford.ac.uk

Dr Esther van Sluijs (Co–Principal Investigator)
Programme Leader and MRC Investigator
MRC Epidemiology Unit
Institute of Metabolic Science, School of Clinical Medicine
University of Cambridge, Cambridge Biomedical Campus, Cambridge, CB2 0QQ
E-mail - esther.vansluijs@mrc-epid.cam.ac.uk

Funder: National Institute for Health and Care Research (NIHR), Public Health Research Programme (PHR) – NIHR174726 - The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the NIHR PHR Programme or the Department of Health and Social Care.

HRA Protocol Compliance Declaration: This protocol has regard for the Health Research Authority (HRA) guidance and recommended order of content for research protocols. The structure and level of detail are proportionate to the low-risk, non-clinical nature of the study.

Contents

2. Study team: key contacts and responsibilities

Name	Role	Responsibilities	Institution & contact
Professor Andy Daly-Smith	Co–Principal Investigator	Bradford operational lead; oversight of delivery across all work packages; lead for Knowledge Mobilisation (WP5).	University of Bradford A.Daly-Smith@bradford.ac.uk
Dr Esther van Sluijs	Co–Principal Investigator	Chair of the Study Management Group; lead for research governance and independence; co-lead for long-term effectiveness (WP1); lead for integration and contribution analysis (WP4); oversight of statistical analyses	University of Cambridge esther.vansluijs@mrc-epid.cam.ac.uk
Dr Daniel Bingham	Co-Investigator	Co-Lead for Work Package 1; responsibility for delivery of long-term effectiveness analyses and associated data collection and interpretation.	University of Bradford d.bingham@bradford.ac.uk
Dr Anna Chalkley	Co-Investigator	Lead for Work Package 3; responsibility for long-term implementation and process evaluation, including qualitative data collection and analysis.	University of Bradford a.chalkley@bradford.ac.uk
Dr Vijay Gc	Co-Investigator	Lead for Work Package 2; responsibility for health economic and cost-effectiveness analyses.	University of York vijay.gc@york.ac.uk
Mr Mark Miller	Public Co-Investigator	Co-lead for Knowledge Mobilisation (WP5); contribution to systems-level engagement with schools, education networks and policy stakeholders.	Bradford Research School, Dixons Research School mmiller@dixonsat.com
Cambridge Epidemiology & Trials Unit (CETU)	Independent analysis and monitoring	Independent monitoring and analysis of quantitative outcomes, including oversight of statistical analyses to ensure methodological rigour and research independence.	University of Cambridge

3. Governance and management

3.1 Study Management Group (SMG)

The Study Management Group (SMG) has overall responsibility for scientific integrity, governance, risk management, and delivery oversight. The SMG will meet The SMG will be chaired by Co-PI - Dr Esther van Sluijs.

The SMG will meet quarterly and will include:

- Both Co-Principal Investigators.
- Work Package leads.
- Senior research staff.
- CETU representation where required.
- Programme administrator.

Responsibilities include:

- Oversight of protocol adherence.
- Approval of analysis plans prior to unblinding.
- Monitoring recruitment, retention, and data quality.
- Oversight of ethics, amendments, and risk mitigation.
- Financial and staffing oversight.

3.2 Operational Group

An Operational Group chaired by Professor Daly-Smith will meet monthly and oversee day-to-day delivery, coordination across work packages, data collection logistics, and operational risk management.

3.3 Study Steering Committee (SSC)

An independent Study Steering Committee will provide external oversight of scientific quality, ethical conduct, and participant safety. Membership will include independent academics, a headteacher, a teacher, and a lay member. The SSC will meet annually (twice in Year 1).

3.4 Independent monitoring

To strengthen research independence and data integrity:

- CETU will conduct trial monitoring and source-data audits.
- Effectiveness analyses will be undertaken by blinded statisticians (i.e. will not know the identity of the intervention group, school name, or school location).
- Economic analyses will be led independently by academics at the University of York.

4. Abbreviations

APEASE	Acceptability, Practicability, Effectiveness, Affordability, Spillover effects and Equity
BMI	Body Mass Index
CAS	Creating Active Schools
CoI	Co-Investigator
EQ-5D-Y	EuroQol 5 Dimension Youth Version
IMD	Index of Multiple Deprivation
MVPA	Moderate-to-Vigorous Physical Activity
NPD	National Pupil Database
PCIEP	Public and Community Involvement, Engagement and Participation
PdsQL	Paediatric Quality of Life Inventory
PE	Physical Education
PI	Principal Investigator
TIDieR-PHP	Template for Intervention Description and Replication for Population Health and Policy
QALY	Quality Adjusted Life Year
SLT	Senior Leadership Team
SMG	Study Management Group
SSC	Study Steering Committee
WP	Work Package

5. Plain English summary

Children's physical activity is vital for their health, well-being, and learning. Yet, fewer than half of children in England do the recommended 60 minutes of moderate to vigorous activity each day. This problem is even worse for children from less wealthy families, girls, and those from Black, Asian or other minority ethnic groups. These inequalities cause poorer health and school outcomes, both now and in later life. Schools are key places to encourage children to be more active. But despite the government investing billions of pounds in physical activity and school sport, most school programmes have only shown small short-term changes in physical activity. Very few studies have looked at whether these last over time, or how well schools can continue to deliver activity programmes in the long run.

This project will measure the long-term effects of the "Creating Active Schools" (CAS) programme. CAS is a whole-school approach created with schools in Bradford, one of the most diverse and deprived areas in the UK. It helps schools make changes in four key areas: policy (e.g., teaching strategies), environment (e.g., changing playgrounds), people (e.g., teachers), and activities (such as break time or active travel). Schools assess their current activity offer, develop an action plan, and carry out ideas with support from trained staff and a digital hub at www.creatingactiveschools.org. They repeat this cycle every year.

Early studies of CAS in Bradford showed that after two years, children were more active on weekdays. Schools also made lasting changes to support physical activity. More local funding means that there is a rare chance to study CAS for longer to look at impact over seven years.

The study has five parts, which were shaped with help from Bradford schools and CAS lead:

1. Measuring impact on children's activity and health -we will measure how much physical activity children do in CAS schools and compare them to those in similar schools that do not do CAS. We will use physical activity monitors, and run health checks, and ask teachers and parents about the children's well-being. We will also explore if CAS benefits some groups of children more than others.
2. Assessing the value for money - we will ask schools how much CAS costs to deliver to calculate value for money.
3. Understanding how schools put CAS into practice – we will work with school staff to understand what helps them (or not) in making changes. They will look at what's working well, challenges, and how schools adapt over time.
4. Exploring why the programme works (or doesn't) – By combining the results of parts 1 to 3, the team will find out how different parts of CAS make a difference. We will know which schools and children benefit most and if there are differences by groups. We can use this information to make CAS better for the future.
5. Sharing the learning – We will create toolkits, videos, reports, and hold events to share learning. This will help schools, families, policymakers and researchers to use CAS or similar programmes in other places.

This will be the first long-term UK study of a whole-school physical activity programme in less wealthy and ethnically diverse communities. It will help us create school-based activity programmes that work better and last longer. The results will help make sure that more children can benefit from schools that are active and health.

6. Scientific abstract

Physical inactivity in childhood remains a global public health crisis, with fewer than half of English primary-aged children meeting the recommended 60 minutes of moderate to vigorous physical activity (MVPA) per day. This burden disproportionately affects children from Black, Asian, and socioeconomically disadvantaged backgrounds, contributing to long-term health inequalities and poorer academic outcomes. Despite significant investments into school-based activity initiatives in England, the long-term population-level effects remain unclear due to short-term evaluations and a lack of implementation science approaches.

To address this challenge, this study proposes a comprehensive, interdisciplinary evaluation of the Creating Active Schools (CAS) programme, based on a co-designed, whole-school physical activity framework. CAS recognises schools as complex adaptive systems and applies behavioural and implementation science to promote sustainable organisational change, supporting an active school culture. Following initial two-year evidence of increased weekday MVPA and sustained physical activity infrastructure improvements in 16 Bradford schools, which deepened over time, an additional five years of local funding has been secured for CAS implementation, providing an unparalleled opportunity to assess CAS' long-term implementation and effectiveness.

This mixed-method, longitudinal evaluation will assess the 5- and 7-year impact of CAS across five integrated work packages (WPs). WP1 will examine long-term effectiveness using repeated cross-sectional accelerometry and anthropometric data in Years 1–3 students, comparing those at intervention and matched control schools. Primary outcome is weekday MVPA; secondary outcomes include weekly and in-school MVPA, sedentary time, physical activity habits, BMI, well-being, and educational attainment. The health economic analysis of WP2 will model quality-adjusted life years and long-term healthcare costs to assess value for money from a school funder perspective.

WP3 will investigate sustained implementation using annual qualitative and quantitative assessments across intervention schools, examining system, organisational, and stakeholder-level factors that enable or hinder implementation. WP4 will integrate implementation and effectiveness data using Contribution Analysis, developing a comprehensive theory of change to understand the differential impact of CAS across subgroups, including by gender, ethnicity, and deprivation. WP5 focuses on knowledge mobilisation, co-producing an open-access implementation toolkit, policy briefs, and multimedia outputs for diverse stakeholders, including policymakers, educators, and families.

This project represents the first UK-based long-term evaluation of a large-scale, whole-school physical activity approach embedded in a multi-ethnic, socioeconomically challenged population. Findings will inform national and international policies on school-based health promotion, identify scalable and equitable strategies for sustainable implementation, and support cross-sector decision-making on physical activity investment. Through rigorous evaluation, integrated stakeholder engagement, and translational impact, this study aims to deliver transformative knowledge on addressing childhood inactivity, narrowing health inequalities, and enabling lifelong well-being through systemic educational reform.

7. Background and rationale

7.1 The public health burden of physical inactivity in childhood

Physical inactivity is a major contributor to poor health across the life course and is recognised as one of the leading modifiable risk factors for non-communicable disease globally (1, 2). In childhood, insufficient physical activity is associated with poorer cardiometabolic health, lower physical fitness, poorer mental health, and reduced cognitive and educational outcomes (3-6). These associations track into adulthood, contributing to increased risk of cardiovascular disease, type 2 diabetes, certain cancers, and premature mortality (2, 7, 8). In England, fewer than half of primary school-aged children meet the recommended guideline of at least 60 minutes of moderate-to-vigorous physical activity (MVPA) per day (9). Importantly, physical activity levels are not evenly distributed across the population. Children from socioeconomically disadvantaged backgrounds, girls, and children from Black, Asian and other minority ethnic groups consistently accumulate lower levels of physical activity than their more advantaged peers (9-11). These disparities emerge early in childhood and widen with age, contributing to persistent and intergenerational health inequalities (12, 13). The COVID-19 pandemic has further exacerbated these inequalities, with evidence of disproportionate reductions in physical activity among children living in deprived communities and from minority ethnic backgrounds (12, 14). At a population level, physical inactivity places a substantial burden on public services, with estimates suggesting it costs the UK economy approximately £7.4 billion per year through increased healthcare expenditure, lost productivity and wider societal costs (15, 16). Preventive approaches that support sustained increases in physical activity during childhood are therefore a public health priority.

7.2 Schools as a setting for population-level physical activity promotion

Schools are widely recognised as a key setting for promoting physical activity because they reach almost all children for sustained periods during critical developmental stages (1). In England, children spend approximately 35 hours per week in school during term time, providing multiple opportunities to influence movement behaviours across the school day, including physical education (PE), break and lunchtime, active travel, extracurricular activities and physically active learning (17, 18). In response to this potential, successive UK governments have invested heavily in school sport and physical activity, including the introduction of the PE and Sport Premium and cumulative investment exceeding £2.2 billion since 2012 (19). However, despite this sustained investment, national surveillance data show little evidence of population-level improvement in children's physical activity (9, 11). This raises critical questions about whether current approaches are effective, equitable, and sustainable, and whether public investment is being optimally allocated. A growing body of evidence suggests that interventions focusing on single components (e.g. PE lessons or extracurricular sport) are unlikely to generate meaningful or sustained population-level change (10, 20-22). Instead, international guidance increasingly recommends whole-school approaches that integrate physical activity across policies, environments, staff practices and daily routines (1, 17, 22-24).

7.3 Limitations of existing whole-school physical activity evidence

While whole-school approaches are conceptually appealing and increasingly advocated, the empirical evidence base remains limited. Systematic reviews indicate that most school-based physical activity interventions demonstrate small-to-moderate short-term effects, with substantial heterogeneity in outcomes (10, 20, 21). Critically, very few studies examine whether such effects are sustained over time. A recent review found that fewer than 4% of school-based physical activity interventions lasted three years or more, none were conducted in the UK, and very few incorporated explicit implementation or sustainability frameworks (20). Where longer-term studies exist, they often focus narrowly on PE provision, rely on retrospective self-report data, or lack robust baseline measures, limiting their utility for informing long-term policy decisions (10, 20). More broadly, sustainability is a recognised but under-researched challenge in

public health. Less than 1% of physical activity research published in the last decade has focused explicitly on intervention sustainability, despite evidence that only around one-quarter of public health interventions are sustained beyond two years after initial implementation (25, 26). This disconnect between investment, implementation and long-term impact has been described as one of the most significant translational research challenges in public health (22, 25, 26). As a result, policymakers and practitioners currently lack robust evidence to answer critical questions, including whether whole-school physical activity approaches deliver sustained benefits, whether they represent good value for money over time, and how implementation evolves within complex school systems.

7.4 The Creating Active Schools (CAS) whole-school approach

Creating Active Schools (CAS) was developed in response to these evidence gaps. CAS is a whole-school physical activity programme grounded in behavioural science, implementation theory and systems thinking. It conceptualises schools as complex adaptive systems and recognises that sustained behaviour change requires coordinated action across multiple interacting domains (17, 27).

CAS supports schools to embed physical activity across four interconnected domains:

- **Policy** (e.g. school policies and strategic priorities),
- **Environment** (e.g. physical and social environments that enable activity),
- **Stakeholders** (e.g. staff, pupils, families and partners), and
- **Opportunities** (e.g. PE, active lessons, breaktimes, active travel and extracurricular provision).

Rather than prescribing a fixed set of activities, CAS uses a place-sensitive, asset-based co-production approach. Schools review their existing provision using a digital hub, identify priorities, develop evidence-informed action plans using APEASE criteria, implement changes with ongoing support, and evaluate progress annually. Delivery is supported by trained CAS Champions (seconded teachers), communities of practice, and collaborative cross-school projects that enable peer learning and local adaptation. This flexible yet structured approach is designed to maximise acceptability, feasibility and sustainability within diverse school contexts, while maintaining fidelity to core principles (17, 27).

7.5 CAS in Bradford and existing evidence

Creating Active Schools (CAS) was co-developed and piloted with 12 Bradford primary schools (2019–2021) as part of the Active Bradford whole-system Sport England Local Delivery Pilot, Join Us: Move Play (JU:MP)(28). Bradford is one of the most ethnically diverse and socioeconomically deprived local authorities in the UK, with high levels of childhood inactivity, poor health outcomes and educational disadvantage, making it a priority setting for preventative public health interventions (12, 29, 30). In 2021, a further 24 schools joined the programme, of which 16 participated in a two-year mixed methods-controlled evaluation of JU:MP, including CAS. Twenty matched control schools from South and West Yorkshire were recruited with support from Yorkshire Sport Foundation (31, 32). An initial nine-month implementation evaluation, informed by McKay's implementation and scale-up framework (26), demonstrated high levels of adoption and acceptability (33). CAS was reported to align with educational values and priorities and to facilitate early whole-school change in physical activity provision. Identified challenges included permeation beyond PE and sport into wider school practices, programme complexity, and time demands (33, 34). The 24-month trial demonstrated both behavioural and organisational impacts (32). Compared with control schools, children in JU:MP schools accumulated an additional 4.99 minutes per day (95% CI: 1.01–8.96) of accelerometer-assessed MVPA, with larger weekday effects (5.77 minutes; 95% CI: 1.87–9.67), suggesting that school-environment change contributed to behavioural impact (32). Organisational outcomes showed sustained and meaningful whole-school change between nine and 24 months, including a large overall effect on school physical activity culture (ES = 0.60) and medium-to-large effects across staff support, peer norms, physically active learning, PE, break and lunchtime provision, and active travel (35). Longitudinal

qualitative findings indicated increasing permeability of CAS within school systems over time, with initiatives becoming embedded and normalised (36). Schools emphasised the importance of aligning implementation expectations with educational realities, reinforcing the need for ongoing evaluation. Sustained implementation of policy and environmental interventions has been shown to enhance population-level impact over time (37). Continued funding for CAS delivery in Bradford for up to seven years, supported by Sport England and Active Bradford, therefore presents a rare opportunity to evaluate long-term effectiveness, sustainability, and cost-effectiveness using existing baseline data within a real-world, socioeconomically disadvantaged, and ethnically diverse context.

7.6 Why this research is needed now

There is an urgent need for long-term, theory-informed evaluations that move beyond short-term effectiveness to examine sustainability, implementation and value for money (20, 25, 26). This study directly addresses priorities identified by NIHR PHR, the UK government and international bodies, including the need to reduce health inequalities, embed prevention within systems, and generate evidence that supports scalable, sustainable solutions (1, 22, 38-40). By integrating effectiveness, economic and implementation evidence over 5- and 7-year follow-up, this research will provide critical insights into whether whole-school physical activity approaches such as CAS can deliver sustained and equitable benefits, how they operate within complex school systems, and whether they represent good value for public investment. The findings will have direct relevance for schools, local authorities, national policymakers and funders responsible for decisions about long-term investment in school-based physical activity and prevention more broadly.

8. Aims and objectives

The overall aims of this research are to:

1. Evaluate the sustained implementation, long-term effectiveness and cost-effectiveness of the Creating Active Schools (CAS) programme on children's physical activity and health and educational outcomes in multi-ethnic and socioeconomically deprived communities.
2. Build a policy, practice and research knowledge mobilisation community to support evidence-informed whole-school physical activity

The research aims will be achieved through different research questions which will be answered through work occurring with five different Work packages (WPs).

Research Questions:

WP1: Evaluating long-term effectiveness of CAS on health & educational outcomes.

1a- In multi-ethnic and socioeconomically deprived primary schools, what is the impact of sustained CAS implementation (up to 7 years) on children's time spent in MVPA on weekdays?

1b- What is the impact of sustained CAS implementation on secondary outcomes including health, wellbeing and educational outcomes?

1c- Do the effects of CAS on primary and secondary outcomes differ by time, child gender, ethnicity, socioeconomic position, or CAS implementation quality?

WP2: Investigating the cost-effectiveness of CAS.

2a- What is the cost-effectiveness of CAS to promote physical activity at school?

2b- What are the expected long-term (lifetime) costs and quality-adjusted survival of sustained CAS implementation?

WP3: Assessing the long-term implementation of CAS.
3a- What are the key features and facilitators of high-quality, sustained CAS implementation within primary schools?
3b- How do primary school stakeholders and those implementing CAS perceive the factors influencing sustained whole-school PA?

WP4: Integrating implementation & effectiveness data.
4a- To what extent, and how, have the key CAS intervention components contributed to changes in children's outcomes, and variation therein?

WP5: Knowledge mobilisation and dissemination.
5a- To create an effective policy, practice and research community to promote knowledge exchange around whole-school physical activity.

5b- To promote impact in policy, research and practice through effective dissemination of project outcomes.

9. Study design and methods

9.1 Study Design:

This is a mixed-methods natural experimental evaluation of the sustained implementation, long-term effectiveness and cost-effectiveness of the Creating Active Schools (CAS) whole-school physical activity programme. The study is designed to generate robust evidence under real-world conditions, where interventions are delivered as part of routine systems rather than controlled research environments (41, 42). Randomised controlled trials are often considered the gold standard for evaluating intervention efficacy; however, they can be impractical, inequitable or inappropriate for complex, system-level public health interventions delivered at scale (41, 42). In the context of CAS, randomisation would undermine ecological validity, disrupt established research–practice partnerships, and restrict access to a programme already embedded within local policy and practice.

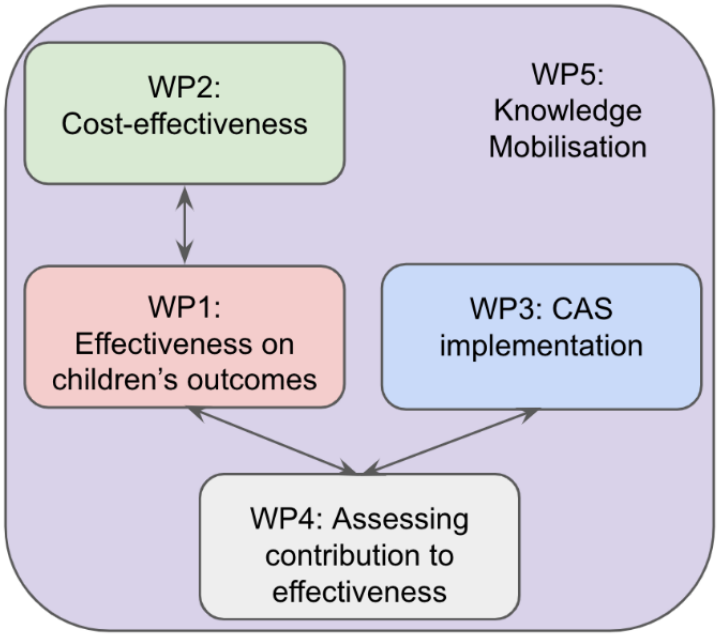


Figure 1: Connection of Work packages

The evaluation integrates quantitative effectiveness and economic analyses (Work Packages 1 and 2) with a longitudinal mixed-methods implementation evaluation (Work Package 3). Evidence from these work packages is synthesised using a theory-based Contribution Analysis approach (Work Package 4) to strengthen causal inference for a complex intervention and explain variation in outcomes between schools and population subgroups (43). Knowledge mobilisation activities (Work Package 5) are embedded throughout to maximise policy and practice relevance.

9.2 Setting and context

The study is conducted in Bradford (West Yorkshire), a metropolitan district characterised by high levels of socioeconomic deprivation and ethnic diversity. Bradford ranks among the most deprived local authorities nationally, with high levels of childhood poverty, poor health outcomes and educational disadvantage (12, 30). The school population includes a high proportion of children from South Asian heritage and other minority ethnic backgrounds, groups that experience disproportionately low physical activity and poorer health outcomes (9, 14, 44). Bradford provides a uniquely policy-relevant setting because CAS has been embedded within the city's whole-system physical activity strategy (JU:MP), supported by sustained investment from Sport England and Active Bradford(45-47). Existing baseline data from a prior controlled evaluation enable long-term follow-up, while continued programme delivery ensures sustained exposure in intervention schools (31, 32). This combination of long-term delivery, baseline data and population need is rare in school-based physical activity research and directly addresses a major gap in the evidence base (20, 43).

9.3 Participants

Schools

Intervention schools are those delivering CAS as part of routine practice within JU:MP in the city of Bradford. These schools were originally recruited into a quasi-experimental controlled evaluation of JU:MP using matched comparison schools from South and West Yorkshire (31, 32). Control schools were selected using a matched design based on school-level deprivation (Index of Multiple Deprivation), ethnic composition, and the proportion of pupils eligible for free school meals, consistent with best practice in quasi-experimental school-based research where randomisation is not feasible (48). Matching was undertaken using publicly available school-level data (49). The long-term evaluation adopts a quasi-experimental repeated cross-sectional design anchored to the original baseline sample. Baseline data from all originally recruited intervention and control schools will be retained to preserve the integrity of the initial comparison, regardless of subsequent participation status. For follow-up data collection, all original schools will be re-approached through established leadership contacts (headteachers and senior leadership teams) and provided with detailed information outlining study procedures, timelines, governance arrangements, and anticipated workload. If intervention or control schools decline participation at follow-up, a pre-specified replacement strategy will be implemented. Replacement schools will be identified from comparable local authorities within the same regions and matched using the same deprivation and demographic criteria applied in the original evaluation. Replacement schools will contribute follow-up data only and will be assessed using identical measurement protocols to ensure comparability. To preserve statistical power and reflect real-world programme exposure, schools that commenced CAS delivery during the same implementation period but were not originally part of the JU:MP evaluation may also be eligible for inclusion as intervention schools. Eligibility criteria will include: (1) continuous engagement with CAS since the commencement of the Bradford-wide implementation in 2021; and (2) availability of school-level demographic and contextual indicators sufficient to support matching (e.g., deprivation, ethnic composition, free school meal eligibility). Primary analyses will be conducted using the subset of schools with both baseline and follow-up data. Secondary analyses will include replacement and additional eligible CAS schools to maximise precision and external validity. Sensitivity analyses will compare findings across these analytic samples to assess the potential impact of school attrition and replacement. All recruitment

decisions, matching procedures, and analytic strategies will be specified in advance within a detailed statistical analysis plan to ensure transparency and reproducibility.

Children

All children in Years 1–3 in participating schools will be eligible to take part in data collection at five- and seven-years post-baseline as part of Work Package 1. The study adopts a repeated cross-sectional design; therefore, the same children will not be followed over time. Instead, independent samples of pupils will be assessed at each follow-up wave to estimate population-level effects within schools. This approach is appropriate for evaluating environmental and system-level interventions where the primary unit of change is the organisational setting rather than the individual child. In the context of whole-school physical activity interventions, repeated cross-sectional designs have great utility, particularly where cohort follow-up is impractical due to pupil progression through school year groups and transitions to secondary education. By sampling successive cohorts exposed to the sustained CAS programme, this design enables assessment of longer-term institutional and cultural change while maintaining feasibility and representativeness.

Parents/carers and school staff

Parents/carers contribute questionnaire data relating to child health, wellbeing and quality of life and may participate in qualitative components. School staff, including headteachers, senior leaders, teachers and in-school CAS leads, participate primarily in implementation evaluation activities. CAS Champions and wider system stakeholders contribute to understanding programme delivery and sustainability.

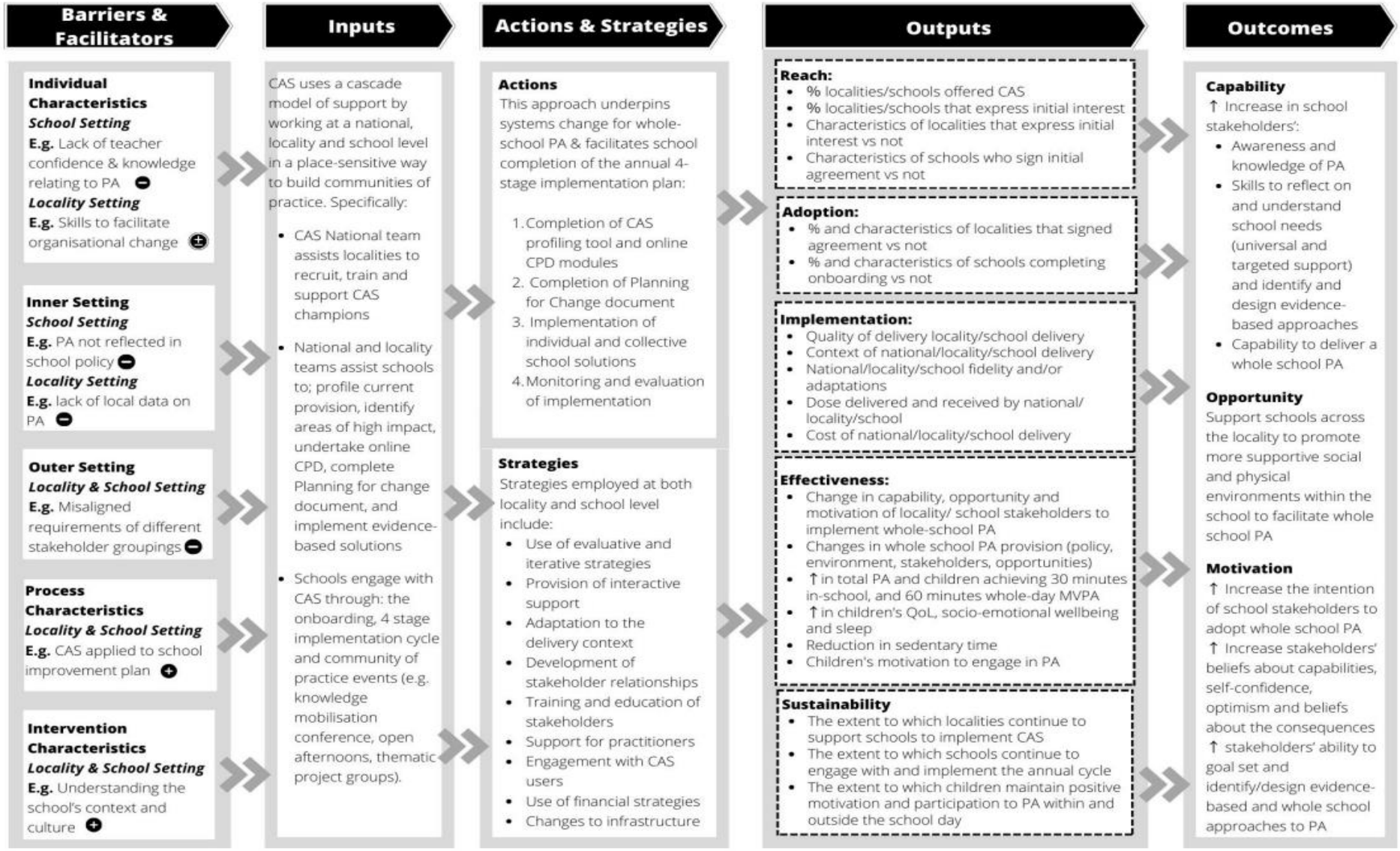


Figure 2: Creating Active School Logic Model

9.4 Description of the Creating Active Schools (CAS) intervention

The conceptual basis and development of CAS are described in Section 7.4. This section specifies the operational characteristics of CAS as implemented in Bradford primary schools from 2021 onwards, in accordance with the Template for Intervention Description and Replication for Population Health and Policy (TIDieR-PHP)(50). The CAS Logic Model is presented in Figure 1.

Why - CAS is a whole-school physical activity implementation framework designed to embed physical activity across four interconnected domains: policy, environment, stakeholders and opportunities. It is intended to support sustained organisational change by strengthening school capability, opportunity and motivation to deliver physical activity throughout the school day, through a structured and repeatable annual cycle of review, planning, implementation and evaluation (Figure 1, reported in full with Helme et al (27)) specifies key implementation determinants and mechanisms that underpin delivery, including leadership engagement, organisational readiness, facilitation and peer learning, and provides the basis for defining and assessing implementation outcomes (e.g. reach, adoption, fidelity, dose and sustainability) within this evaluation.

What (materials) - CAS is supported by a set of standardised resources provided through national and locality infrastructure. Core materials include the CAS Digital Hub, which hosts the school profiling tool, Planning for Change documentation, online CPD modules and a shared resource bank. The profiling tool supports structured self-assessment of school provision across 22 domains within the four CAS domains. Action planning is documented using the Planning for Change template, guided by APEASE criteria (Acceptability, Practicability, Effectiveness, Affordability, Spillover effects and Equity)(51), to support prioritisation and selection of feasible and context-appropriate actions. Additional materials include CAS Champion training resources, facilitation guidance and Community of Practice resources used to support peer learning and collaborative problem solving.

What (procedures) - CAS is delivered through a structured annual implementation cycle aligned with the academic year. Schools complete profiling via the Digital Hub to establish their baseline provision and identify priority domains for improvement. Schools then complete a documented Planning for Change process and implement selected strategies aligned with the identified priorities. Implementation is supported through a combination of CAS Champion facilitation, participation in Communities of Practice and access to online CPD. Schools monitor progress during the year and undertake review and evaluation activities to inform the subsequent cycle. The annual cycle consists of profiling, planning, implementation and review, and is repeated each academic year, supporting iterative refinement and sustained embedding of whole-school physical activity practices over time.

Who provided - CAS is delivered through a cascade model. The CAS National Team provides governance, training, quality assurance and access to programme resources. At locality level, a CAS Manager and CAS Champion(s) provide implementation support, including onboarding, facilitation, coordination of Communities of Practice and review of profiling outputs. Within schools, senior leadership teams and designated CAS leads are responsible for integrating CAS processes into school development planning and day-to-day practice, coordinating staff engagement and ensuring that profiling and action planning are completed.

In Bradford, CAS was implemented from 2021 following this standard delivery structure and within the wider local system context for child physical activity improvement. Delivery and support structures remained consistent over the period from initial implementation to the current evaluation.

Where - In Bradford, a total of 23 primary formally enrolled in CAS beginning in 2021, of which 16 primary schools were part of the previous effectiveness trial (31). These schools are in socio-economically and ethnically diverse communities and operate within existing education governance arrangements. CAS

implementation is embedded within the routine functioning of participating schools and is intended to influence physical activity opportunities across the full school day, including curriculum time and non-curriculum time.

When and how much - Schools entered CAS from 2021 onwards and progressed through successive annual implementation cycles. Each annual cycle follows the structured sequence of profiling, planning, implementation and review and is repeated each academic year. The present evaluation examines sustained implementation at approximately five and seven years post-baseline, corresponding to later stages of programme embedding rather than initial onboarding. In this evaluation, the timing and maturity of schools' CAS engagement will be characterised using programme records, including the number of completed cycles, engagement with profiling and action planning, and participation in Communities of Practice.

Tailoring and modifications - CAS includes defined core processes (completion of profiling, documented Planning for Change guided by APEASE, participation in Communities of Practice and annual cycle repetition). Within this framework, schools retain autonomy to determine which domains to prioritise and which specific strategies to implement, reflecting local assets, constraints and priorities. Tailoring may therefore occur in the selection, intensity and sequencing of school-level actions, while maintaining fidelity to the core CAS processes. No material changes were made to the core CAS processes in Bradford between initial implementation in 2021 and the current evaluation period.

Fidelity and exposure definition - Fidelity is defined as adherence to core CAS processes rather than uniform delivery of specific physical activity activities. Implementation activity is documented through Digital Hub records and locality reports, including completion of profiling and Planning for Change documentation and participation in Communities of Practice.

For the purposes of this evaluation, exposure to CAS is defined as formal enrolment in the programme and participation in the structured annual implementation cycle, including documented completion of profiling and Planning for Change processes. Variation in exposure (e.g. engagement intensity and cycle completion) will be described and incorporated into the implementation evaluation (WP3).

9.5 Comparator (usual practice)

Control schools will continue with usual practice, which may include statutory PE, extracurricular sport, and use of the PE and Sport Premium, but will not engage in CAS or any other formal whole-school physical activity programme during the study period. This comparator reflects the real-world counterfactual faced by policymakers and enables assessment of the added value of a structured, theory-informed whole-school approach over existing provision. Of the 20 control schools recruited into the original trial,18 actively participated through to trial completion in March 2025. These schools demonstrated sustained engagement and high levels of compliance with study procedures. All 18 will be re-approached for participation in the long-term follow-up. We will also re-contact the two schools that did not complete the initial trial, as their baseline data remain available and their organisational circumstances may have changed. To support continued engagement across both intervention and control schools, an honorarium of £1,000 per data collection wave will be provided to reflect the time and administrative resources required. This increase responds directly to feedback from schools and Public and Patient Involvement (PPI) advisors, who indicated that previous payments (£200) did not adequately compensate staff time. In addition, schools will receive regular study updates (e.g., newsletters and visits) and anonymised year-group wellbeing and physical activity summaries to ensure reciprocal value and alignment with school priorities. If control schools choose not to participate, then alternative schools will be identified following criteria already outlined in section 9.3.

10. Work Package overview

The evaluation comprises five interlinked work packages designed to operate in parallel and iteratively, with integration occurring throughout the project lifecycle. Presented in Figure 3 is the flow diagram outlining all of the data collection and processes across all the work packages, and Figure 4 is the flow diagram of different data collection waves within WP1.

WP1 (Effectiveness): long-term impacts on children's physical activity, health, wellbeing and educational outcomes.

WP2 (Health economics): within-study and model-based cost-effectiveness from a public sector perspective

WP3 (Implementation): how CAS is implemented and sustained over time, and why implementation varies.

WP4 (Integration): contribution analysis integrating evidence to explain causal pathways and variation.

WP5 (Knowledge mobilisation): co-produced outputs and engagement to maximise uptake and impact.

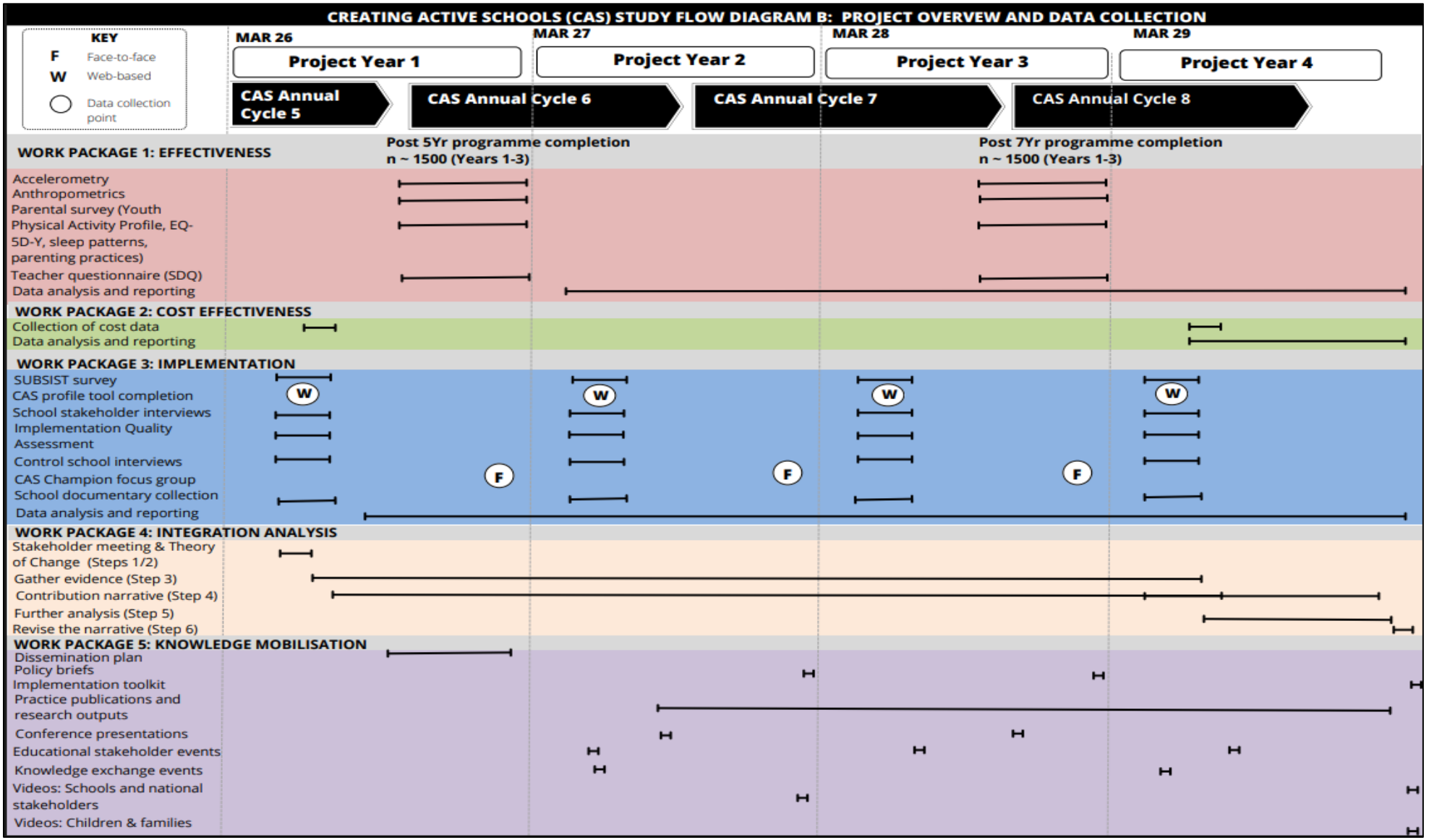


Figure 3: Flow diagram for the study in its entirety presenting when components of each work package will occur.

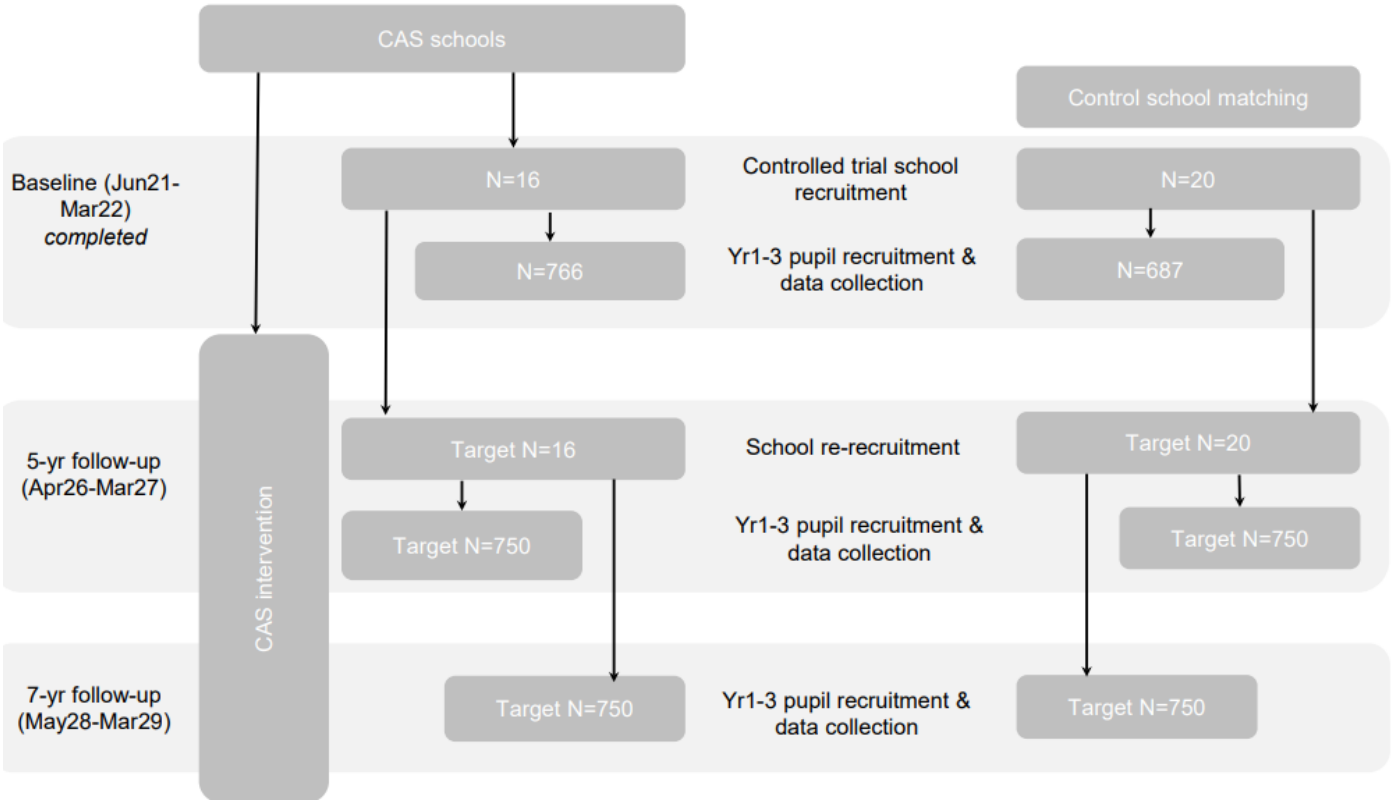


Figure 4: Flow diagram for Work package 1 – effectiveness.

11. Work Package 1: Long-term effectiveness

11.1 Design

WP1 includes two complementary natural experimental evaluations:

WP1a: repeated cross-sectional quasi-experimental evaluation at 5 and 7 years post-baseline with de novo data collection on physical activity, health and wellbeing outcomes

WP1b: quasi-experimental evaluation of educational outcomes using routinely collected National Pupil Database (NPD) data

11.2 WP1a: Repeated cross-sectional study of Yr1-3 children's health & wellbeing

We will conduct a quasi-experimental repeated cross-sectional study at 5- & 7-yrs post-baseline, building on the baseline data collected in 2021/22 (31). While the original controlled trial followed up individual children as they progressed through primary school, by 5-year follow up the majority of original participants will have transitioned to secondary school and are no longer exposed to the primary school environment. A repeated cross-sectional design is appropriate to assess changes in population-level outcomes over time where the focus of an intervention is to change the environment, in this case the primary school environment and its culture and practices (42,47).

Sampling and recruitment:

Available baseline sample: Our baseline sample (collected 2021/22) (31, 32) includes 1,453 Year 1–3 children (6.8±0.9 years; 52.8% female; 43.8% South Asian, 41.5% White British, 14.7% other; 65.5% living in the most deprived IMD quintile). Of these, 1,043 participants provided at least one day of valid accelerometry data (600 minutes of wear a day), with a total of 4595 valid days collected for the primary outcome of weekday MVPA.

New recruitment*:* Using the same research approach as for the baseline data collection, we will repeat cross-sectional data collection of children in school Years 1-3 at the 16 intervention and 20 control schools at 5- (Sep26–Mar27) and 7-years (Sep28–Mar29) follow-ups. These participants will not have been exposed to the JU:MP whole-system programme within which CAS delivery was originally embedded. We will approach current head teachers and key school staff to re-recruit schools. We are continuing to engage schools, and all schools will be offered an honorarium of £1,000 per data collection point as an incentive. Following school approval, we will seek to enrol new cohorts of ~1,500 participants per wave; at each wave, all children in Years 1-3 will be eligible to participate. Our approach to recruitment is based on extensive experience in successfully recruiting children in deprived communities; recognising the need for higher staffing and printed resources to maintain relationships and promote increased data return rates. Recruitment will be coordinated in partnership with a school's leadership team, ensuring robust engagement and clear communication about the study requirements. We will request to visit schools and explain the study to children and teachers directly through class or Year group assemblies, giving them the opportunity to ask questions. A parent information sheet and infographic will be sent out with a short study video using the school's communication system. In consultation with schools, we will look to support recruitment via hosting parents' evenings, virtual Q&A sessions, coffee mornings and be available at school gates at drop off and pick up times to provide parents and carers with opportunities to ask questions about the study. Written parental consent and oral child assent will be obtained prior to data collection. Where appropriate we will translate materials into different languages for parents/carers whose first language is not English.

In the event that original intervention or control schools decline participation at follow-up, replacement schools will be recruited in accordance with the criteria and matching procedures described in **Section 9.3**. Replacement schools will contribute follow-up data only and will be incorporated into secondary analyses to preserve statistical power and external validity. Primary analyses will be restricted to schools with baseline and follow-up data to maintain the integrity of the original comparison.

Data collection procedures: Data collection procedures for the repeat cross-sectional study will replicate baseline (31) and be the same at each follow-up. Experienced researchers trained in safeguarding, and with an enhanced Disclosure and Baring service (DBS) certificate, will perform data collection following Standardised Operating Procedures (SOPs). To assess the primary outcome, weekday minutes in MVPA, trained researchers will fit each consenting child with a hip worn ActiGraph wGT3X-BTcaccelerometer (over or under clothing). Children will be instructed to wear the monitor for 24 hours for seven consecutive days, removed only for bathing or swimming. Children will receive a practical demonstration, and parents/carers will receive information to reinforce instructions at home. Children will be asked to return the monitors to school, to be collected by the research team. Waist worn accelerometry is a frequently employed and valid method of assessing children's physical activity participation (52). Anthropometric measurements will be taken in a private and child-friendly environment following standard operating procedures. Height (portable stadiometer) and weight (digital scales) will be measured in light clothing to the nearest 0.1 unit; BMI z-score will be assessed based on UK reference data (53, 54). Waist circumference will be measured at the midpoint between the bottom rib and iliac crest using a flexible, ergonomic tape. Three measurements will

be taken to ensure reliability, with the average used in analysis. Participating children will receive a small gift pack, which may include a book and small rewards.

Teachers: will complete the 25-item Strengths and Difficulties Questionnaire (SDQ) for each participating child to assess psychosocial well-being (55, 56). The SDQ assesses 5 subscales: “prosocial behaviour”, “emotional problems”, “behavioural problems”, “peer problems”, and “hyperactivity/inattention”.

Parents/carers: will complete a structured questionnaire comprising: (1) child and respondent information, including child name, class, teacher’s name, age and relationship to the respondent; (2) child physical activity assessed using the Youth Activity Profile (57); (3) sleep duration (58); (4) health-related quality of life (EQ-5D-Y and PedsQL)(59, 60); and (5) contextual influences on physical activity. Contextual measures include locations where the child engaged in physical activity for more than 10 minutes and the number of days visited in the previous seven days (e.g. home, garden/yard, streets, organised sport, leisure centre, community centre, religious setting, parks and green spaces). Given the demographic profile of Bradford, additional items capture attendance at mosque or madrassa in the previous seven days, including arrival and departure times and whether active travel occurred. The questionnaire also includes validated measures of parenting practices related to physical activity and perceptions of neighbourhood social cohesion and walking/exercise environment characteristics (61, 62). These measures provide behavioural, contextual and quality-of-life data to complement accelerometer-derived outcomes, support health economic analyses and help explain variation in physical activity and wellbeing across schools and population subgroups. The questionnaire will be available in paper and online formats, with translated versions and support provided where required. At baseline, response rates were 70% for the teacher-reported SDQ and 74% for the parent/carer questionnaire.

Schools: will be asked to provide demographic data for each child (following parental/carer consent), including date of birth, gender, ethnicity, postcode (to derive deprivation indices), free school meal eligibility, and any special educational needs or disabilities. This data will be transferred securely and managed in line with data protection and ethical requirements.

Study power: At baseline the standard deviation of weekday MVPA was 22.38 min/day and on average 28.7 children/school provided valid accelerometry data (32). Using an intra-school correlation coefficient for weekday MVPA of 0.07 (63), this suggests that aiming to recruit 1500 participants with similar accelerometer wear would provide 80% power to detect a difference in mean MVPA between the intervention and control groups of 6.8 min/day as significant at the 5% level, or 90% power to detect a difference of 7.9 min/day. These differences would be associated with a significant impact on population health, including waist circumference and fasting insulin (64), and are consistent with the results at 2 year follow-up, where the 95%CI around the effect estimate was 1.87-9.67 min/day (32).

11.3 Quasi-experimental evaluation of impact on educational outcomes (National Pupil Database)
We will apply to access individual-level education-related outcomes data in the National Pupil Database (NPD) to assess CAS’s impact over time on outcomes of importance to schools. We will ensure timely submission of the data request to avoid unnecessary delays. All relevant research team members will apply to become ONS-accredited researchers and we will access the data through the Secure Research Server (ONS Trusted Research Environment). We will access repeated cross-sectional data in the form of de-identified individual-level data at intervention and control schools from 2016 (5 years before starting CAS) to 2028 on pupil demographics (Year, gender, ethnicity, free school meals eligibility) and key educational outcomes. Based on stakeholder input, we will prioritise analysis of the following outcomes: Key Stage 2 (end of primary school) SATS scores for reading, writing and maths, and attendance.

11.4 Outcomes

The primary outcome for Work Package 1 is accelerometer-assessed weekday MVPA, expressed as mean minutes per day among children in Years 1–3 at five- and seven-year follow-up. Secondary outcomes include accelerometer-derived total physical activity, sedentary time and in-school physical activity; anthropometric measures (body mass index z-score and waist circumference); psychosocial wellbeing (teacher-reported Strengths and Difficulties Questionnaire); health-related quality of life (EQ-5D-Y and PedsQL); sleep duration; parent-reported physical activity; and educational outcomes derived from the National Pupil Database, including school attendance and Key Stage 2 attainment (reading, writing and mathematics).

All outcomes will be assessed at both follow-up waves and compared between intervention and control schools.

11.5 Analysis

11.5.1 Accelerometer data processing.

Accelerometer data will be downloaded using ActiLife v6 software and processed to remove non-wear and sleep periods using validated sleep detection algorithms (65, 66). Daytime data will be processed in 15-second epochs, consistent with the calibration study underpinning the cut-points used to estimate physical activity intensity (67). The first day of wear will be excluded to minimise reactivity. A valid day will be defined as a minimum of 600 minutes of wear time (31), and non-wear time will be defined as 20 minutes of consecutive zeros and will be removed from the data. To maximise data use, children with at least one valid day of data will be included in analyses.

11.5.2 Statistical analysis.

All quantitative analyses will be conducted in accordance with a pre-specified Statistical Analysis Plan, finalised prior to commencement of primary analyses. Analyses will be undertaken by an independent statistician at the Cambridge Epidemiology & Trials Unit (CETU; University of Cambridge), who will remain blinded to school allocation. For both the health and wellbeing outcomes (WP1a) and educational outcomes (WP1b), generalised linear mixed-effects models will be employed. Models will include intervention group (intervention vs control) as the primary exposure; year, age, gender, ethnicity and free school meal eligibility as fixed effects; and school as a random effect to account for clustering at school level. The primary analysis will estimate the effect of CAS on weekday MVPA (minutes/day). The primary analysis will be restricted to schools with both baseline and follow-up data to preserve the integrity of the original matched comparison. Where replacement schools are recruited at follow-up, these will be included in secondary analyses to maximise precision and external validity, with appropriate covariate adjustment for school-level characteristics. Secondary analyses will examine effects on accelerometer-derived physical activity and sedentary outcomes, anthropometric measures, psychosocial wellbeing, health-related quality of life, sleep, parent-reported physical activity, and educational outcomes derived from the National Pupil Database. Models will be extended to include interaction terms to assess potential effect modification by child characteristics (gender, ethnicity and socioeconomic position) and by CAS implementation quality. An interaction between intervention group and follow-up wave will be included to assess whether intervention effects differ between the five- and seven-year follow-ups. Effect estimates will be presented with 95% confidence intervals.

12. Work Package 2: Cost-effectiveness

12.1 Study Design

The health economic evaluation will be conducted in the form of a within-study cost-consequences analysis and a model-based cost-effectiveness analysis to assess the value for money of CAS intervention compared to usual practice, from the perspective of the public sector. We will use the data collected in WPs 1 and 3 to undertake the health economic evaluation.

12.2 Collection of cost data

We will collect data on school-level resource use related to physical activity, sport, and PE through a researcher-assisted survey/audit with school leadership teams in both intervention and control schools. This process will capture relevant resource investments, including retrospective financial information from CAS delivery as part of JU:MP, and ongoing expenditures in both intervention and control settings, forming the basis for the economic analysis. To minimise burden on schools, this data collection will be integrated into the WP3 data collection procedures (see section 13.2) and conducted towards the end of each data collection year (Years 5 and 7). Working in collaboration with headteachers and business managers, researchers will gather information on estimated staff hours for physical activity-related roles, planned use of PE and School Sport Premium funding, additional physical activity spending, staff training activities, and key physical activity initiatives, with associated time and cost estimates.

12.3 Outcomes

Work Package 2 outcomes include total and disaggregated costs associated with CAS delivery at school and pupil level, resource use related to physical activity provision in intervention and control schools, and incremental costs of CAS compared with usual practice. Cost-effectiveness outcome measures include cost per unit change in health-related quality of life derived from EQ-5D-Y, cost per unit change in moderate-to-vigorous physical activity (MVPA) and modelled long-term outcomes including quality-adjusted life years (QALYs) and lifetime healthcare costs. These outcomes inform both the within-study cost-consequences analysis and the model-based economic evaluation.

12.4 Analysis

12.4.1 Within-study cost-consequences analysis

Data on resource use and CAS-related expenditures will be valued using published unit costs and combined to estimate total costs per participating school and per child. Additional costs associated with training and intervention delivery will be estimated from the perspective of participating schools; no direct resource implications for families are anticipated (68). Health benefits will be assessed in terms of changes in health-related quality of life, measured using EQ-5D-Y. At present, a UK value set for EQ-5D-Y is not available. If a UK value set becomes available prior to analysis, it will be used to estimate QALYs. Otherwise, alternative value sets (e.g., UK EQ-5D-3L and European EQ-5D-Y) will be explored in sensitivity analyses, consistent with current methodological guidance and NICE reference-case principles (69). Expected incremental costs and outcomes, including MVPA minutes and health-related quality of life, will be estimated using regression models to explore variation in costs and consequences between intervention and control schools. The influence of baseline characteristics on resource use, costs and outcomes will be assessed using appropriate regression approaches, including generalised linear models for cost data (70). Descriptive statistics (means, standard deviations, and interquartile ranges) for resource use, total costs and outcomes will be reported at baseline and at each follow-up point.

12.4.2 Model-based economic analysis

To estimate the longer-term implications of observed changes in MVPA on chronic disease outcomes, QALYs and resource use over the life course, we will adapt a physical activity cost-effectiveness model previously developed for adolescent populations (71). This age- and sex-dependent state transition Markov model incorporates published evidence linking physical activity to long-term health outcomes, including cardiovascular disease, type 2 diabetes and selected cancers. For this study, the model will be extended to reflect childhood populations, incorporate impacts on mental health, and explore distributional effects (e.g. by area-level deprivation). Model inputs will include changes in MVPA (minutes/day), health-related quality of life and intervention costs. Results will be presented as incremental mean costs per incremental QALY gained, where appropriate. Uncertainty will be explored using probabilistic sensitivity analysis, and structural uncertainty will be assessed through scenario analyses. Long-term costs and health outcomes will be discounted at 3.5% per annum, in line with NICE guidance (69).

13. Work Package 3: Implementation and sustainability

13.1 Research design

A convergent mixed-method design will be used to assess CAS implementation annually whereby qualitative and quantitative data will be collected and analysed concurrently to provide a comprehensive understanding of change over time.

13.2 Sampling and recruitment

This WP will explore CAS implementation in all 16 intervention schools included in WP1. Factors associated with sustained implementation at the wider system, organisational and individual levels will be explored, thus participants will include headteacher(s), senior leadership team (SLT) representatives, teachers, in-school CAS leads, other school staff and wider stakeholders (n=~8 per school) and Bradford CAS Champions (n=5). To explore the counterfactual, and contribute to data collection for WP2, we will also recruit a member of the SLT from each control school. Invitations to participate will be sent via email with a detailed information sheet. Written informed consent will be obtained from all participants prior to data collection.

13.3 Data collection procedures

Based on previously used procedures (33), which align with the CAS annual cycle and schools' strategic planning, we will collect the following between May - July annually:

- Factors associated with sustained implementation will be assessed via school stakeholder completion of the *School-wide Universal Behaviour Sustainability Index- School Teams (SUBSIST)* web-based survey (72).
- Summaries of the schools' implementation journeys (using SUBSIST data and *CAS profile tool data*) will facilitate annual in-person *semi-structured interviews* with SLT members and in-school CAS leads with the intervention schools. Breadth and depth of implementation within each school will be assessed via an implementation *quality (IQ)* measure. This is being co-developed and piloted with school stakeholders experienced in CAS implementation (external funding secured, tool to be available Mar26).
- *Semi-structured interviews* with a member of SLT from the control schools will be conducted to explore their physical activity provision.

All interviews will be audio recorded and transcribed verbatim.

In addition, each year we will capture:

- CAS engagement via completion of the CAS profile tool, attendance at community of practice events, CAS Champion contact (frequency and type) and CAS project involvement (number & role).
- CAS Champions' knowledge of the schools' implementation journey via semi-structured *focus groups* to coincide with annual training (Jan27, 28 & 29).
- Insights into strategic influences on long-term implementation and impact of physical activity provision through key school documents (e.g. school development plans).

13.4 Outcomes

Work Package 3 outcomes relate to the quality and sustainability of CAS implementation over time. These include measures of implementation depth and quality at school level; organisational sustainability indicators such as leadership engagement and integration of CAS within school systems; engagement with CAS components (including use of the CAS profile tool, participation in communities of practice and CAS Champion contact); perceived facilitators and barriers to sustained implementation; and evidence of adaptation of CAS components across different school contexts. Implementation and sustainability outcomes are assessed annually in intervention schools.

13.5 Analysis

13.5.1 Quantitative analysis.

Survey data will be analysed using descriptive statistics (means and standard deviations for continuous variables) to summarise implementation and sustainability indicators. Inferential analyses will be undertaken to explore variation in organisational and individual-level characteristics, implementation quality and sustainability over time and between schools, where appropriate.

13.5.2 Qualitative analysis.

Interview and focus group data will be analysed using a structured and transparent qualitative approach. Data will first be analysed inductively using codebook thematic analysis (73) to identify patterns across participants and time points. Findings will then be examined deductively using a Framework approach (74), mapped to a priori themes adapted from McKay et al.'s Implementation Evaluation Roadmap (26). This combined approach will support systematic exploration of how implementation processes evolve over time and within different school contexts.

13.5.3 Documentary analysis.

Strategic school documents related to physical activity provision (e.g. school policies, school development plans and PE and Sport Premium reports) will be analysed using content analysis. Coding will be guided by a priori themes focusing on (i) school physical activity provision, (ii) implementation processes and (iii) perceived impact, aligned with the four domains of the CAS framework (Policy, Environment, Stakeholders and Opportunities).

13.5.4 Integration of data sources.

A convergence coding matrix will be used to synthesise findings within and across cases (schools), integrating quantitative and qualitative evidence. This will support identification of patterns, divergences and meta-themes relevant to implementation quality, sustainability and contextual variation (75).

14. Work Package 4: Integration and contribution analysis

14.1 Study design

Work Package 4 uses a theory-based evaluation approach to integrate evidence from the effectiveness (WP1), cost-effectiveness (WP2) and implementation (WP3) evaluations. The purpose of WP4 is to strengthen causal inference for CAS as a complex, system-level intervention and to explain variation in outcomes across schools and population subgroups.

WP4 applies Contribution Analysis, a structured theory-based approach designed to assess whether an intervention is a plausible contributory cause of observed outcomes, while explicitly considering alternative explanations (42, 43). Contribution Analysis is well suited to complex public health interventions delivered in real-world systems where randomisation is not feasible and outcomes emerge from interactions between multiple components and contextual influences (43, 76). Although its application within health intervention evaluation remains limited, recent methodological work supports its use within mixed-methods designs such as that proposed here (43, 76-78).

Using this approach, WP4 addresses the overarching question: **To what extent, and through which mechanisms, have the key components of CAS plausibly contributed to observed long-term changes in children's outcomes, and how does this contribution vary across school contexts?**

WP4 will follow the six-step Contribution Analysis process outlined by Mayne (43, 76), adapted to the context of school-based physical activity systems (see Figure 5).

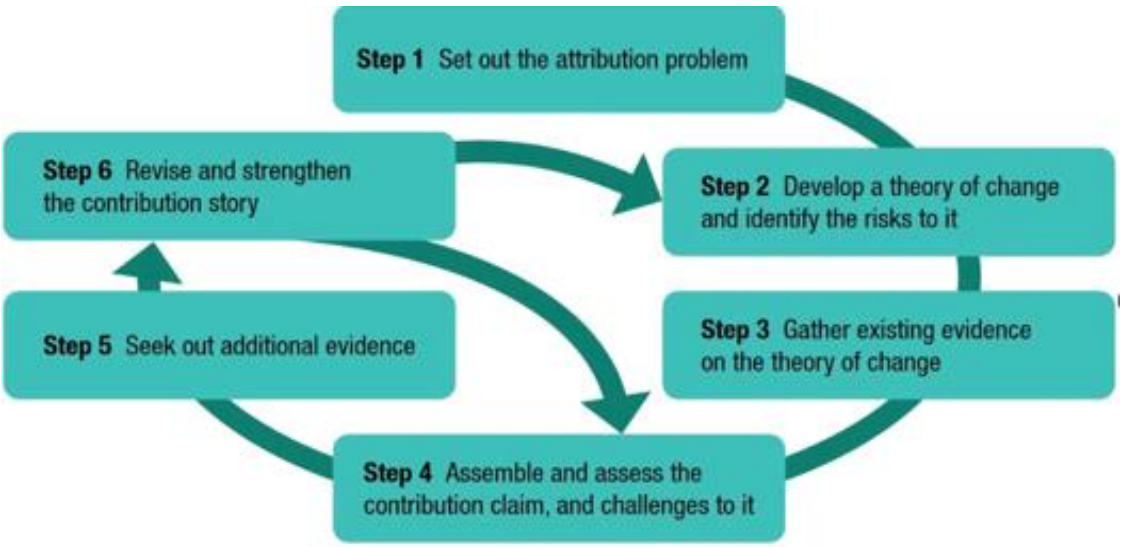


Figure 5: 6-step process contribution analyses (from Apgar et al 2020 (78))

14.3 Outcomes

Outcomes for WP4 include refined theories of change describing how CAS components plausibly contribute to observed outcomes; integrated contribution narratives combining effectiveness, economic and implementation evidence; identification of contextual and implementation conditions associated with stronger or weaker impacts; and systematic assessment of alternative explanations for observed changes. These outcomes support causal interpretation, enhance external validity and inform judgments about transferability and scalability of CAS and similar whole-school approaches.

14.3 Procedures & analysis

WP4 will integrate data generated in WPs 1–3 with the published CAS logic model (27) to construct and iteratively refine a contribution narrative. Activities are aligned to the six stages of Contribution Analysis.

Step 1: Defining the attribution problem - At the start of the project, a stakeholder workshop will be convened involving approximately nine stakeholders, including in-school CAS leads (n=2), headteachers (n=2), CAS Champions (n=2), the Bradford CAS programme manager (n=1) and representatives from the CAS national team (n=2). The purpose of this workshop is to define and agree the attribution problem, identify key CAS components of interest, and consider other plausible influences on outcomes at school and system levels.

Step 2: Developing theories of change - With the same stakeholder group, we will co-develop a theory of change describing how CAS is expected to contribute to long-term outcomes. This will be informed by the published CAS COM-B-based logic model (27), which provides a robust behavioural and implementation theory foundation for Contribution Analysis. An overarching theory of change will be developed alongside nested theories describing specific causal pathways for key CAS components (e.g. CAS profile tool, Communities of Practice), including explicit assumptions underpinning each pathway.

Step 3: Assembling the evidence base - Quantitative and qualitative data generated through WP1 (effectiveness), WP2 (cost-effectiveness) and WP3 (implementation and sustainability) will form the primary evidence base. Where the theory of change identifies critical evidence gaps, limited additional analyses may be undertaken using existing data sources. Additional primary data collection is not anticipated.

Step 4: Developing the initial contribution narrative - Evidence will be synthesised to produce an initial contribution narrative describing how CAS implementation was sustained over time and how this may plausibly contribute to observed long-term outcomes and variation between schools. A face-to-face stakeholder workshop will be used to critically assess the strength of evidence across causal links, challenge assumptions, identify alternative explanations, and explore the relative influence of child characteristics and broader contextual factors. This process will explicitly consider the possibility of multiple causal pathways operating in different school contexts.

Step 5: Seeking additional evidence and refinement - Where weaknesses or uncertainties in the contribution narrative are identified, additional analyses of effectiveness or implementation data may be conducted to strengthen the evidence base. This stage is expected to rely on secondary analyses rather than further primary data collection.

Step 6: Revising and validating the contribution narrative - The contribution narrative will be revised in light of additional evidence and stakeholder feedback. A final stakeholder workshop will be convened to assess whether the narrative has been sufficiently strengthened and whether the evidence supports CAS as a plausible contributory cause of observed outcomes. Iteration between Steps 4 and 6 will occur as required.

14.4 Value of the contribution analysis

By integrating evidence across outcome, economic and implementation domains, WP4 moves beyond simple attribution to develop a nuanced understanding of how CAS operates within complex school systems. This approach supports interpretation of null, mixed or differential effects, strengthens external validity, and provides actionable insights for policymakers and practitioners regarding the conditions under which CAS is most likely to be effective, sustainable and equitable. Over time, such theory-informed integration can support more informed decisions about scaling, adaptation and investment in whole-school physical activity approaches, with the potential to reduce inequalities in physical activity and health outcomes between more and less advantaged children.

15. Work Package 5: Knowledge mobilisation

15.1 Purpose and approach

Work Package 5 (WP5) ensures that learning from the evaluation is actively mobilised throughout the programme to maximise relevance and uptake by policy, practice and research audiences. WP5 is embedded across the full project lifecycle and is delivered in partnership with the Public and Professional Advisory Group (PPAG) and supported by the Study Steering Committee (SSC). The approach is co-productive and iterative: early engagement will prioritise shaping outputs around decision needs and implementation realities, with subsequent activities responding to emerging findings from WPs 1–4.

15.2 Outcomes

WP5 outcomes relate to the reach, engagement and uptake of study findings. These include co-produced policy briefs and practice-facing summaries; a whole-school physical activity implementation toolkit; delivery of knowledge exchange events; and evidence of dissemination reach and stakeholder engagement (e.g. attendance, feedback and digital analytics). These outcomes are monitored throughout the programme to inform adaptive knowledge mobilisation.

15.2 Audiences, outputs and activities

WP5 targets three primary audiences:

- Policy audiences, including national and regional decision-makers (e.g., Department for Education, Sport England and relevant public health bodies).
- Practice audiences, including school leaders, teachers, localities, and sector organisations supporting whole-school physical activity.
- Research audiences, including public health, education and implementation science communities.

Activities are designed to move beyond dissemination and support practical use. Outputs will include (i) accessible products for schools and families, (ii) implementation-focused resources to support scale and sustainability, and (iii) policy-facing syntheses aligned to investment decisions. A detailed knowledge mobilisation plan will be refined within nine months of project initiation, drawing on PPAG and SSC input and aligned to the timing of interim and final findings.

Key outputs and engagement routes include: policy briefs (including early insights and needs analysis informed by CAS profiling data), annual educational stakeholder updates, practice publications and presentations (e.g., sector-facing outlets and conferences), peer-reviewed open-access research articles and conference presentations, and ongoing communications through newsletters and social media. Two policy–practice–research knowledge exchange events will convene stakeholders to test emerging interpretations, share learning and support translation into system action. In addition, the programme will produce accessible video outputs for (i) parents and children and (ii) school and national stakeholders.

A major applied output will be a whole-school physical activity implementation toolkit, incorporating best-practice guidance, implementation prompts and case study examples, hosted on the CAS digital hub (www.creatingactiveschools.org) and designed to support both adoption and sustained delivery.

15.3 Mapping outputs to audiences

Table 1. Mapping dissemination, knowledge mobilisation and outputs to target audiences

Dissemination and output approach	Policy	Practice	Research
Policy briefs (e.g., DfE, WHO) including early findings and needs analysis using CAS profile data	✓		
Toolkit for the implementation of whole-school physical activity approaches	✓	✓	✓
Policy, practice and research knowledge exchange events (x2)	✓	✓	✓
Annual educational stakeholder updates		✓	
Parent and child video		✓	
School and national stakeholder video	✓	✓	✓
Practice publications and presentations (e.g., TES, NAHT)		✓	
High-impact open-access research articles (x6)	✓		✓
Research conference presentations (e.g., ISPAH, BERA)			✓
Social media promotion (ongoing)	✓	✓	✓

15.4 Knowledge exchange events and existing infrastructure for impact

The knowledge exchange events will build on existing infrastructure and established networks developed through whole-school physical activity knowledge mobilisation in Bradford and nationally. They will be designed to support two-way exchange, including interpretation of interim findings, identification of practice implications, and refinement of the implementation toolkit and policy outputs.

15.5 Public, school and wider stakeholder engagement

Communication and engagement activities will be designed to ensure that schools, families and wider stakeholders remain informed and able to interact with the study throughout delivery. Engagement will be supported through school-friendly updates, accessible outputs (including video resources), and routes for feedback via PPAG and existing school networks. Where appropriate, interim summaries will be shared with participating schools in formats that support understanding and practical action (e.g., anonymised year-group wellbeing summaries and brief implementation learning updates).

15.6 Pathways to impact

WP5 is designed to ensure that outputs enter policy and practice systems through established routes and trusted intermediaries. The team's existing connections with national organisations (e.g., Sport England, afPE, DfE, OHID) and international networks (e.g., WHO, HEPA Europe) provide clear pathways for translation into guidance, commissioning and future place-based investment decisions. Practice-facing outputs will be designed for usability within school improvement systems, including research school networks and sector bodies, supporting adoption and adaptation beyond Bradford.

15.7 Timeline

Knowledge mobilisation activities will take place throughout the programme, with outputs aligned to project milestones and emerging findings. The detailed mobilisation plan will be finalised within nine months of project initiation. Interim outputs (e.g., early policy briefs and stakeholder updates) will be scheduled to support decision points during delivery, with major outputs (implementation toolkit, videos, knowledge exchange events and final policy syntheses) aligned to completion of WP1–WP4 analyses and interpretation workshops.

16. Public and Community Involvement, Engagement and Participation (PCIEP)

Public and Community Involvement, Engagement and Participation (PCIEP) is embedded throughout the design, delivery, analysis and dissemination of this study. Activities build on established partnerships developed through the earlier evaluation of Creating Active Schools (CAS) and the wider JU:MP programme in Bradford, providing a strong foundation for sustained and inclusive involvement across the study lifecycle.

16.1 Structures and governance

The study is supported by two advisory structures: a Public and Professional Advisory Group (PPAG) and a Children and Young People's Advisory Group (CYPAG). Membership includes parents/carers, school staff, community representatives, practitioners and children from participating communities. The PPAG comprises members of the public (n=2), public health practitioners (n=1), locality leads (n=1), headteachers (n=1) and teachers (n=1). The CYPAG includes six children and young people recruited from diverse neighbourhoods within Bradford. Advisory groups will meet at regular intervals, with meetings held in accessible community venues where appropriate. Their role is to provide advice, challenge and oversight to ensure study activities remain relevant, acceptable and sensitive to community needs. PCIEP representatives may also contribute to relevant Study Management Group discussions.

16.2 Integration across Work Packages

PCIEP input is integrated across all Work Packages. Contributors have informed, and will continue to inform, outcome selection, recruitment and data collection procedures (WP1); interpretation of economic findings and perceptions of value and feasibility (WP2); refinement of qualitative tools and interpretation of implementation findings (WP3); development and refinement of theories of change and contribution narratives (WP4); and co-production of dissemination outputs and engagement activities (WP5).

16.3 Engagement with underserved communities

Given the study focus on multi-ethnic and socioeconomically deprived communities, PCIEP activities are designed to support inclusive engagement. This includes the use of accessible language, translated materials where appropriate, flexible meeting formats and timing, and support for families for whom English is not a first language. Children's involvement will be supported through age-appropriate, interactive methods delivered by researchers experienced in working with children in school and community settings.

16.4 Feedback and impact

The influence of PCIEP on study design, conduct and outputs will be documented throughout the project. Feedback from advisory groups will be used to refine procedures and dissemination activities on an ongoing basis. Contributions will be acknowledged in study outputs in line with NIHR guidance.

17. Equality, diversity and inclusion (EDI)

Equality, diversity and inclusion are integral to the design, conduct, analysis and dissemination of this study. The research explicitly focuses on multi-ethnic and socioeconomically deprived communities, where children experience disproportionately lower physical activity levels and poorer health outcomes. EDI considerations have informed the research questions, study design, recruitment and data collection procedures, analytical approach and knowledge mobilisation across all Work Packages.

17.1 Study design and setting

The study is conducted in Bradford, an area characterised by high ethnic diversity and socioeconomic deprivation. Participating schools serve populations with a high proportion of children from Black, Asian and other minority ethnic backgrounds and from households experiencing socioeconomic disadvantage. Focusing on this setting aligns directly with NIHR priorities on health inequalities and the generation of evidence relevant to underserved populations. The natural experimental design enables inclusion of schools and communities often underrepresented in randomised trials, while matching intervention and control schools on deprivation and ethnic composition supports equity in comparisons.

17.2 Recruitment and participation

Recruitment strategies are designed to maximise inclusive participation among children, families and schools. All children in Years 1–3 in participating schools are eligible to take part in Work Package 1, reducing selection bias. Parental consent materials are provided in accessible formats, with translated versions and additional support for families for whom English is not a first language. Data collection procedures are designed to be inclusive and sensitive to children's needs, with anthropometric measurements conducted in private, child-appropriate settings. Participation is voluntary, with clear options to withdraw at any time without consequence.

17.3 Measurement and data collection

Outcome measures capture a broad range of impacts relevant to diverse populations, including physical activity, health, wellbeing and educational outcomes. Validated instruments with evidence of use across diverse populations are employed where possible. Implementation data collected in Work Package 3 explicitly explore how contextual factors, including school demographics, resource constraints and community characteristics, influence delivery and sustainability of CAS, supporting assessment of equity in implementation and impact.

17.4 Analysis and interpretation

Analytical plans explicitly examine differential effects by gender, ethnicity and socioeconomic position. In Work Package 1, subgroup analyses will explore whether intervention effects differ across these characteristics, with interpretation focused on implications for health inequalities. In Work Package 2, economic analyses will consider whether costs and benefits vary across contexts, supporting assessment of equitable value for money. In Work Packages 3 and 4, qualitative and mixed-methods analyses will examine how implementation processes and contextual factors shape equitable delivery and outcomes.

17.5 Knowledge mobilisation

Knowledge mobilisation activities (Work Package 5) are designed to ensure findings are accessible and relevant to diverse audiences. Dissemination materials will use inclusive language and formats, and engagement activities will prioritise schools and communities serving underserved populations. Findings relating to equity and differential impact will be explicitly highlighted in outputs for policymakers and practitioners to support evidence-informed decision-making aimed at reducing inequalities.

18. Ethics and safeguarding

This study will be conducted in accordance with the Declaration of Helsinki, the UK Policy Framework for Health and Social Care Research, and all applicable regulatory and institutional requirements. Ethical approval will be obtained prior to the commencement of any data collection activities. The study involves children, school staff and community stakeholders, and includes comprehensive procedures to ensure ethical conduct, participant welfare and safeguarding across all Work Packages.

18.1 Ethical approval and oversight

A single, integrated ethics application will be submitted to the appropriate University Research Ethics Committee to cover all Work Packages within this programme of research. Any additional approvals required from external bodies, including local authorities, schools or data custodians (e.g. Department for Education for National Pupil Database access), will be obtained prior to data collection. Substantial protocol amendments will be submitted for ethical review and approval prior to implementation, in line with institutional procedures.

18.2 Informed consent and assent

Informed consent and assent procedures will be applied consistently across the study and tailored to participant groups.

For Work Package 1, written informed consent will be obtained from parents or legal guardians prior to children's participation in data collection. Children will also be asked to provide age-appropriate written assent, while verbal consent will be sought before every measure is taken. Participant information sheets for parents/carers and children will be written in clear, accessible language and will describe the purpose of the study, what participation involves, potential risks and benefits, data handling arrangements and the voluntary nature of participation.

For Work Packages 2 and 3, written informed consent will be obtained from adult participants, including school leaders, teachers, CAS Champions and other stakeholders, prior to participation in interviews, surveys or audits.

Participation in Work Packages 4 and 5 (e.g. stakeholder workshops and knowledge mobilisation activities) will also be voluntary, with informed consent obtained as appropriate for each activity.

All participants will be informed that they may withdraw from the study, or from specific components of data collection, at any time without providing a reason and without any adverse consequences.

18.3 Risks, burden and participant welfare

The study involves minimal risk to participants. Data collection methods used in Work Package 1, including accelerometry, anthropometric measurement and questionnaires, are non-invasive and have been used safely in previous research with children in school settings. Any potential discomfort or embarrassment associated with anthropometric measurements will be minimised through the use of private, child-appropriate spaces and trained researchers.

For adult participants, the primary burden relates to the time required for interviews, surveys and audits. Data collection schedules will be agreed in advance with schools and participants to minimise disruption to school activities and workloads.

18.4 Safeguarding

Safeguarding is a priority across all Work Packages involving children and school settings. All researchers involved in data collection will hold up-to-date Disclosure and Barring Service (DBS) clearance and will receive training in safeguarding and working with children. Researchers will adhere to school safeguarding policies at all times while on school premises.

Any safeguarding concerns identified during data collection will be reported immediately in line with school safeguarding procedures and the study safeguarding protocol. The Chief Investigator will be informed of any safeguarding incidents, and appropriate actions will be taken in consultation with designated safeguarding leads.

18.5 Data protection and confidentiality

Ethical conduct of the study includes strict adherence to data protection and confidentiality requirements, which are described in detail in Section 24. Personal identifiable information will be minimised, stored securely and accessed only by authorised members of the research team.

18.6 Adverse events

Given the low-risk nature of the study, serious adverse events are not anticipated. Any adverse events or unanticipated problems related to study participation will be documented and reported in accordance with institutional policies and the conditions of ethical approval.

19. Confidentiality and data protection

This study will be conducted in full compliance with the UK General Data Protection Regulation (UK GDPR), the Data Protection Act 2018, and institutional policies relating to data protection and information governance. Procedures have been designed to ensure that participant confidentiality is maintained at all stages of the research and that personal data are processed lawfully, fairly and transparently.

19.1 Lawful basis for processing

The lawful basis for processing personal data under UK GDPR is that the processing is necessary for the performance of a task carried out in the public interest, namely public health research. Where special category data are processed, this will be on the basis that the processing is necessary for scientific research purposes, with appropriate safeguards in place. Participants will be provided with clear information about how their data will be collected, stored, used and shared as part of the informed consent process described in Section 18.

19.2 Data minimisation and anonymisation

Only data necessary to address the study aims and research questions will be collected. Each participant will be assigned a unique study identifier, which will be used on all research data. Personal identifiable information (e.g. names, dates of birth, contact details) will be stored separately from research data and will not be included in analysis datasets. Where possible, data will be anonymised or pseudonymised at the earliest opportunity. Identifiable data will only be accessible to authorised members of the research team who require access for specific study purposes.

19.3 Data storage and security

Electronic data will be stored on secure, password-protected servers hosted by the participating universities, with access restricted to named members of the research team. Appropriate technical and organisational measures will be in place to protect against unauthorised access, loss or disclosure. Paper-based data, where collected, will be stored in locked filing cabinets within secure university premises. Data transferred between research sites will be encrypted and transferred using secure methods approved by institutional information governance teams.

19.4 Access to routinely collected data

Educational data accessed via the National Pupil Database will be obtained following approval from the Department for Education and accessed only by researchers with appropriate accreditation. These data will be accessed and analysed within approved secure research environments, and outputs will be subject to disclosure control procedures to prevent identification of individuals or schools.

19.5 Data sharing and publication

Anonymised data may be shared with collaborators or deposited in appropriate data repositories in line with NIHR open research principles and institutional policies. Any data sharing will be governed by formal data sharing agreements and will ensure that participants cannot be identified.
Findings from the study will be reported in aggregate form only. No individual participant, school or staff member will be identifiable in publications, reports or dissemination materials.

19.6 Data retention and destruction

Data will be retained for the period of 10 years, which is the University of Bradford process. This time frame allows for audit, secondary analysis and verification of findings. At the end of the retention period, sensitive and identifiable data will be securely destroyed in accordance with institutional data disposal procedures.

20. Conflicts of interest and research independence

This section describes arrangements to identify, manage and mitigate potential conflicts of interest and to ensure the scientific independence of the research.

20.1 Declaration of interests

Members of the research team have been involved in the development, delivery and evaluation of the Creating Active Schools (CAS) programme. This includes academic leadership in programme design and ongoing collaboration with policy and practice partners involved in CAS delivery. These relationships are transparently declared and reflect the embedded nature of the research within real-world public health practice. No member of the research team has any financial interest in CAS or its associated tools, platforms or training materials.

20.2 Management of potential conflicts of interest

To mitigate the risk of perceived or actual conflicts of interest, clear governance and management arrangements are in place. Oversight of the study is provided through a Study Management Group and an independent Study Steering Committee, which includes members who are independent of CAS development and delivery. Decisions relating to study design, analysis and interpretation will be documented and subject to oversight by these governance structures. Any potential conflicts of interest arising during the course of the study will be declared and managed in accordance with institutional policies.

20.3 Research independence

Scientific independence is ensured through several mechanisms. Statistical analyses of primary and secondary outcomes will be undertaken by analysts who are independent of CAS programme delivery and, where feasible, blinded to intervention allocation until analysis plans are finalised and datasets are locked. Health economic analyses will be led by investigators who are not involved in CAS delivery. Implementation and qualitative analyses will be conducted using transparent and systematic analytic approaches, with findings subject to team discussion and independent challenge to avoid undue influence from programme involvement.

20.4 Independence in reporting and dissemination

The research team retains full independence in the analysis, interpretation and reporting of findings. Funders and delivery partners will not have editorial control over study outputs. Results will be reported honestly and transparently, regardless of whether findings demonstrate positive, null or negative effects. Any deviations from the protocol or analysis plans will be documented and justified in reporting, in line with good research practice.

21. Dissemination and knowledge mobilisation

Dissemination and knowledge mobilisation activities are led within WP 5 and embedded throughout the study. This section provides an overview of how findings from the study as a whole will be reported and shared in a timely, accessible and responsible manner.

The overarching objectives are to ensure that study findings inform policy and practice decision-making, contribute to the academic evidence base, and support the wider adoption of evidence-informed whole-school physical activity approaches. Dissemination will be proportionate to the stage of the study and will prioritise clear communication of findings, including uncertainties and limitations. Study findings will be disseminated to policy, practice, research and public audiences through a combination of peer-reviewed publications, policy- and practice-facing outputs, and stakeholder engagement activities as described in WP 5. Academic outputs will be submitted to appropriate journals and presented at relevant conferences, with publications made open access wherever possible in line with NIHR requirements. All findings will be reported in aggregate form only, ensuring that no individual participant, school or community can be identified. Participating schools and stakeholders will receive accessible summaries of findings at appropriate stages of the study, supporting transparency, trust and ongoing engagement.

22. Study timeline and milestones

This study will be conducted over a seven-year period to enable assessment of sustained implementation and long-term outcomes associated with the Creating Active Schools (CAS) programme. The timeline aligns with continued CAS delivery in Bradford and is structured to support iterative data collection, analysis, integration and dissemination across the five Work Packages. All dates are indicative and subject to minor adjustment following ethical approval and school-level scheduling.

24.1 Overview of study phases

The study comprises three overlapping phases:

1. **Set-up and preparation (2026):** ethical approvals, school re-engagement and refinement of procedures
2. **Data collection and analysis (2026–2029):** five- and seven-year follow-up data collection, implementation evaluation and economic analyses
3. **Integration and dissemination (2027–2030):** contribution analysis, synthesis of findings and staged knowledge mobilisation

24.2 Work Package timelines (summary)

WP1 (Long-term effectiveness): repeated cross-sectional follow-up data collection at approximately five (2026–27) and seven years (2028–29) post-baseline, followed by final outcome analyses

WP2 (Cost-effectiveness): collection of school-level cost data aligned with follow-up waves, with within-study and model-based analyses completed by 2030

WP3 (Implementation and sustainability): annual implementation data collection in intervention schools (2026–2029) with ongoing qualitative and quantitative analysis

WP4 (Integration and contribution analysis): iterative integration of effectiveness, economic and implementation findings, with interim (post five-year follow-up) and final contribution analyses

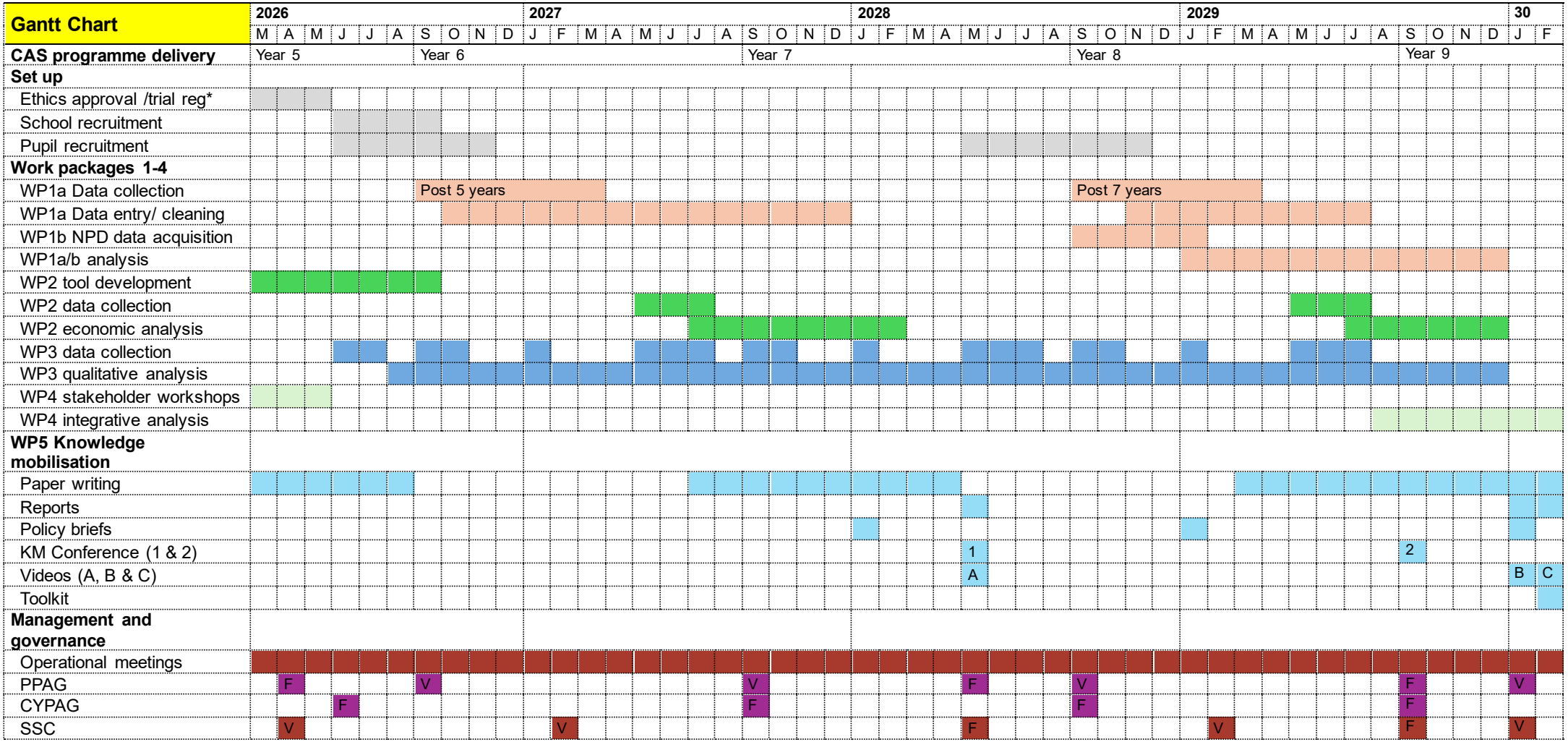
WP5 (Knowledge mobilisation): embedded throughout the study, with interim dissemination aligned to five-year findings and final outputs following completion of analyses

24.3 Key milestones

Key milestones include:

- Ethical and governance approvals obtained (early 2026)
- Completion of five-year follow-up data collection (2027)
- Completion of seven-year follow-up data collection (2029)
- Completion of effectiveness, economic and implementation analyses (late 2029)
- Completion of integration and contribution analysis (mid-2030)
- Delivery of final dissemination and knowledge exchange outputs (2029–2030)

Progress against milestones will be monitored by the Study Management Group and reported to the funder in line with NIHR reporting requirements.



**Ethics submission to be completed upon grant award. NPD: National Pupil Database. KM: knowledge mobilisation (1 interim; 2 final). Videos (A- stakeholder interim; B-final parent/child; C- final stakeholder) PPAG: Professional & Public Advisory Group. CYPAG: Children & Young People's Advisory Group. SSC: Study Steering Group. F: face-to-face meeting. V: virtual meeting. ^:* 2 technical staff appointed during each time block, part-time hourly paid Grade 4 technical staff to support.

25. Protocol amendments

Any amendments to this protocol will be reviewed, approved and documented in accordance with institutional policies, sponsor requirements and ethical approval conditions. The Study Management Group (SMG) will oversee all proposed amendments and determine whether they are substantial or non-substantial. Substantial amendments will be submitted for approval to the appropriate Research Ethics Committee, sponsor and any relevant oversight bodies prior to implementation. All approved amendments will be version-controlled, logged and communicated as appropriate to participating schools and stakeholders.

26. References

1. World Health O. Global action plan on physical activity 2018–2030: More active people for a healthier world. Geneva: World Health Organization; 2018.

2. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. The Lancet. 2012;380(9838):219-29.

3. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020;54(24):1451-62.

4. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7:40.

5. Biddle SJH, Ciaccioni S, Thomas G, Vergeer I. Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. Psychology of Sport and Exercise. 2019;42:146-55.

6. Singh A, Uijtdewilligen L, Twisk JW, van Mechelen W, Chinapaw MJ. Physical activity and performance at school: a systematic review of the literature including a methodological quality assessment. Arch Pediatr Adolesc Med. 2012;166(1):49-55.

7. Telama R. Tracking of physical activity from childhood to adulthood: a review. Obes Facts. 2009;2(3):187-95.

8. Jones RA, Hinkley T, Okely AD, Salmon J. Tracking physical activity and sedentary behavior in childhood: a systematic review. Am J Prev Med. 2013;44(6):651-8.

9. Sport E. Active Lives Children and Young People Survey Academic year 2023-24. London: Sport England; 2024.

10. Love RE, Adams J, van Sluijs EMF. Equity effects of children's physical activity interventions: a systematic scoping review. International Journal of Behavioral Nutrition and Physical Activity. 2017;14(1):134.

11. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. Lancet Child Adolesc Health. 2020;4(1):23-35.

12. Pickett K, Taylor-Robinson D, Erlam J. Child of the North: Building a fairer future after COVID-19. Newcastle upon Tyne: The Northern Health Science Alliance and N8 Research Partnership; 2021 2021/12.

13. World Health O. Global health risks: mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization; 2009.

14. Bingham DD, Daly-Smith A, Hall J, Seims A, Dogra SA, Fairclough SJ, et al. Covid-19 lockdown: Ethnic differences in children's self-reported physical activity and the importance of leaving the home environment; a longitudinal and cross-sectional study from the Born in Bradford birth cohort study. International Journal of Behavioral Nutrition and Physical Activity. 2021;18:1-19.

15. Department of H, Social C. DHSC's areas of research interest. London: Department of Health and Social Care; 2023 2023/01.

16. Scarborough P, Bhatnagar P, Wickramasinghe KK, Allender S, Foster C, Rayner M. The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006-07 NHS costs. J Public Health (Oxf). 2011;33(4):527-35.

17. Daly-Smith A, Quarmby T, Archbold VS, Corrigan N, Wilson D, Resaland GK, et al. Creating Active Schools Framework: driving system change to improve children's physical activity. 2020.

18. Department for E. Length of the school week: non-statutory guidance. London: Department for Education; 2023.

19. Department for E. PE and sport premium for primary schools. London: Department for Education; 2024.

20. Moeller NC, Oestergaard L, Rasmussen MGB, Schmidt-Persson J, Larsen KT, Juhl CB. How to get children moving? The effectiveness of school-based interventions promoting physical activity in children and adolescents – A systematic review and meta-analysis of randomized controlled- and controlled studies. Health & Place. 2024;89:103333.

21. Cassar S, Salmon J, Timperio A, Naylor P-J, van Nassau F, Contardo Ayala AM, Koorts H. Adoption, implementation and sustainability of school-based physical activity and sedentary behaviour interventions in real-world settings: a systematic review. International Journal of Behavioral Nutrition and Physical Activity. 2019;16(1):120.

22. Ding D, Chastin S, Salvo D, Nau T, Gebel K, Sanchez-Lastra MA, et al. Realigning the physical activity research agenda for population health, equity, and wellbeing. Lancet. 2024;404(10451):411-4.

23. Milton K, Cavill N, Chalkley A, Foster C, Gomersall S, Hagstromer M, et al. Eight Investments That Work for Physical Activity. J Phys Act Health. 2021;18(6):625-30.

24. World Health O. Making every school a health-promoting school: global standards and indicators. Geneva: World Health Organization; 2021.

25. Wiltsey Stirman S, Kimberly J, Cook N, Calloway A, Castro F, Charns M. The sustainability of new programs and innovations: a review of the empirical literature and recommendations for future research. Implementation Science. 2012;7(1):17.

26. McKay H, Naylor PJ, Lau E, Gray SM, Wolfenden L, Milat A, et al. Implementation and scale-up of physical activity and behavioural nutrition interventions: an evaluation roadmap. Int J Behav Nutr Phys Act. 2019;16(1):102.

27. Helme Z, Chalkley A, Walker T, Bartholomew J, Morris J, McLoughlin G, et al. Opening the Black Box of Implementation: Developing the Creating Active Schools Logic Model. Translational Journal of the American College of Sports Medicine. 2024;9.

28. Yorkshire NARC, Humber. JUMP (Join Us: Move & Play) Project [Available from: https://arc-yh.nihr.ac.uk/research/projects/jump-join-us-move-play/.

29. Ministry of Housing C, Local G. English indices of deprivation 2019. London: Ministry of Housing, Communities and Local Government; 2019.

30. Office for National S. Census 2021: Local authority profile – Bradford. London: Office for National Statistics; 2022.

31. Bingham DD, Daly-Smith A, Seims A, Hall J, Eddy L, Helme Z, Barber SE. Evaluation of the Effectiveness of a Whole-System Intervention to Increase the Physical Activity of Children Aged 5 to 11 Years (Join Us: Move Play, JU:MP): Protocol for a Quasiexperimental Trial. JMIR Res Protoc. 2023;12:e43619.

32. Barber SE, Bingham DD, Dawkins NP, Helme Z, Hall J, Seims A, et al. The effectiveness of JU:MP a whole system approach to improve physical activity of children aged 5 to 11 years living in multi-ethnic and socio-economically deprived communities: a non-randomised controlled trial. BMC Public Health. 2025.

33. Morris JL, Chalkley AE, Helme ZE, Timms O, Young E, McLoughlin GM, et al. Initial insights into the impact and implementation of Creating Active Schools in Bradford, UK. International Journal of Behavioral Nutrition and Physical Activity. 2023;20(1):80.

34. Helme Z. The evaluation of the implementation and impact of the Creating Active Schools programme in Bradford primary schools [Doctoral thesis]. Bradford: University of Bradford; 2025.

35. Helme ZE, Morris JL, Nichols J, Chalkley AE, Bingham DD, McLoughlin GM, et al. Assessing the Impacts of Creating Active Schools on Organisational Culture for Physical Activity. Int J Environ Res Public Health. 2022;19(24).

36. Silva ECM, Helme ZE, Silva DRP, Morris JL, Archbold VSJ, Daly-Smith A, Chalkley A. Creating Active Schools: What Influences Continuous Implementation Following Adoption? J Phys Act Health. 2026;23(1):51-62.

37. Goodman A, Sahlqvist S, Ogilvie D. New walking and cycling routes and increased physical activity: one- and 2-year findings from the UK iConnect Study. Am J Public Health. 2014;104(9):e38-46.

38. Government HM. Levelling Up the United Kingdom. London: HMSO; 2022.

39. Government HM. Childhood obesity: a plan for action. London: DHSC; 2016.

40. National Institute for H, Care R. Public Health Research (PHR) Programme: remit and scope. Southampton: NIHR; 2023.

41. Craig P, Campbell M, Deidda M, Dundas R, Green J, Katikireddi SV, et al. Using natural experiments to evaluate population health and health system interventions: new framework for producers and users of evidence. BMJ. 2025;388:e080505.

42. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ. 2021;374:n2061.

43. Mayne J. Contribution analysis: Coming of age? Evaluation. 2012;18(3):270-80.

44. Dickerson J, Lockyer B, McIvor C, Bingham DD, Crossley KL, Endacott C, et al. The impact of the COVID-19 pandemic on families living in the ethnically diverse and deprived city of Bradford: findings from the longitudinal Born in Bradford COVID-19 research programme. COVID-19 Collaborations: Policy Press; 2022. p. 73-87.

45. Frazer M, Seims A, Tatterton MJ, Lockyer B, Bingham D, Barber S, et al. Child and family experiences of a whole-systems approach to physical activity in a multiethnic UK city: a citizen science evaluation protocol. BMJ Open. 2023;13(2):e069334.

46. Hall J, Bingham DD, Seims A, Dogra SA, Burkhardt J, Nobles J, et al. A whole system approach to increasing children's physical activity in a multi-ethnic UK city: a process evaluation protocol. BMC Public Health. 2021;21(1):2296.

47. Hall J, Lever E, Dawkins N, Young E, Crowther J, Williams R, et al. Taking a partnership approach to embed physical activity in local policy and practice: a Bradford District case study. International Journal of Behavioral Nutrition and Physical Activity. 2025;22(1):3.

48. Stuart EA. Matching methods for causal inference: A review and a look forward. Stat Sci. 2010;25(1):1-21.

49. Department for E. Schools, pupils and their characteristics: January 2020. London: Department for Education; 2020 2020/06/25.

50. Campbell M, Katikireddi SV, Hoffmann T, Armstrong R, Waters E, Craig P. TIDieR-PHP: a reporting guideline for population health and policy interventions. BMJ. 2018;361:k1079.

51. Michie S, Atkins L, West R. The Behaviour Change Wheel: A Guide to Designing Interventions. Great Britain: Silverback Publishing; 2014.

52. Migueles JH, Cadenas-Sanchez C, Ekelund U, Delisle Nyström C, Mora-Gonzalez J, Löf M, et al. Accelerometer Data Collection and Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and Practical Considerations. Sports Med. 2017;47(9):1821-45.

53. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. Bmj. 2000;320(7244):1240-3.

54. Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK, 1990. Arch Dis Child. 1995;73(1):25-9.

55. Goodman R. The Strengths and Difficulties Questionnaire: a research note. J Child Psychol Psychiatry. 1997;38(5):581-6.

56. Mieloo C, Raat H, van Oort F, Bevaart F, Vogel I, Donker M, Jansen W. Validity and reliability of the strengths and difficulties questionnaire in 5-6 year olds: differences by gender or by parental education? PLoS One. 2012;7(5):e36805.

57. Fairclough SJ, Christian DL, Saint-Maurice PF, Hibbing PR, Noonan RJ, Welk GJ, et al. Calibration and Validation of the Youth Activity Profile as a Physical Activity and Sedentary Behaviour Surveillance Tool for English Youth. Int J Environ Res Public Health. 2019;16(19).

58. Ibáñez V, Silva J, Cauli O. A survey on sleep assessment methods. PeerJ. 2018;6:e4849.

59. Verstraete J, Lloyd A, Scott D, Jelsma J. How does the EQ-5D-Y Proxy version 1 perform in 3, 4 and 5-year-old children? Health Qual Life Outcomes. 2020;18(1):149.

60. Varni JW, Seid M, Rode CA. The PedsQL: measurement model for the pediatric quality of life inventory. Med Care. 1999;37(2):126-39.

61. Echeverria SE, Diez-Roux AV, Link BG. Reliability of self-reported neighborhood characteristics. J Urban Health. 2004;81(4):682-701.

62. Mâsse LC, O'Connor TM, Lin Y, Carbert NS, Hughes SO, Baranowski T, Beauchamp MR. The physical activity parenting practices (PAPP) item Bank: a psychometrically validated tool for improving the measurement of physical activity parenting practices of parents of 5–12-year-old children. International Journal of Behavioral Nutrition and Physical Activity. 2020;17(1):134.

63. Salway R, Jago R, de Vocht F, House D, Porter A, Walker R, et al. School-level intra-cluster correlation coefficients and autocorrelations for children's accelerometer-measured physical activity in England by age and gender. BMC Med Res Methodol. 2024;24(1):179.

64. Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. Jama. 2012;307(7):704-12.

65. Tudor-Locke C, Barreira TV, Schuna JM, Jr., Mire EF, Katzmarzyk PT. Fully automated waist-worn accelerometer algorithm for detecting children's sleep-period time separate from 24-h physical activity or sedentary behaviors. Appl Physiol Nutr Metab. 2014;39(1):53-7.

66. Sadeh A, Sharkey KM, Carskadon MA. Activity-based sleep-wake identification: an empirical test of methodological issues. Sleep. 1994;17(3):201-7.

67. Evenson KR, Catellier DJ, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. J Sports Sci. 2008;26(14):1557-65.

68. Devlin NJ. Valuing EQ-5D-Y: the current state of play. Health and Quality of Life Outcomes. 2022;20(1):105.

69. National Institute for H, Care E. Introduction to health technology evaluation. 2022.

70. Barber J, Thompson S. Multiple regression of cost data: use of generalised linear models. Journal of Health Services Research & Policy. 2004;9(4):197-204.

71. Gc V, Owen L, Rasmussen SR. Cost-effectiveness of physical activity interventions in adolescents: model development and illustration using two exemplar interventions. BMJ Open. 2019;9(8):e027566.

72. Kittelman A, Bromley KW, Mercer SH, McIntosh K. Validation of a Measure of Sustainability of School-Wide Behavior Interventions and Supports. Remedial and Special Education. 2018;40(2):67-73.

73. Roberts K, Dowell A, Nie JB. Attempting rigour and replicability in thematic analysis of qualitative research data; a case study of codebook development. BMC Med Res Methodol. 2019;19(1):66.

74. Ritchie J, Lewis J. Qualitative Research Practice. California, CA: SAGE Publications; 2003.

75. O'Cathain A, Murphy E, Nicholl J. Three techniques for integrating data in mixed methods studies. Bmj. 2010;341:c4587.

76. Mayne J. Revisiting Contribution Analysis. Canadian Journal of Program Evaluation. 2019;34(2):171-91.

77. Buetti D, Fitzgerald M, Barber C, Labelle PR, Bourgeois I, Aubry T, et al. The Use of Contribution Analysis in Evaluating Health Interventions: A Scoping Review. Evaluation & the Health Professions. 2024;48(3):363-73.

78. Apgar M. Contribution analysis for adaptive management. Global Learning for Adaptive Management; 2020.

26. Appendix - Summary of Creating Active Schools (CAS) Programme using the Template for Intervention Description and Replication in Public Health Programmes (TiDeR-PHP)

TiDieR-PHP Item	CAS Description		
	National Level	**Locality level**	**School level**
Why: logic, mechanisms of goals of intervention	To adopt a place-sensitive and asset-based co-production approach to support systems change for physical activity within and beyond schools	To adopt a place-sensitive and asset-based approach to promote evidence-based practice for physical activity in schools	To create a solution which transforms physical activity culture in schools by building interconnected policies, supportive environments, engaged stakeholders and structured physical activity opportunities
What materials	National support for locality leads includes: ● Guidance (job description and recruitment process) to support locality lead to recruit and designate a CAS Champion(s) ● Initial CAS Champion training programme ● A national Community of Practice (CoP) including monthly CAS Champion CPD and support webinars, and an annual conference for CAS Champions to share latest research and practice insights ● Educational support materials for CAS Champion(s) ● Termly newsletter for CAS Champions and schools ● CAS Digital Hub which includes the profiling tool, tools, resources and pupil level assessment tool and the resource bank which enables the assets developed by schools and localities to be shared nationally	Locality based support for schools includes: ● CAS Champion support for schools to: complete the profiling tool and planning for change process, review of school profile within locality and identification and implementation of individual and collective school solutions (including the identification and co-ordination of themed project groups, and monitoring and evaluating the tendering process). ● Access to the CAS Digital Hub which allows the integration of school-level data into the locality dashboard to support CAS Champion decision making, the profiling tool, tools, resources and pupil level assessment tool, and the resource bank which enables the assets developed by schools and localities to be shared nationally ● Termly CoP for in school CAS leads providing CPD and implementation support ● CAS annual knowledge mobilization conference	Support for schools includes: • Link with CAS Champion to access locality support • Access to CAS Digital Hub which provides the profiling tool to identify areas of need, Online CPD to support priority areas, assessment tool, and the resource bank which enables the assets developed by schools and localities to be shared nationally • APEASE quality assessment tool and training to be able to use it to ensure evidence-based approach to implementation • Guidance to help prioritize activities and plan for change • Formation of thematic project groups to support implementation and access to external expertise and support • Half termly CoP for in school CAS lead and other staff members providing CPD, sharing of research and practice and implementation support • Annual CAS conference • School-led Open Afternoons to facilitate sharing of practice

TiDieR-PHP Item	CAS Description		
	National Level	**Locality level**	**School level**
What and how	The CAS national team builds CoPs to support collective school-based physical activity. Localities are onboarded during which the following takes place: contacting and meeting locality leadership, signing letter of agreement to adopt the CAS process, recruitment of CAS Champion to the role, training of CAS Champion, access to and familiarization of the CAS Digital Hub	The respective locality lead and CAS Champion works with the school as a CoP to facilitate peer to peer learning and intra and inter school knowledge exchange. Schools are onboarded during which, the following takes place: School (and trust) leadership contacted, meeting with senior leadership and wider school staff, school identifies middle/senior CAS lead, programme training for in-school CAS lead, school signs letter of agreement to be part of CAS, in-school CAS lead delivers whole-school meeting. Once onboarded the school completes their profiling tool to identify priority areas for action. CAS Champions review school profiling tools and identify common domain areas and physical activity approaches. Following this, the CAS Champion will create a CoP around the physical activity approach which may involve tendering for external support (e.g. external company to deliver teacher training) or identify pioneering schools who may support others within the locality. The locality-based CAS Manager identifies cross-school priorities using the locality dashboard on the digital hub. Schools with similar priorities join “CAS projects” to co-develop place-sensitive approaches.	Once onboarded, schools commence the annual four stage implementation cycle. 1. (~May) Schools use the CAS digital hub (www.creatingactiveschools.org) to profile the schools’ physical activity provision against; policy (5 domains), environments (5 domains), stakeholders (5 domains) and opportunities (7 domains). Following completion, the profiling tool recommends three high priority domains on which the school may focus their physical activity efforts for the following year. To facilitate the domain focused implementation efforts schools are supported by *online CPD modules* (total 22 modules). 2. (~June-September) Schools complete the *Planning for Change document* that is underpinned by the APEASE framework to promote evidence-led practice. Using this, schools identify their priority domains and associated physical activity approaches. 3. (~September – May) Individual and collective solutions are implemented in school supported via CoP and school led open afternoons. 4. (Year round) Schools undertake continuous evaluation using pupil voice, staff feedback and/or Sport England Active Lives survey). This data feeds into the next CAS profiling exercise.

TiDieR-PHP Item	CAS Description		
	National Level	**Locality level**	**School level**
Who provided the intervention	CAS National Manager (provided by the Active Partnership Network)	Locality-based CAS Manager and CAS Champion(s)	In-school CAS lead and wider school stakeholders
Where	N/A	CAS is a practice-led programme, therefore localities opt-in based on perceived need. To date, CAS has been implemented in 18 localities across England	CAS is a practice-led programme, therefore schools opt in based on perceived need. To date, CAS has been used in over 300 schools in England
When and how often	Locality onboarding takes place June to November. Once onboarded, the locality receives support on an annual basis aligned with the CAS annual cycle	School onboarding takes place November to May	The school annual cycle commences in May each year with a review of current provision using the profiling tool and runs until the end of the academic year in July
Planned and unplanned variation	N/A	There are different locality models (involving different locality partners) available to support the place sensitive implementation of CAS which flexes to the needs of the system. These include one or more of the following: local authority, multi academy trust, active partnership	Flexibility and school-level autonomy and agency is an integral part of the programme. Bespoke elements are built in so that schools can implement according to their needs and circumstances