NIHR | National Institute for Health and Care Research

Journals Library

Check for updates

Programme Grants for Applied Research

Volume 14 • Issue 8 • June 2026

ISSN 2050-4330

Engaging adolescents in changing behaviour to improve diet and physical activity levels in teenagers: the EACH-B research programme

Mary Barker, Sarah Jenner, Kath Woods-Townsend, Judit Varkonyi-Sepp, Millie Barrett, Lisa Bagust, Donna Lovelock, Sarah Shaw, Patricia Coakley, Naomi Leonard, Laila Khawaja, Hamid Homatash, Leanne Morrison, Danielle Lambrick, Wendy Lawrence, David Farrell, Christina Vogel, Mary Christina Horsfall, Sofia Strömmer, Neelam Kalita, Joanne Lord, Janis Baird and Hazel Inskip

DOI 10.3310/GJMB4821

NIHR | National Institute for Health and Care Research

Programme Grants for Applied Research

Extended Research Article

Engaging adolescents in changing behaviour to improve diet and physical activity levels in teenagers: the EACH-B research programme

Mary Barker[1,2,3*] Sarah Jenner[1,2,4] Kath Woods-Townsend[3,5] Judit Varkonyi-Sepp[6,7] Millie Barrett[1] Lisa Bagust,[5] Donna Lovelock[5] Sarah Shaw[1,3] Patricia Coakley,[1] Naomi Leonard[1] Laila Khawaja[1] Hamid Homatash[8] Leanne Morrison[4,6] Danielle Lambrick[2] Wendy Lawrence[1,6] David Farrell[8] Christina Vogel[1,9] Mary Christina Horsfall,[1] Sofia Strömmer[1,3] Neelam Kalita[10] Joanne Lord[10] Janis Baird[1,3] and Hazel Inskip[1]

[1]MRC Lifecourse Epidemiology Centre, Faculty of Medicine, University of Southampton, Southampton General Hospital, Southampton, UK
[2]School of Health Sciences, Faculty of Environmental and Life Sciences, University of Southampton, Southampton, UK
[3]NIHR Southampton Biomedical Research Centre, University Hospital Southampton NHS Foundation Trust, University of Southampton, Southampton, UK
[4]School of Psychology, Faculty of Environmental and Life Sciences, University of Southampton, Southampton, UK
[5]School of Healthcare Enterprise and Innovation, Faculty of Medicine, University of Southampton, Southampton, UK
[6]School of Primary Care, Population Science and Medical Education, Faculty of Medicine, University of Southampton, Southampton, UK
[7]Department of Clinical Health Psychology, Southern Health NHS Foundation Trust, Southampton, UK
[8]Department of Computer Science, Glasgow Caledonian University, Glasgow, UK
[9]Centre for Food Policy, City St George's, University of London, London, UK
[10]Southampton Health Technology Assessment Centre, University of Southampton, Southampton, UK

[*]**Corresponding author** meb@mrc.soton.ac.uk

Published June 2026
DOI: 10.3310/GJMB4821

This article should be referenced as follows:

Barker M, Jenner S, Woods-Townsend K, Varkonyi-Sepp J, Barrett M, Bagust L, *et al*. Engaging adolescents in changing behaviour to improve diet and physical activity levels in teenagers: the EACH-B research programme. *Programme Grants Appl Res* 2026;**14**(8). https://doi.org/10.3310/GJMB4821

Programme Grants for Applied Research

ISSN 2050-4330 (Online)

A list of Journals Library editors can be found on the NIHR Journals Library website

Programme Grants for Applied Research (PGfAR) was launched in 2013 and is indexed by Europe PMC, NCBI Bookshelf, DOAJ, Ulrichsweb™ (ProQuest LLC, Ann Arbor, MI, USA) and Scopus® (Elsevier, Amsterdam, Netherlands).

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: journals.library@nihr.ac.uk

The full PGfAR archive is freely available to view online at www.journalslibrary.nihr.ac.uk/pgfar.

Criteria for inclusion in the *Programme Grants for Applied Research* journal

Manuscripts are published in *Programme Grants for Applied Research* (PGfAR) if (1) they have resulted from work for the PGfAR programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

Programme Grants for Applied Research programme

The Programme Grants for Applied Research (PGfAR) programme, part of the National Institute for Health and Care Research (NIHR), was established in 2006 to fund collaborative, multidisciplinary programmes of applied research to solve health and social care challenges. Findings are expected to provide evidence that lead to clear and identifiable patient benefits, in the relatively near future.

PGfAR is researcher led and does not specify topics for research; however, the research must be in an area of priority or need for the NHS and the social care sector of the Department of Health and Social Care, with particular emphasis on health and social care areas that cause significant burden, where other research funders may not be focused, or where insufficient funding is available.

The programme is managed by the NIHR Central Commissioning Facility (CCF) with strategic input from the Programme Director. For more information about the PGfAR programme please visit the website: https://www.nihr.ac.uk/explore-nihr/funding-programmes/programme-grants-for-applied-research.htm

This article

The research reported in this issue of the journal was funded by PGfAR as award number RP-PG-0216-20004. The contractual start date was in October 2017. The draft manuscript began editorial review in May 2025 and was accepted for publication in November 2025. As the funder, the PGfAR programme agreed the research questions and study designs in advance with the investigators. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The PGfAR editors and production house have tried to ensure the accuracy of the authors' manuscript and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this article.

This article presents independent research funded by the National Institute for Health and Care Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, CCF, PGfAR or the Department of Health and Social Care. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, the PGfAR programme or the Department of Health and Social Care.

This article was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Newgen Digitalworks Pvt Ltd, Chennai, India (www.newgen.co).

Abstract

Background: Globally, the health of young people is in decline, with increasing rates of mental health issues, obesity and sedentary lifestyles. Existing health behaviour change interventions for this group face challenges in engagement and implementation. Effective, targeted interventions are needed to improve lifelong health outcomes for young people.

Objective: To develop, implement and evaluate a multicomponent health behaviour change intervention aimed at improving diet and increasing physical activity in young people in the United Kingdom.

Design and methods: A person-based approach drawing on systematic and literature reviews and qualitative data (interviews, group discussions and participatory 'game jams') was used to develop the Engaging Adolescents in Changing Behaviour intervention, which was tested using a cluster-randomised trial. A pilot trial informed modifications to recruitment, data collection and app usage processes. Schools selected two Year 8 classes (12–13 years old) to participate, with randomisation at the school level. Baseline and 12-month follow-up data on diet, physical activity and general well-being were collected from students, and demographic data were provided by schools with parental permission. An economic model was designed to estimate future effects on health outcomes of the intervention, and mixed-methods process evaluation examined participant perspectives (students, parents and teachers), LifeLab® attendance and app download statistics.

Setting and participants: Of our planned sample of 2300, we collected baseline data from 2065 students from 45 of 49 recruited and randomised secondary schools across Hampshire and the south coast of England. Four schools dropped out before baseline data collection, and we followed up 55% of students at 1 year. The process evaluation involved 88 of these students, 23 teachers and 11 parents.

Intervention: The Engaging Adolescents in Changing Behaviour intervention had three components: experiential science education for students at LifeLab, teacher training to support students' health behaviours and a gamified smartphone app for students to encourage better diet and physical activity.

Main outcome measures: Diet quality (standard deviation scores), total physical activity (minutes/day). Secondary outcomes included further diet and physical activity outcomes, self-efficacy for health behaviours and general well-being, assessed using both objective and self-report methods. Data were analysed using linear mixed-effects models and binary regression, accounting for clustering.

Results: Development work indicated that effective interventions should support young people's autonomy, competence and relatedness while making healthier choices accessible and appealing. Digital platforms and social media were identified as key for engagement. Pilot findings prompted adjustments to school recruitment, data collection and app presentation for the main trial. At baseline, the intervention group had a mean diet quality score that was 0.22 standard deviation (95% confidence interval −0.05 to 0.51) higher than in the control group. At follow-up, the difference between groups was −0.02 standard deviation (95% confidence interval −0.32 to 0.27), and after adjustment for the baseline, diet quality score was −0.10 standard deviation (95% confidence interval −0.29 to 0.09). For the total physical activity outcome, the baseline difference between groups was minimal; at follow-up, the difference was 1.19 minutes/day (95% confidence interval −15.5 to 17.9) and after adjustment for baseline was 8.65 minutes/day (95% confidence interval −7.79 to 25.1). Minor differences were observed in secondary outcomes. Index of Multiple Deprivation scores of schools in intervention and control groups showed no baseline differences. Overall, 88% of eligible students attended LifeLab, and 42.5% downloaded the app. Students and teachers reported positive experiences with LifeLab and teacher training, though COVID-19 impacted in-person delivery for some schools. Students valued learning about their health but engaged minimally with the app. Parents viewed the intervention positively but often lacked communication from their children or schools about it. Teachers were eager to support health initiatives but had limited opportunities during the school day. A Markov model was produced to estimate the cost-effectiveness of LifeLab Plus, but our findings did not warrant such an analysis.

Limitations: Most students did not engage with the app due to its lack of appeal and insufficient motivation to revisit it. Only 55% of students participated in the follow-up and provided data on the diet quality score, and only 28% had complete physical activity data at baseline and follow-up. Thus, the power of the trial was reduced, making it difficult to

detect differences between groups. Trials in school settings tend to include more advantaged children, as opt-in consent favours parents who complete forms. Even opt-out consent does not fully address this issue, as disadvantaged students are more likely to miss school during data collection. Demographic data collection required parental opt-in, introducing further bias.

Conclusions: The trial detected no significant impact of the intervention on diet and physical activity among secondary school students. Substantial baseline differences in diet and physical activity between intervention and control groups introduced noise, complicating conclusions about intervention effects. While schools are suitable settings for health interventions, randomised trials may not be ideal for evaluating large-scale, real-world interventions. Intervention design, particularly for smartphone applications, requires greater attention to foster sustained engagement.

Future work: Although the Engaging Adolescents in Changing Behaviour intervention did not improve diet or physical activity, it provided valuable insights. Interventions must support young people's autonomy, competence and relatedness and offer them meaningful opportunities to support their aspirations in life. Health topics have to be important to young people to be engaging, and research has to be coproduced. Our current and future research focuses on evaluating the impact of this participatory approach on health and well-being and aims to translate findings into policy through collaborations with local authorities and Integrated Care Systems in Wessex. Exploring alternative designs for evaluating large-scale public health interventions is another important research agenda.

Trial registration: This trial is registered as ISRCTN74109264.

Funding: This award was funded by the National Institute for Health and Care Research (NIHR) Programme Grants for Applied Research Programme (NIHR award ref: RP-PG-0216-20004) and is published in full in *Programme Grants for Applied Research*; Vol. 14, No. 8. See the NIHR Funding and Awards website for further award information.

Contents

List of tables

List of figures

List of supplementary material

Report Supplementary Material 1	Research on research
Report Supplementary Material 2	Identity systematic review
Report Supplementary Material 3	Narratives paper
Report Supplementary Material 4	Adolescent food environment
Report Supplementary Material 5	Digital intervention development
Report Supplementary Material 6	Teacher experiences

Supplementary material can be found on the NIHR Journals Library article page (https://doi.org/10.3310/GJMB4821).

Supplementary material has been provided by the authors to support the article and any files provided at submission will have been seen by peer reviewers, but not extensively reviewed. Any supplementary material provided at a later stage in the process may not have been peer reviewed.

The supplementary materials (which include but are not limited to related publications, patient information leaflets and questionnaires) are provided to support and contextualise the publication. Every effort has been made to obtain the necessary permissions for reproduction, to credit original sources appropriately, and to respect copyright requirements. However, despite our diligence, we acknowledge the possibility of unintentional omissions or errors, and we welcome notifications of any concerns regarding copyright or permissions.

List of abbreviations

BCT	behaviour change technique
BMI	body mass index
CHU9D	Child Health Utility 9 Dimensions
CVD	cardiovascular disease
EACH-B	Engaging Adolescents in Changing Behaviour
FFQ	food frequency questionnaire
GCU	Glasgow Caledonian University
HCS	Healthy Conversation Skills
ICB	Integrated Care Board
ICP	Integrated Care Partnership
IDACI	Income Deprivation Affecting Children Index
MRC	Medical Research Council
NDNS	National Diet and Nutrition Survey
PA	physical activity
PPI	patient and public involvement
PPIE	patient and public involvement and engagement
PSC	Programme Steering Committee
PSHE	personal, social, health and economic education
QoL	quality of life
RCT	randomised controlled trial
RQ	research question
RS	research stream
SE-HEPA	Self-Efficacy for Healthy Eating and Physical Activity measure
SES	socioeconomic status
T2D	type 2 diabetes
TeC-19	Teenagers and COVID-19
UKRI	UK Research and Innovation
WP	work package

Plain language summary

Young people in the United Kingdom have the worst diets of any age group and insufficient exercise, increasing risks of conditions such as heart disease and diabetes later in life. Since health habits formed in adolescence can last a lifetime, researchers are trying to find ways to help young people adopt healthier behaviours. Interactive programmes, called interventions, can improve health habits but are difficult to design and implement with young people.

The Engaging Adolescents in Changing Behaviour programme developed and tested a school-based intervention for healthier choices among students. A method of assessing the money that could be saved on health care if this intervention was successful was developed. To inform the programme, researchers consulted young people, parents and teachers, finding that:

- young people valued health but felt it had to fit into their social lives and activities
- the environment around young people made it hard for parents and teachers to support young people's healthy habits
- effective interventions must respect adolescents' need for independence and a social life while making healthy choices enjoyable and accessible.

The intervention involved 2065 students (aged 12–13 years at baseline and 13–14 years at follow-up) from 45 schools in Hampshire and Southern England. Forty-nine schools were recruited and randomly allocated to intervention or control, but four schools (two intervention and two control) subsequently dropped out. Half of the schools implemented the programme, while the others continued regular activities as a comparison group. The Engaging Adolescents in Changing Behaviour intervention included:

- teacher training for supportive health discussions
- LifeLab (in-school lessons and a trip to a health education facility for an experiential science day)
- the Engaging Adolescents in Changing Behaviour gamified smartphone app to promote eating better and exercising more.

Students completed diet and activity questionnaires and wore activity trackers for a week. Data were collected again a year later, alongside feedback from participants, parents and teachers.

Findings revealed no meaningful improvements in diet quality or physical activity between intervention and comparison groups, though small differences in well-being and food choices were noted. We may not have found any effect of the intervention because i) there were differences in initial diet scores between groups, ii) only being able to see 55% of the original group of students a year after the intervention and iii) feedback that the app was not engaging enough to compete with social media for young people's attention. Because we did not see any impact of the intervention, we were unable to carry out a cost-effectiveness evaluation.

Key recommendations:

- continue partnering with schools despite logistical challenges
- ensure digital interventions work alongside other digital activities like social media rather than compete.

Scientific summary

The health of young people across the world is in decline, and most existing health behaviour change interventions have failed to shift young people onto more positive health trajectories. The National Institute for Health and Care Research (NIHR) funded the Engaging Adolescents in Changing Behaviour (EACH-B) programme to examine whether a multicomponent intervention could improve health behaviour outcomes for young people on the south coast of England. We developed the intervention, evaluated its effectiveness using a cluster-randomised controlled trial and conducted a process evaluation of the delivery, implementation and mechanisms of impact of the EACH-B intervention.

Programme research stream and work package aims and objectives

Research stream (RS) 1 [work package (WP) 1.1, WP1.2, WP1.3]: to find the best methods for helping young people make healthier choices by looking at previous research and talking to experts. To build a health economic model to estimate the costs and benefits of existing interventions.

Research stream 2 (WP2.1, WP2.2, WP2.3, WP2.4): to develop an intervention that young people, parents and teachers found helpful in improving diet and increasing exercise.

Research stream 3 (WP3.1, WP3.2): to test the intervention to see how well it works, whether it offered good value for money and the best way of implementing it in schools.

Methods

Research stream 1

Work package 1.1: three systematic reviews were conducted to inform the economic modelling (RS1) and intervention development (RS2).

The first synthesised evidence from quantitative studies on the effectiveness of digital interventions to improve diet quality (www.sciencedirect.com/topics/medicine-and-dentistry/diet-quality) and increase physical activity (PA) (www.sciencedirect.com/topics/psychology/physical-activity) in adolescents, to identify effective intervention components and to assess the cost-effectiveness of these interventions.

The second focused on the literature investigating the effectiveness of health education interventions delivered in school settings to prevent overweight and obesity and/or reduce body mass index (BMI) in adolescents, and to explore the key features of effectiveness.

The third systematic review examined the influence of community and consumer nutrition environments on young people's food purchasing and dietary behaviours in high-income countries was conducted.

The protocol paper described the design of the EACH-B trial to test the intervention.

Work package 1.2: a Markov model, considering mental health, earnings, type 2 diabetes (T2D) and pregnancy outcomes over 20 years, was developed using published literature and sensitivity analyses to assess the cost-effectiveness of a school-based intervention for improving diet and PA in young people. The model was designed to be used with data produced in WP3.2 to test cost-effectiveness.

Work package 1.3: stakeholders were identified and regular meetings set up throughout the duration of the programme. Opportunities to contribute to consultations, briefings and policy documents were sought. A stakeholder consortium was formed in the last 3 years of the programme.

Research stream 2

Work package 2.1: a review examined the reasons for the ineffectiveness of existing behaviour change interventions. Findings informed questions asked in group interviews with young people aged 13–14 years. Semistructured interviews with parents of adolescents were also conducted, exploring parental involvement in adolescent health interventions. Another study analysed quantitative adolescent dietary data and qualitative interviews with parents, teachers and adolescents to examine energy drink consumption and associated factors. A further study conducted focus groups with adolescents aged 11–18 years to explore the interplay between social and food environments in adolescent food choices.

Work package 2.2: the content of the intervention was designed using findings from RS1 and RS2. Components of the intervention were developed using data collected in WP2.1 and drawing on evidence review from RS1.

Work package 2.3: the smartphone application, referred to as 'the app' or 'LifeLab Plus', was developed by game designers at Glasgow Caledonian University and tested by young people. Think-aloud interviews were conducted with young people testing prototypes of the app to capture immediate reactions to aspects of the intervention.

Work package 2.4: focus groups were conducted with secondary school teachers to explore their perceptions of how they could use Healthy Conversation Skills (HCS) to support students to make lifestyle changes, what additional training needs they had and how the final HCS training programme could best be delivered in the school context. Following a pilot of the HCS training, further interviews were conducted with teachers who took part (see *Report Supplementary Material 6*).

Research stream 3

Work package 3.1: the EACH-B trial was piloted in six secondary schools in the Southampton area, randomised to intervention or control. A process evaluation was conducted to assess the implementation of the intervention, the influence of context on the trial and the mechanisms of impact underlying the intervention.

The research team analysed data from the UK National Diet and Nutrition Survey to develop a short, 20-item food frequency questionnaire (FFQ) to use in the EACH-B trial. Principal component analysis was used to identify key dietary patterns and create diet quality scores.

Work package 3.2: in total, 49 schools were recruited to the main trial, and 45 took part in both baseline and follow-up measures. Schools were randomised to receive the EACH-B intervention or not. Two middle-ability classes were chosen to take part by teachers in each school. Outcomes were dietary change (measured by the 20-item FFQ) and PA change [measured using GENEActiv™ (ActivInsights, Cambridge, UK) accelerometers]. Secondary outcomes were self-reported PA, behavioural regulation and self-efficacy for diet and PA, quality of life and well-being.

A mixed-methods process evaluation was also conducted, following the format of that carried out with the pilot trial (WP3.1). Interviews and focus groups were conducted with students, teachers and parents from 11 schools (5 intervention and 6 control) that took part in the trial. Quantitative data were collected describing numbers of students who attended LifeLab and downloaded and used the app.

Results

Research stream 1

Work package 1.1: the systematic review of digital interventions found that the most effective digital interventions incorporate education, goal-setting self-monitoring and parental involvement. We found too little data on the cost-effectiveness of digital health interventions to be able to draw conclusions.

The systematic review and meta-analysis of school-based adolescent health interventions suggested that school-based health education interventions have the potential to lower BMI towards a healthier range in adolescents. Multicomponent interventions involving teachers and parents and digital components are promising.

The systematic review of influences of the community and consumer nutrition environment on the food purchases and dietary behaviours of young people found no clear associations between exposure to healthy community nutrition environments and dietary outcomes. However, most of the studies reviewed (57%) reported that greater exposure to unhealthy food outlets was associated with less healthy food purchases and dietary intakes. Results for consumer environments were inconsistent.

Work package 1.2: a Markov model was developed to extrapolate short-term observed effects on diet, activity and/or BMI to estimate future effects on the incidence of T2D and cardiovascular disease. While the intention was to apply the model to estimate the cost-effectiveness of LifeLab Plus, our findings did not warrant such an analysis. The published model has utility beyond the present study, however, and could be applied by others undertaking such complex intervention research.

Work package 1.3: stakeholders were engaged systematically throughout the programme to ensure buy-in to the intervention and insights for subsequent implementation. Significant achievements were the Innovation-to-Commercialisation fellowship for Woods-Townsend, WP1.3 lead. This involved intense stakeholder engagement to understand the implementation aspects of the programme, including conversations with a wide variety of stakeholders to explore the potential for scale-up and roll-out of EACH-B. Insights from EACH-B fed into the ukactive 'Generation Inactive 2' report, the Southampton City Council's scrutiny review of their Childhood Obesity Policy and the formation of the Pathways to Health (www.pathways-to-health.org/) Consortium, a grouping of more than 30 organisations in Southampton that is committed to improving young people's health and well-being.

Research stream 2

Work package 2.1: The article summarising the findings of a review of factors involved in reducing intervention effectiveness identified three issues: a focus on mean effect sizes, assumptions about the value young people place on health, and overemphasis on cognitive mechanisms in interventions. The article suggests that interventions should consider both rational and emotional influences on health behaviours. Subsequent qualitative work (n = 54, 13- to 14-year-olds) identified that young people valued being with friends, being active and being healthy without compromising other priorities. Health alone is not a motivating factor for them. They prioritised social experiences over food quality, valued familiar food outlets and chose food promotions that aided quick decision-making. Energy drink consumption among young people (n = 2587 adolescents aged 11–18) was associated with poorer dietary quality and higher deprivation. Qualitative data from 74 adolescents, 24 parents and 15 teachers revealed that young people drink energy drinks because of peer influence and low cost and believe voluntary bans on their sales are ineffective. In additional interviews, parents (n = 24) saw themselves as gatekeepers and role models for healthy behaviour but struggled with balancing their influence and their children's increasing autonomy.

Work package 2.2: guiding principles for intervention content were that it (1) persuades adolescents that healthy eating and PA can be a positive experience with positive outcomes, (2) enhances Self-Efficacy for Healthy Eating and Physical Activity and persuades users that it can be easy and (3) supports adolescents to seek support from their social network with healthy eating and PA. The logic model developed for the funding application which described the programme and outlined the hypothetical mechanisms of the intervention was modified based on the data collected in RS2 (*Figure 1*).

Work package 2.3: a description of the app development process is described in a paper entitled, 'Enhancing the relevance of nutrition and physical activity interventions for adolescents: design and development of the LifeLab Plus App' (see *Report Supplementary Material 5*). Findings from the qualitative research and coproduction activities informed the integration of behaviour change components into each element of the app, for example, the 'Gutsy' game, to maximise engagement. The paper concludes that theoretical and evidence-informed approaches, while crucial for initial development, were not sufficient to deliver an app that was meaningful and relevant to adolescents. Genuine coproduction and testing with target users is an essential step in app development.

Work package 2.4: the qualitative research explored teachers' perceptions of their roles in supporting their students to make healthy choices. Interviews with 15 secondary school teachers and focus groups with another 14 revealed that they were enthusiastic about talking to their students about health in supportive and encouraging ways and found

opportunities to have these sorts of conversations. Teachers had ideas about strategies that could help them to support their students' health but felt powerless because they witnessed the way environmental, individual, financial and social factors made it more difficult for students to make healthy choices. They felt school cultures and systems did not facilitate health behaviour change but, in fact, actively made it harder for teachers to support their students.

Research stream 3

Work package 3.1: the results of the study developing the shortened version of the FFQ showed a strong correlation (0.87) between the 20-item and 139-item scores. Both scores correlated with nutritional biomarkers. The study concluded that the 20-item questionnaire could effectively assess diet quality in large-scale studies with young people.

The pilot demonstrated that the trial could be conducted in schools, though some minor modifications were made before the main trial started. Just as the main trial started, schools were shut as part of the first COVID-19 lockdown period of the COVID-19 pandemic, and further modifications had to be made to accommodate that.

Work package 3.2: despite using a minimisation algorithm, baseline imbalances existed in this cluster-randomised school trial, notably a 0.22 standard deviation (SD) difference in diet quality score – a primary outcome –almost as large as the 0.25 SD the study aimed to detect. This complicated analysis, as cluster-randomisation at the school level, with only 45 schools and over 2000 students, is prone to imbalance. Income Deprivation Affecting Children Index score (a measure of area household deprivation for children) also differed at baseline in control and intervention groups.

The intention-to-treat analysis, including adjustment for clustering, showed minimal difference between groups in the primary outcomes at follow-up. However, follow-up rates were only 55% for the diet quality score and 28% for the PA measure. Further analyses incorporating adjustment for the baseline values of the outcome being assessed also revealed minimal group differences. The intervention group had a mean diet quality score that was 0.10 SD [95% confidence interval (CI) −0.29 to 0.09] lower than in the control group, and 8.65 minutes/day (95% CI −7.79 to 25.1) more total PA than in the control group. Both these differences are small. Secondary outcomes highlighted some effects, notably reduced risk for high crisp consumption [relative risk (RR) = 0.75 (95% CI 0.63 to 0.89)] and similar or lower fizzy drink consumption [RR = 0.77 (95% CI 0.58 to 1.03)], but baseline diet imbalances cast doubt over these findings. In the intervention group, there was a higher proportion [RR = 1.42 (95% CI 0.99 to 2.03)] of students meeting the 60-minute daily activity guideline than in the control group, yet other activity outcomes showed no differences.

Compliance challenges also arose: LifeLab day attendance varied, and app engagement was low, with only 228 students using the app an average of 2.2 sessions with a duration per session of 17.7 minutes. There was no way of assessing the fidelity of the HCS component of the intervention or of the LifeLab delivery in schools. The COVID-19 pandemic was the backdrop to this research, and its effects on the findings are hard to assess.

Quantitative data from the process evaluation of the main trial showed that 87.9% of eligible students attended the LifeLab facility and 42.5% of eligible students downloaded the smartphone application. Students and teachers had positive experiences of LifeLab and the teacher professional development, despite the COVID-19 pandemic preventing in-person delivery for some schools. Parents had positive views of research and were enthusiastic about the EACH-B intervention, but most said they did not know about the study from their children or school. Students valued learning about their own health and bodies, and teachers were enthusiastic about supporting their students to make healthier choices, but opportunities to talk to students about health during the school day were limited.

Conclusions

The EACH-B programme successfully developed and tested an intervention to improve diet and PA among 12- to 14-year-olds. Stakeholder engagement and evidence synthesis informed programme design, and the programme produced a range of outputs, including 18 peer-reviewed publications, 47 conference presentations and 4 doctoral theses.

Engaging Adolescents in Changing Behaviour highlights the challenges of cluster-randomised trials in schools, particularly baseline imbalances affecting data interpretation. The study aimed to recruit 50 schools and 2300 students; 49 were recruited and randomised, and 45 provided data at both baseline and follow-up, and 2065 students were seen at baseline. Only 1127 (55%) students provided data at follow-up, however. Dropout rates were higher among disadvantaged students and exacerbated by an opt-in consent process, which limited participation. Engagement with two of the intervention components was low.

Despite this, the EACH-B programme has advanced understanding of youth health interventions and influenced policy, underscoring the need for engagement-driven, adaptable and collaborative approaches. Key insights from the programme highlight that interventions must support young people's autonomy, competence and relatedness to be effective. The programme's impact extends beyond research, notably through the UK Research and Innovation-funded Pathways to Health Consortium, which integrates young people into local policy decision-making. Another major output is the NxtGen Researchers Training Programme, which equips young people with research and advocacy skills. This led to the Young People's Manifesto for Change, containing 12 policy recommendations to be endorsed by the Hampshire and Isle of Wight Integrated Care Board. NxtGen Researchers continues to run and is in the process of being accredited by the Royal Society for Public Health.

Trial registration

This trial is registered as ISRCTN 74109264.

Funding

This award was funded by the National Institute for Health and Care Research (NIHR) Programme Grants for Applied Research Programme (NIHR award ref: RP-PG-0216-20004) and is published in full in *Programme Grants for Applied Research*; Vol. 14, No. 8. See the NIHR Funding and Awards website for further award information.

Synopsis

Background

Adolescence as a critical period in the development of lifelong health

Poor diet costs the NHS £6B annually; physical inactivity £1B.[1] UK adolescents have poorer diets than other age groups, and fewer than 20% meet physical activity (PA) guidelines.[2,3] Health behaviours track into adulthood, implying that suboptimal diet and body composition in adolescence will affect immediate health but also raise the risk of obesity and non-communicable diseases later and in the next generation.[4–7] Body composition at conception and during pregnancy have profound impacts on the long-term health of the offspring.[8–10] Adolescence is a period of rapid growth and physiological change and may be a critical period for the development of later health and disease.[11] Because of this, the Lancet commission on adolescent health claims: 'investments in adolescent health and well-being bring a triple dividend of benefits now, into future adult life, and for the next generation of children'.[12]

Improving public health

Adolescents are not simply young adults or older children but have unique physiological and psychological characteristics. They are an underserved population, with largely unrecognised and unmet needs, perhaps because they discount health and are reputedly difficult to engage in behaviour change.[11] The potential for improved dietary quality and PA to enhance the current and future health of adolescents was recognised in the 2014 Chief Medical Officer for England report written shortly before the application for Engaging Adolescents in Changing Behaviour (EACH-B) funding was first drawn up, suggesting that the personal, social, health and economic education (PSHE) curriculum could be used to 'empower children with the information that they need to plan healthier lives'.[10] Adolescents require interventions tailored specifically to their needs, however, through a process of cocreation.

At the time this proposal was submitted, there was some question about whether a public health programme was 'in scope' for the PGfAR scheme. As a result, our application had to be approved as in remit by the Programme Director and CCF Deputy Director. The award recognised the public health relevance of EACH-B as coming from: (1) the potential to improve diet and PA levels in adolescence, (2) amplification of this benefit over the life course and into the next generation and (3) the resulting greater cost-effectiveness of interventions in adolescence versus in adulthood.

Challenges of adolescent engagement in behaviour change

Despite the fact that adolescents find it difficult to engage with the long-term consequences of health behaviour, systematic reviews suggest motivated and engaged adolescents can improve their health behaviours. Unfortunately, little is known about how to motivate and engage them in sustaining changes in the long term.[13] Systematic reviews also identify significant opportunities for engaging adolescents in behaviour change.[14]

School-based interventions: a scoping review carried out in preparation for EACH-B showed interventions based in schools may be effective, perhaps because schools can provide a supportive environment and because there is less attrition. School-based interventions offering peer modelling, social support and choice increased PA.[13,15] Less is known about interventions effective in improving adolescent diet, but parental and teacher involvement may be important.[13,16,17] Peer support is effective for health behaviours other than diet and PA.[18] More work is needed to understand how these influences can be harnessed to be optimally acceptable and persuasive to adolescents, who will vary in their response to interventions.

Digital platforms: these offer another opportunity for engagement; 95% of 12- to 15-year-olds owned smartphones in 2024.[19] At the time EACH-B began, evidence for effectiveness of digital interventions with adolescents was limited.[20] More focus was needed on incorporating effective behavioural techniques (e.g. self-monitoring; gaining approval; modelling; intention formation), and on better methods of engagement as previous digital interventions have suffered from low usage and high attrition.[21] Our review of digital interventions suggested that the most unhealthy participants show more significant behaviour change and rate interventions more highly than their healthier counterparts, although

they are less compliant.[22] Formative interviews with 13- to 14-year-olds suggest younger adolescents know of existing commercial diet and lifestyle smartphone applications but do not feel that they are appropriate for their age group.

Incorporating gaming: our patient and public involvement (PPI) groups said social support and competition are important in helping them maintain healthy lifestyle behaviours. Incorporating these features through game elements into digital interventions may increase engagement. Games may have superior capacity to engage over other digital interventions and to sustain behaviour changes because of their potential to be highly enjoyable and intrinsically motivating.[23,24] Serious games are best tailored to a particular demographic, benefit from a strong focus on game and/or psychological theory and can be effective on their own or in multicomponent programmes.[25]

Formative work for an intervention to maximise engagement and sustain change

Evidence reviewed above, two scoping reviews and our previous work led us to propose a complex, three-component intervention: (1) engaging and motivating adolescents in behaviour change through a school-based education programme and (2) initiating and sustaining change through a combination of face-to-face support from teachers trained in skills to support behaviour change and (3) a personalised digital intervention that involves social support.

1. LifeLab is a 2-week science module for 12- to 14-year-old secondary school students, which delivers part of the National Curriculum for Science, helps them understand the science underlying their health, engages them in thinking about their health and the health of their future children and motivates them to improve health behaviours and health outcomes.[26,27] Since 2009, 93% of schools approached have participated, involving over 16,000 students.
2. 'Healthy Conversation Skills' (HCS) supports health and social care practitioners to engage and motivate individuals to change their health behaviours (Southampton IP).[28] HCS are accessible skills, shown to increase the confidence and competence of practitioners in addressing diet and PA in their clients.[29] Evidence from our research group suggests face-to-face support improves the effectiveness of digital interventions in adults.[30] We adapted HCS for teachers.
3. Design of the digital intervention built on 20 years of expertise gained from the LifeGuide research programme, Southampton (www.lifeguideonline.org/; Director: Yardley; Deputy Director: co-applicant Morrison). Numerous complex digital behaviour change interventions for public health promotion and illness management have been shown to be effective in randomised controlled trial (RCT).[30–32] The development of the gamified digital intervention that we developed as part of EACH-B drew on award-winning game design expertise.

Aim of the programme

The aim of this programme was to develop and test a complex intervention designed to engage, motivate and support adolescents aged 12–14 years in improving their diets and PA levels. The question we were asking was *'how could adolescents be effectively and cost-effectively engaged and supported to make and sustain positive changes to their diets and physical activity levels?'* Our approach to answering this question is summarised in *Figure 1*.

Objectives

We planned to develop and evaluate in secondary school students an intervention using the three components described above. We set out to work with adolescents and other stakeholders to determine the most effective and cost-effective methods of integrating this intervention into the school curriculum.

To meet these objectives, we undertook the following activities organised under three research streams (RSs). We:

1. used evidence synthesis and qualitative research to identify key features of interventions to improve adolescent diet and PA levels likely to be (1) effective and cost-effective and (2) engaging, feasible and acceptable to adolescents, parents and teachers (RS1)
2. developed a health economic model to evaluate costs and health effects of diet and PA interventions for adolescents (RS1)
3. used a person-based approach to develop an intervention that is feasible, acceptable and persuasive to students, parents and teachers (RS2)

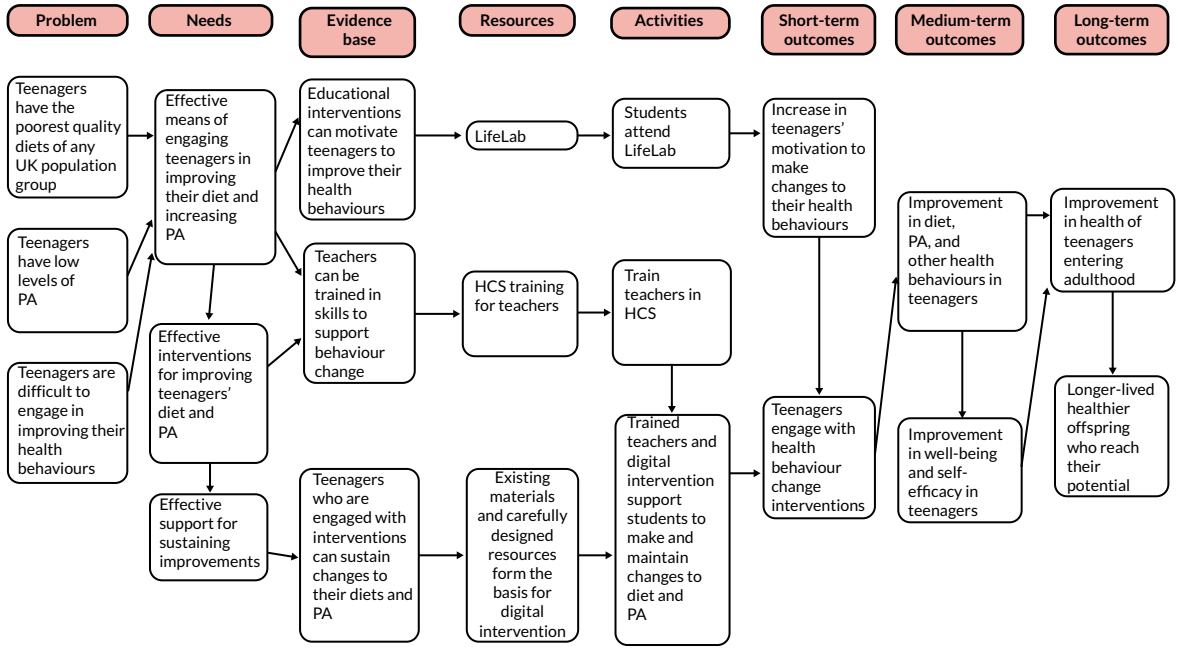

FIGURE 1 Logic model justifying and summarising the EACH-B programme and its intended outcomes.

4. undertook a RCT of the effectiveness and cost-effectiveness of this intervention to improve quality of diet and PA levels of secondary school students (RS3)
5. with stakeholders, planned integration of learnings from this programme of research into the school curriculum and broader public health activities (RS1).

The relationships between these research activities are illustrated in *Figure 2*.

Programme management

Robust programme management was ensured through a structure of delivery, scientific and strategic accountability and input as depicted in *Figure 3*. The programme delivery team was organised into RSs, led by RS leads designated in the grant application. Each RS was divided into work packages (WPs) with discrete deliverables and assigned teams, led by WP leads. Depending on the type of work, deliverables and delivery timelines, team members could be part of more than one WP team, could lead two WPs or could have a combination of leadership roles.

Delivery was overseen by the Programme Leads, supported by the Scientific Programme Manager and the Operational Programme Manager who were members of the Programme Operational Management Group alongside the Programme Leads.

Strategic and scientific oversight was provided by the Programme Steering Committee (PSC) comprising three scientific and one public contributor and the National Institute for Health and Care Research (NIHR) Programme Manager.

Co-applicants also provided strategic and scientific input. Stakeholders and public contributors provided strategic input. Details of our stakeholder engagement and PPI activities are given in sections that follow.

Stakeholder engagement

Stakeholder engagement was essential to ensure relevance and sustainability of the intervention. By building a programme of stakeholder engagement which involved a diverse range of stakeholders, including young people, parents, teachers, local authorities, non-governmental organisations and charities, we tapped into a wealth of insights and expertise.

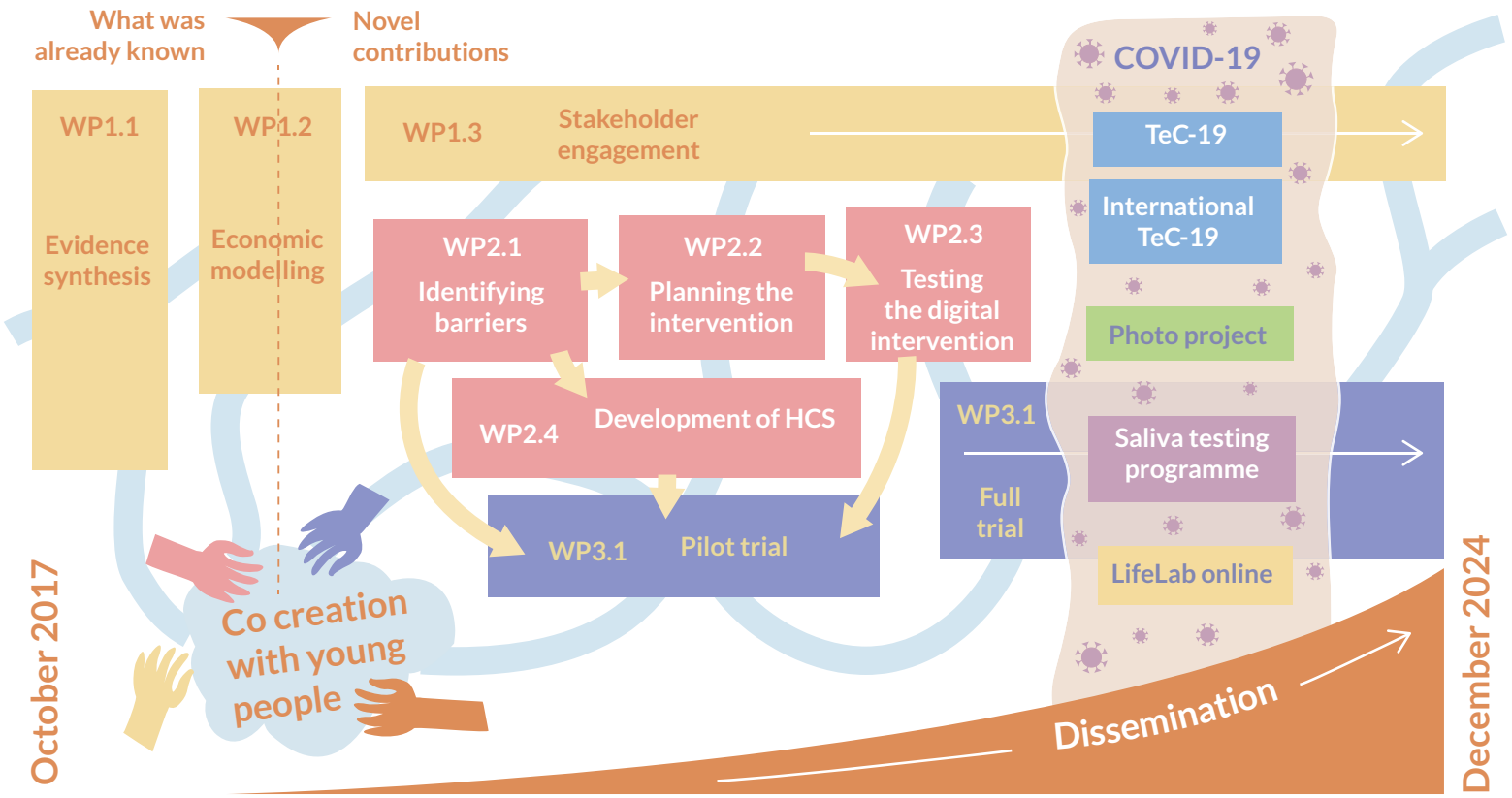

FIGURE 2 Research pathway diagram showing relationships between the elements of the programme.

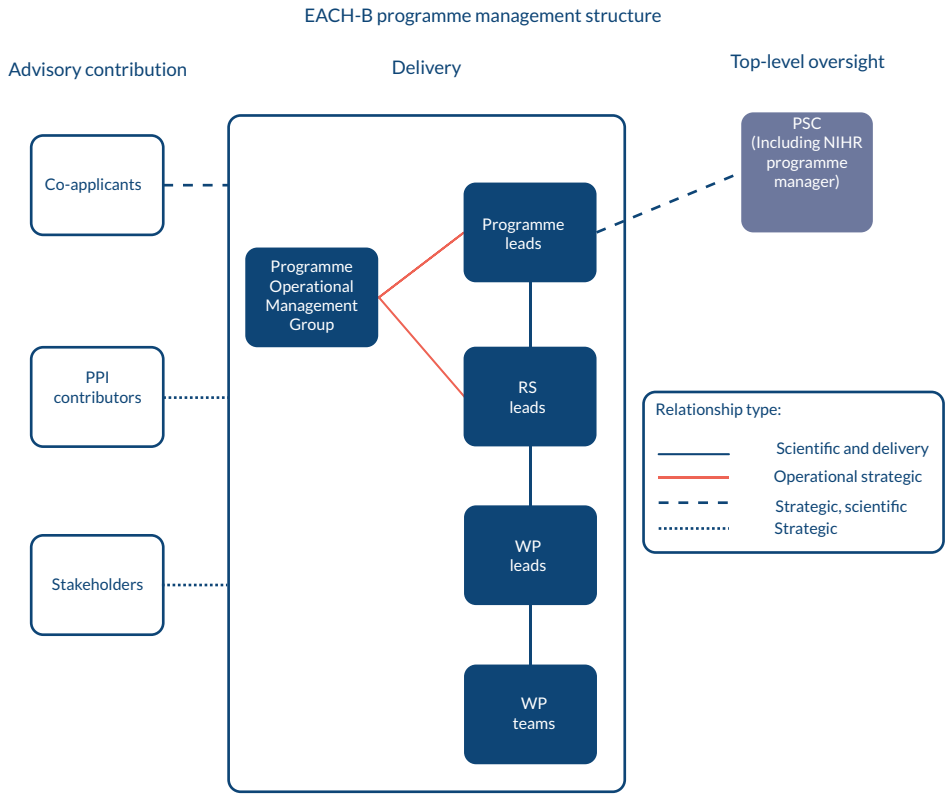

FIGURE 3 Engaging Adolescents in Changing Behaviour programme management structure and types of management and oversight relationships.

Patient and public involvement and engagement

Our public contributors have supported us throughout the programme. This activity has had two tracks. Engagement with young people has been organised as and when a specific contribution was needed. Our experience is that standing groups of young people are difficult to sustain for longer than about 3 months. We have therefore established a rolling programme of young people to inform us and collaborate with us. This LifeLab Youth Panel runs three times a year with 6–8 young people who are employed by the University of Southampton for 12 weeks a time to work as part of the research team. These groups are designed to be diverse and reflect experience from young people across a spectrum of ages from 13 to 17 years and of different backgrounds. Every group addresses a new issue, usually one that they identify as important for young people's health. In addition to carrying out their own work, this group has provided EACH-B with specific support and advice on, for example, the design of outward-facing research materials or the wearability of activity trackers. The second track involved three to four parents of young people who were paid to make a public contribution to meetings of our co-applicants and the PSC. New public contributors were recruited as others left maintaining a core group who support the activity of EACH-B. Alongside the two ongoing patient and public involvement and engagement (PPIE) streams, between 2018 and 2024, EACH-B ran a series of events and projects that involved young people and other members of the public in our research. As a matter of principle, young people recruited to these activities drew from groups that were diverse in experience and background. The large numbers who took part in game jams in schools generally reflected the make-up of those schools. In total, over 1000 young people play-tested the app during different stages of its development. We ran an extensive range of PPIE activities involving young people and their parents between 2017 and 2024 when the programme ended. A full list of these is available in *Appendix 1*.

Understanding existing evidence for effective and cost-effective interventions with young people: research stream 1

Evidence synthesis and systematic reviews

This WP (*Figure 4*) aimed to address the following research questions (RQs) in order to inform the development of the EACH-B intervention, details of which are published in the protocol paper.[33]

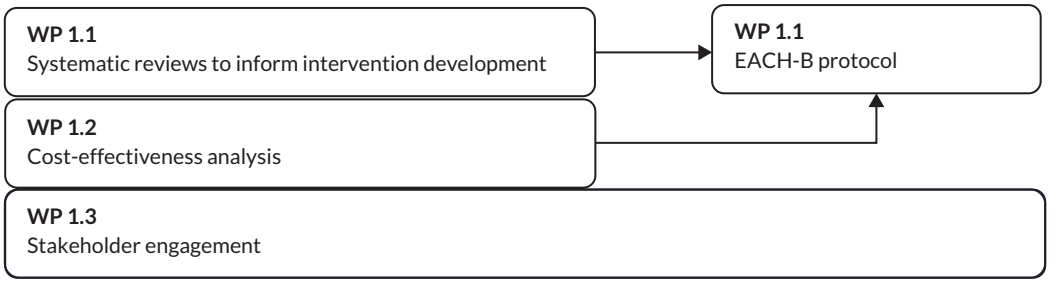

FIGURE 4 Showing the organisation of the WPs within RS1.

Research question 1. How can digital intervention approaches, including games, engage young people in improving their diet/PA? What features are associated with effectiveness/cost-effectiveness?

Research question 2. What interventions are effective in improving young people's diet/PA? What features are associated with effectiveness/cost-effectiveness?

The first systematic review addressed RQ1.[22] We identified effective intervention components from 27 studies and assessed the cost-effectiveness of these interventions. Due to heterogeneity of studies, meta-analysis was not feasible. Most were website interventions. Other delivery methods were text messages, games, multicomponent interventions, e-mails and social media. We found that digital interventions most likely to be effective are those that incorporate education, goal-setting, self-monitoring and parental involvement. We found too little data on the cost-effectiveness of digital health interventions to be able to draw any conclusions, and future trials should report these data.

The systematic review and meta-analysis of school-based interventions focused on diet, and weight outcomes suggested that school-based health education interventions have the potential to lower body mass index (BMI) towards a healthier range in adolescents.[34] This review focused on quantitative evidence from studies reporting outcome and process evaluation findings. Multicomponent interventions involving key stakeholders such as teachers and parents and digital components were most effective and offered a promising strategy for improving the health behaviours of young people. To address these questions for PA, we identified recently conducted systematic reviews of PA interventions, and these informed the work of RS2. We sought evidence on process measures as well as outcomes, including engagement, compliance, implementation, costs and benefits. Findings from these reviews informed the economic modelling and review (WP1.2) and intervention development (RS2).

A third systematic review was carried out as part of Sarah Shaw's PhD studies.[35] The review found no clear relationship between access to supermarkets – classified as healthy food outlets – and healthier diets, possibly due to the availability of both nutritious and unhealthy foods within these stores. Evidence on the role of the consumer environment, including food pricing, availability and in-store marketing, was limited and inconsistent. The review highlighted the need for further high-quality intervention studies to better understand how food environments influence adolescents' independent food choices.

Cost-effectiveness modelling

A Markov model was developed. The model was designed for use in extrapolating short-term observed effects on diet, activity and/or BMI to estimate future effects on the incidence of type 2 diabetes (T2D) and cardiovascular disease (CVD). The health outcomes were quantified using quality-adjusted life-years (QALYs), including direct effects of diet, activity and/or BMI on quality of life (QoL) EuroQol-5 Dimensions as well as survival and QoL effects of T2D and CVD events. Costs were estimated from a public sector perspective, including costs to schools, local authorities and the NHS. The intention was to estimate costs and QALYs over 10 years, 20 years and lifetime horizons, discounted at UK-recommended annual rates. In addition to cohort averages, results were to be presented for socioeconomic subgroups (Index of Multiple Deprivation quintiles) to show potential impacts on inequalities.

While the intention was to apply the model to estimate the cost-effectiveness of LifeLab Plus to improve diet and PA in adolescents using data generated in WP3.2, our findings did not warrant such an analysis. *Main trial* describes problems with data collection and analysis in the main trial, including having to stop measurements required for BMI assessment (a key driver of effectiveness in the economic model), missing data and a large imbalance in diet quality at baseline. The

trial results show no apparent effect for the primary outcomes; and differences for the outcomes used in the economic model [Child Health Utility 9 Dimensions (CHU9D), fruit and vegetable portions per day, and minutes of moderate/severe PA] are small and inconsistent (*Table 1*). We did consider whether subgroup analysis to explore differences by socioeconomic status (SES) would be useful but concluded that this would be subject to bias and difficult to interpret.

TABLE 1 Comparison of outcome variables at follow-up by randomisation group

	Control, *N* = 571		Intervention, *N* = 556					
	N	Mean (SD) Median (IQR) *n* (%)	*N*	Mean (SD) Median (IQR) *n* (%)	Difference/RR[a,b]	*p*-value	Difference/RR[a,c]	*p*-value
Primary outcomes								
Follow-up diet quality score – mean (SD)	570	0.96 (1.56)	554	0.94 (1.33)	−0.02 (−0.32 to 0.27)	0.9	−0.10 (−0.29 to 0.09)	0.3
Total PA (minutes/day) – mean (SD)	356	307.5 (66.8)	376	305.6 (70.9)	1.19 (−15.5 to 17.9)	0.1	8.65 (−7.79 to 25.1)	0.3
Other dietary outcomes								
Water: drinks 1 l or more per day [n (%)]								
No		262 (45.9)		266 (47.8)	0.96 (0.85 to 1.09)	0.6	0.95 (0.84 to 1.06)	0.4
Yes		309 (54.1)		290 (52.2)				
Fizzy drinks: drinks 1 l or more per week [n (%)]								
No		433 (75.8)		459 (82.6)	0.72 (0.52 to 1.01)	0.06	0.77 (0.58 to 1.03)	0.08
Yes		138 (24.2)		97 (17.4)				
Crisps: consumes more than 250 g per week [n (%)]								
No		349 (61.1)		395 (71.0)	0.74 (0.62 to 0.89)	0.001	0.75 (0.63 to 0.89)	0.001
Yes		222 (38.9)		161 (29.0)				
Chips: consumes more than 500 g per week [n (%)]								
No		433 (75.8)		450 (80.9)	0.79 (0.58 to 1.09)	0.2	0.84 (0.64 to 1.09)	0.2
Yes		138 (24.2)		106 (19.1)				
Fruit and vegetables: consumes fewer than five portions per day [n (%)]								
No		343 (60.1)		368 (66.2)	0.85 (0.70 to 1.02)	0.08	0.88 (0.75 to 1.05)	0.2
Yes		228 (39.9)		188 (33.8)				
Well-being outcomes								
Self-efficacy (standardised) – mean (SD)	566	−0.01 (1.01)	553	0.01 (0.99)	0.02 (−0.14 to 0.19)	0.8	−0.01 (−0.14 to 0.13)	0.9
Motivation (standardised) – mean (SD)	566	−0.05 (0.98)	553	0.05 (1.02)	0.11 (−0.06 to 0.27)	0.2	0.05 (−0.09 to 0.20)	0.5
CHU9D (standardised) – median (IQR)	565	0.02 (1.00)	553	−0.01 (1.01)	−0.04 (−0.21 to 0.14)	0.7	−0.01 (−0.13 to 0.10)	0.8

continued

TABLE 1 Comparison of outcome variables at follow-up by randomisation group (*continued*)

	Control, *N* = 571		Intervention, *N* = 556					
	N	Mean (SD) Median (IQR) *n* (%)	*N*	Mean (SD) Median (IQR) *n* (%)	Difference/RR[a,b]	*p*-value	Difference/RR[a,c]	*p*-value
Cantril Ladder (standardised) – mean (SD)	565	−0.02 (1.01)	553	0.02 (0.98)	0.04 (−0.11 to 0.19)	0.6	0.03 (−0.10 to 0.16)	0.7
PA self-efficacy (standardised) – mean (SD)	556	0.06 (0.95)	549	−0.06 (1.05)	−0.11 (−0.25 to 0.03)	0.1	−0.08 (−0.19 to 0.03)	0.2
PA self-determination, Relative Autonomy Index (standardised) – mean (SD)	571	−0.02 (1.01)	556	0.02 (0.98)	0.04 (−0.14 to 0.22)	0.7	0.03 (−0.12 to 0.18)	0.7
Other PA outcomes								
Total moderate and vigorous activity (minutes/day) – median (IQR)	356	33.4 (23.6–49.6)	376	35.5 (23.0–54.3)	0.10 (−0.13 to 0.33)	0.8	0.13 (−0.07 to 0.34)	0.2
Vigorous intensity duration (minutes/day) – median (IQR)	356	1.89 (0.81–5.61)	376	2.55 (1.01–6.03)	0.10 (−0.11 to 0.30)	0.4	0.13 (−0.06 to 0.33)	0.2
Inactive duration (minutes/day) – mean (SD)	356	630.2 (76.3)	376	633.3 (79.3)	1.65 (−15.7 to 19.0)	0.9	0.87 (−14.4 to 16.1)	0.9
Sleep duration (minutes/day) – mean (SD)	356	500.7 (56.5)	376	501.1 (53.3)	−0.99 (−13.5 to 11.5)	0.9	−5.33 (−16.9 to 6.22)	0.4
24-hour intensity distribution (counts) – mean (SD)	356	−2.27 (0.22)	376	−2.24 (0.22)	0.03 (0.00 to 0.06)	0.06	0.02 (−0.02 to 0.06)	0.3
Proxy 24-hour daily activity (mg) – median (IQR)	356	30.9 (26.1–37.8)	376	31.1 (25.8–38.9)	0.05 (−0.18 to 0.27)	0.7	0.14 (−0.07 to 0.35)	0.2
Met 60-minute moderate/vigorous guideline [n (%)]								
No		298 (83.7)		301 (80.1)	1.23 (0.86 to 1.78)	0.3	1.42 (0.99 to 2.03)	0.06
Yes		58 (16.3)		75 (19.9)				

IQR, interquartile range; RR, relative risk.

a Variables that were skewed and presented as medians in the summary have been logged and standardised for the analysis. The differences presented for these variables are in standard deviation (SD) units. For the binary variables, the RR is presented. The first two columns show the raw means. Adjustments for clustering are included in the analysis of the differences.

b All analyses are adjusted for clustering at school level.

c All analyses are adjusted for clustering at school level and for the baseline level of the variable being analysed. Numbers in these analyses, particularly for the GENEActiv data, are reduced as 162 students provided sufficient GENEActiv follow-up, data but their baseline data were incomplete.

Note

Differences or RRs are presented. All analyses adjusted for clustering, but the final set of columns is additionally adjusted for baseline level of the variable being analysed.

The model has been published with intervention effects on BMI z-score and moderate/vigorous PA taken from meta-analyses of multicomponent school-based obesity prevention interventions, including PA, health education and dietary improvement.[36] The model, therefore, has use beyond EACH-B, and application to other complex intervention research.

Stakeholder engagement

Stakeholder engagement meetings were held throughout the programme, evolving in response to insights and changing contexts. These meetings built a strong network across Wessex, ensuring lasting commitment to adolescent health and

effective knowledge translation beyond EACH-B. Early discussions encouraged cocreation of the intervention, fostering ownership and increasing the likelihood of successful implementation.

A key milestone in this strategy was securing an Innovation-to-Commercialisation fellowship for Woods-Townsend, providing £50,000 funding for 3 months of intensive national and international stakeholder engagement. This deepened understanding of implementation needs and the commercial potential of EACH-B outputs while strengthening long-term partnerships.

The programme also contributed to policy development, with several team members actively involved in Southampton City Council's Childhood Obesity Policy scrutiny panel. This led to direct policy impact, including recommendations to scale up LifeLab. EACH-B also supported ukactive's 'Generation Inactive 2' report and played a central role in the UK Research and Innovation (UKRI) Arts and Humanities Research Council-funded Pathways to Health Consortium, a collaboration of over 30 partners reimagining adolescent health and well-being services in Southampton and beyond.

Woods-Townsend further engaged with national policy-makers in health and education through the 2020–1 Royal Society Scientist-Member of Parliament pairing scheme. This engagement reinforced the importance of integrating public health and education sectors in adolescent well-being initiatives.

The stakeholder engagement process successfully secured genuine buy-in by ensuring the intervention met both research and policy needs. This collaborative approach not only achieved the programme's primary objectives but also created wider impact through policy influence and system-wide engagement. The partnerships formed continue to support adolescent health research, policy development and practice, facilitating young people's engagement with Southampton City Council and the Hampshire and Isle of Wight Integrated Care Board (ICB) and Integrated Care Partnership (ICP). The EACH-B programme has delivered lasting benefits to young people across the Wessex region.

Developing the intervention to engage and motivate teenagers: research stream 2

Work on developing the three-component intervention began in the first month of the programme (October 2017) and ran until October 2019 (*Figure 5*). We adopted a person-based approach to guide the planning, development and usability testing of the intervention and ensure that was feasible and acceptable to young people, parents and teachers.[30,37,38] This approach has proven success in supporting the development of numerous effective interventions.[31,39] In an innovation that was unique at that time, we combined this approach with user-centred design principles used for digital game design and a participatory design process in order to produce a behaviourally informed yet engaging game.[40] This RS involved four iterative WPs that each involved systematic and rigorous qualitative research. These were overlapping to enable initial plans for the intervention to be tested early on, revised to minimise adverse reactions from students, teachers and parents, and then tested again.

Identifying barriers to eating better and moving more and strategies for change

Qualitative research with students

This study was conducted in Southampton, England, between 2017 and 2018 and has been published.[41] Participants were 54 13- to 14-year-old students from a mixed, non-selective secondary school, 95% of whom were White British, and 49% were girls. Convenience sampling was used, and focus groups of between three and six students were conducted during school hours. A semistructured topic guide, developed with input from a young people's PPI panel, guided discussions about eating healthily and being active, their experiences and views of existing health information sources and levels of environmental support for behaviour change, social influences on their views and behaviours and

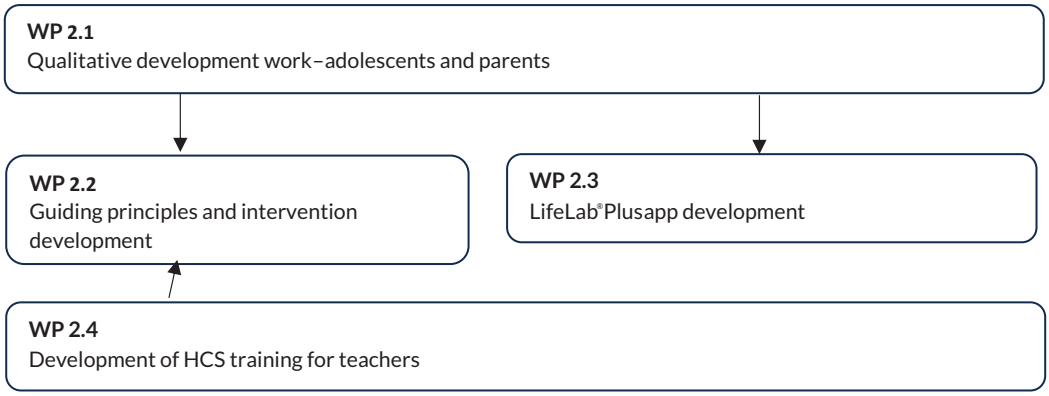

FIGURE 5 Showing the organisation of the WPs within RS2.

their experiences and perceptions of the digital world. Participants completed a brief demographic questionnaire and received a £10 shopping voucher for their participation.

Findings

Thematic analysis identified four main themes to the discussions:

1. I know what healthy means and how it might benefit me.
2. I do what others do.
3. I'm busy doing other things.
4. I want healthy to fit into my life.

These themes aligned with the three basic psychological needs outlined in Self-Determination Theory: autonomy, competence and relatedness (*Figure 6*). Students were aware of health guidance but struggled to maintain healthy

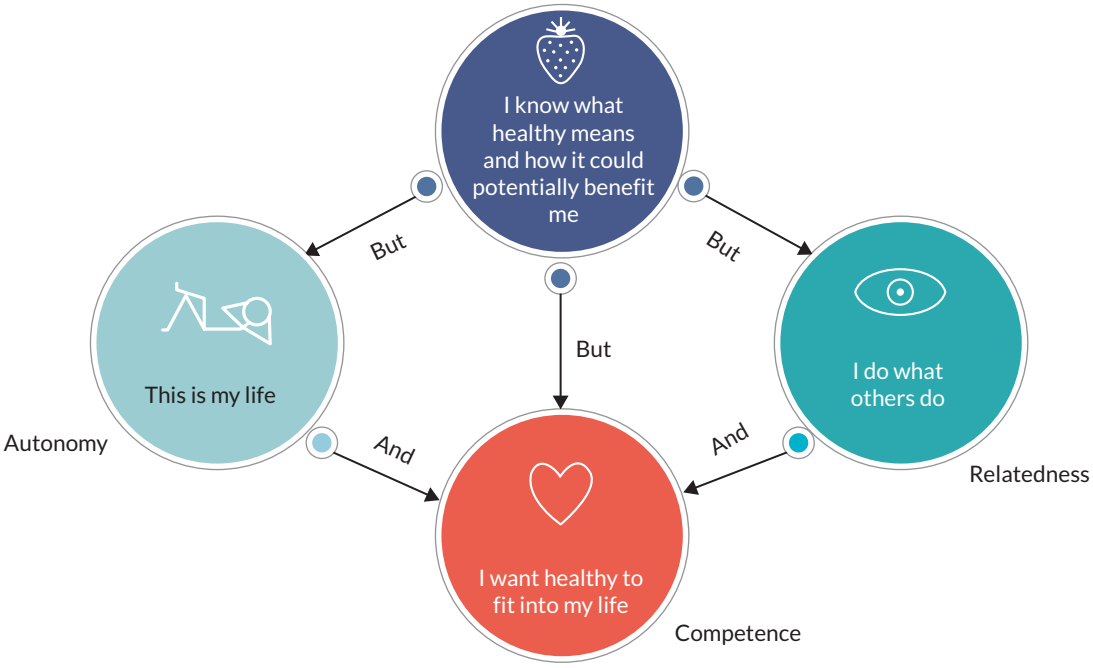

FIGURE 6 The overlap of the components of Self-Determination Theory with themes from interviews with secondary school students and the relationships between these themes. Some text in this figure has been reproduced with permission from Strömmer *et al.*[41] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) licence, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/. The figure includes minor additions and formatting changes to the original text.

habits. Social influences, particularly peers and parents, played a significant role in their health behaviours. Participants reported busy lives filled with various commitments, often compromising between health ideals and personal preferences when making independent choices.

The study suggested that effective health interventions for young people should align with their values and priorities, fulfilling psychological needs for autonomy, competence and relatedness. Interventions should make healthier choices more accessible, appealing and enjoyable, while addressing environmental constraints. The potential of digital platforms and social media in supporting health interventions was highlighted, with suggestions for future research to explore their positive use in engaging young people. Exploration of the role that food plays in identity development during adolescence discovered important differences in the way younger and older adolescents responded to social media. This research is described in *Report Supplementary Material 2* and *Report Supplementary Material 3*.

Qualitative research with parents

The study was conducted in Southampton in 2018 and has been published.[42] It involved 24 parents, with 18 participating in individual interviews and 6 in 2 focus group discussions. Participants were recruited via an e-mail list following their adolescent's visit to LifeLab. All had at least one adolescent attending secondary school. All were women, and all but one was White British. Ten were educated to degree level. Interviews lasted 20–45 minutes and were held in various convenient locations. All participants were women, mostly aged 40–49 years and predominantly White (96%). Thematic analysis was conducted using NVivo (QSR International, Warrington, UK) software.

Findings

Six themes were identified:

1. Parents tried to maintain authority over health behaviours while promoting independence.
2. Parents' health perspectives were influenced by personal experiences and barriers like tight budgets.
3. Adolescents preferred convenient food options and were influenced by peer pressure.
4. External factors like school environments and technology were seen as barriers to health.
5. Changing dynamics of control led to compromises and conflicts.
6. Parents suggested rewards and positive use of technology to support adolescent health.

The study highlighted the shifting dynamics between parents and adolescents regarding control over health behaviours. Parents' influence diminished as adolescents gained autonomy, often leading to communication breakdowns. The study also emphasised the need for public health interventions to address the broader food environment and marketing influences outside the home. Direct methods like parent training were suggested, but concerns about feasibility of this with busy schedules were noted.

The three papers published on the work of WP2.1 are described below.

Review of health behaviour change interventions

The authors drew on their experience developing health behaviour change interventions with diverse populations globally.[43] They analysed data from several studies, including qualitative interviews and focus groups with pregnant women, adolescents and parents/caregivers in the UK and low- and middle-income countries. Thematic analysis was used to explore participants' values, motivations and responses to interventions.

Findings

The authors proposed three main reasons why conventional behaviour change interventions often struggle to demonstrate effectiveness:

1. Interventions focus on mean effects, ignoring individual differences in response. One study, for example, showed variations in how pregnant women engaged with interventions based on their 'health identity' and confidence in overcoming barriers.
2. Interventions assume everyone values health equally. Research with adolescents reveals they prioritised an immediate need for autonomy, competence and relatedness over long-term health outcomes.

3. Interventions appeal primarily to rationality rather than emotions. Evidence suggested positive emotions experienced during healthy behaviours create unconscious or internal motives that sustain change.

The authors argued for a move towards acknowledging individual differences in intervention design. They proposed using creative approaches involving the arts and culture to engage people emotionally in health and well-being, and to build trust through sustained engagement. Future interventions may benefit from strategies that empower communities, appeal to emotions as well as logic, and align with people's values and priorities. The authors concluded that engaging emotions and using creative approaches could lead to more effective and sustained behaviour change than conventional interventions, which involve information giving and education and therefore appeal only to people's rational and cognitive motivations and reasoning.

Mixed-methods exploration of energy drink consumption in United Kingdom adolescents

The study used a mixed-methods approach.[44] Repeated cross-sectional quantitative dietary data, information about consumption of energy drinks and demographic data from the National Diet and Nutrition Survey (NDNS) (n = 2587 adolescents aged 11–18) were analysed using logistic regression. Qualitative data from semistructured interviews included discussion of energy drink consumption with 74 adolescents, 95% of whom were aged 13–14 years, 24 parents and 15 teachers in Hampshire, UK, the majority of whom were women and White British. Data were analysed using thematic analysis.

Findings

Overall, 7% of young people drank energy drinks over the 4-day period of NDNS study. Consumption was higher among older adolescents, those from more deprived areas and lower income households, and those with poorer dietary quality. Consumption of energy drinks by adolescents from the most deprived areas increased between 2008 and 2016, while it decreased among the most affluent adolescents.

Three themes emerged from the qualitative data: (1) adolescent consumption of energy drinks is driven by peer influence and low cost of unbranded drinks; (2) energy drink consumption is associated with other unhealthy behaviours, but adolescents lack understanding of specific health risks; (3) voluntary bans on sale of energy drinks in retail outlets and schools are perceived as ineffective.

The findings support introducing legal restrictions on energy drink sales to minors. However, the proposed ban for under-16s would miss the highest consumers aged 16–18 years. Additional policies like minimum pricing, placement restrictions and public health messaging could enhance effectiveness. Legislation may help address the widening socioeconomic inequalities in energy drink consumption among adolescents.

Qualitative work with adolescents examining their social and food environments[45] (and Report Supplementary Material 4*)*

This qualitative study involved 13 online focus groups with 45 adolescents aged 11–18 years attending secondary school or college in England, UK. Participants, 29% of whom were girls and were from a range of SES groups, took part in semistructured discussions about their experiences making independent food choices. Data were analysed using thematic analysis. The study was conducted between October 2020 and April 2021 during the COVID-19 pandemic.

Findings

Five key themes were identified:

1. Social experiences involving eating were more important than the food itself, with fast-food outlets uniquely suited to facilitating social interactions within this age group.
2. Adolescents wanted to spend money on foods they considered worthwhile, not always the most affordable options.
3. Participants preferred making quick, low-effort food decisions, appreciating factors like prominent placement and promotions.
4. Chain food outlets were valued for offering familiar, frequently advertised foods.
5. Adolescents' search for a sense of autonomy was central to all themes.

The findings highlighted the interplay between social and food environments in shaping adolescents' choices. Fast-food outlets were seen as ideal spaces for socialising independently of family. Participants were aware of some government strategies around food but felt mandatory policies across all outlet types were needed. The study suggested current UK food environment policies may need refinement to effectively impact adolescents, such as including smaller retailers, addressing meal deals and restricting brand advertising. Overall, the research emphasised the need to incorporate adolescents' lived experiences when developing food environment interventions and policies to ensure they align with young people's values and are effective for this age group.

Planning the intervention

Intervention planning was conducted collaboratively within our multidisciplinary team with oversight from our expert co-applicants at every stage. A person-based approach was adopted for development of all three components of the EACH-B intervention. The process was as follows:

1. Data from qualitative and quantitative systematic review (WP1.1) was triangulated with insights from the primary qualitative research and stakeholders (WP2.1/WP1.3) and theoretical models of behaviour change.
2. Based on this process, decisions about components and characteristics required as part of the intervention.
3. A detailed and rigorous description of the intervention was produced, ensuring that potentially important theoretical determinants of behaviour change were not overlooked.
4. The Behaviour Change Wheel was used to define and characterise the identified barriers/facilitators and guide the selection of appropriate behaviour change techniques (BCTs) from the 93v1 taxonomy.[46]
5. The final step was to translate the design principles developed through this process into tangible intervention components.

Following the person-based approach, a set of 'guiding principles' for the intervention was developed (*Table 2*). These defined the key behavioural, psychosocial or contextual issues that needed to be addressed by the intervention, that were not being met within the adolescents' existing support structures, and distinctive ways in which the intervention could address those issues in a persuasive, feasible and acceptable way, both in terms of content (specific BCTs) and delivery (tone, structure, timing).

These guiding principles ensured that priority was given to crucial intervention components and that they were implemented and communicated in ways that were intended to be optimally acceptable, persuasive and likely to support sustained behaviour change. Where there was disagreement between sources of evidence and expert opinion, discussions were held within the team until consensus was reached.

TABLE 2 The guiding principles developed for the EACH-B intervention

Design objectives	Key features
Enable adolescents to seek support from or engage with their social network while encouraging personal discovery	• Support autonomy through enabling choice and experimentation • Incorporate social components (e.g. collaborative quests with peers)
Persuade adolescents that healthy eating and PA can be a positive experience with positive outcomes	Series of quests that: • incorporate activities adolescents engage regularly in (using phone, taking/sharing photos, social media) • are themed on fun and intrigue – not explicitly health focused • establish ownership and responsibility over behavioural choices • demonstrate link between diet/PA and personally valued outcomes
Enhance confidence for healthy eating and PA, persuading users that it can be easy to do	Series of quests that: • require small, achievable changes • focus on environmental discovery • model how small changes can be integrated within existing daily routine • emphasise free, quick, lifestyle-aligned activities

Intervention content

This process produced an intervention that combined three linked components:

1. Professional development involving communication and HCS training for teachers to support their students' health behaviour change. HCS training has been shown to support behaviour change, is accessible to practitioners in different health and social care settings, and can produce sustained changes in how practitioners communicate and support others to change.[29] The process of adapting HCS training for teachers to deliver the intervention's face-to-face support component is described in WP2.4. Teachers were trained online or at LifeLab to conduct healthy conversations with their students whenever the opportunities arose in school.
2. An educational module for secondary school students comprising nine in-person science lessons linked to the English National Curriculum and a practical day visit to a unique educational lab facility (LifeLab) at a large UK teaching hospital (www.southampton.ac.uk/lifelab/index.page). This educational component was based on the programme previously developed and extensively tested at LifeLab. Drawing on this experience, it was redesigned and rebranded to form a component of the EACH-B intervention. LifeLab is a hands-on programme tailored to give the adolescents insights into the impact on their lives of a healthy diet and the benefits of PA.
3. A game-based smartphone app (LifeLab Plus) for young people. This was a self-guided digital tool which was designed to build adolescents' knowledge and motivations for eating better and being more active. Development of this component is described in WP2.3. The app was designed and tested by adolescents themselves to ensure that it was tailored to the way they use their phones. For more details of the app, see *Figure 7*.

Logic models

Figure 1 – the EACH-B logic model – summarises the whole programme. The model proposes that completion of the LifeLab module would motivate young people to eat better and move more. Engagement with HCS-trained teachers was intended to build on and sustain the motivation to improve their health behaviours that students gained from LifeLab. The digital intervention, based on proven BCTs and game features, would support integration of these healthy habits into self-identity, leading to improvements in self-efficacy, diet and PA.

Development and usability testing of the digital intervention

Guiding principles from WP2.2 were used to inform design of the digital intervention content, structure and delivery. Key behaviour change components of the digital component were identified based on the guiding principles. The narrative and game-based elements and the translation of the draft content into a first prototype of the digital intervention was carried out by the game design team at Glasgow Caledonian University's (GCU) digital intervention and game development lab but supported by placements of psychologists from the team at Southampton in Glasgow.

The EACH-B intervention app development process is described in a manuscript currently being prepared for publication entitled, 'Enhancing the relevance of nutrition and physical activity interventions for adolescents: Design and development of the LifeLab Plus app' (this is described in *Report Supplementary Material 5*). The app was designed using combined principles of behavioural science and game design. A blend of theoretical methods (e.g. behavioural analysis, logic modelling), evidence-based strategies (e.g. systematic reviews, qualitative research) and coproduction activities, such as interactive workshops, were used to develop a set of guiding principles and identify opportunities to incorporate behaviour change components into the app. The game design and content were mapped on to 27 BCTs derived from the qualitative research, and user testing carried out in WPs 2.1 and 2.3 to ensure that all issues emerging from primary qualitative work were addressed within the intervention design (see *Table 3* for an illustration of this process).

To support a sustained commitment to diet/PA change, the app was designed to:

- provide tailored feedback and self-monitoring support in combination with goal-setting as these are known to be associated with positive changes in behaviour[47]
- offer support for habit-formation, since evidence is accumulating in adults that this produces sustained behaviour change[48]

TABLE 3 Showing an example of how one BCT was described and translated into the LifeLab Plus game design

BCT	1.1 Goal-setting (behaviour)
Description	Set or agree a goal defined in terms of the behaviour to be achieved. For example, set a goal of daily walking (e.g. three miles); set a goal of eating five pieces of fruit per day
Barriers/facilitators to engagement addressed	• Taste and texture are important to adolescents • Competition with other valued activities can undermine engagement with the goal • Personal choice is important • Some adolescents dislike exercising alone. Others dislike overt competition
Potential translation for gameplay	• Allow players to choose their own goals from a selection framed as 'challenges' or 'quests' • Allow space for choice and autonomy in how the goal is enacted, for example, 'create a meal with four different colours' rather than prescribing specific foods to eat

- include game elements, since these have been found to motivate players to engage with boring tasks and may be associated with positive behaviour change[23]
- address adolescents' specific dietary/PA needs.

Adolescents were heavily involved in the cocreation of the digital intervention. Secondary school students aged 13–17 years (n = 49) from schools in Glasgow and Southampton took part in 'game jams' to develop characters, ideas and concepts. Four game jam events involving 233 university game design students generated ideas for features and quests for the digital intervention. Once there was a 'minimum viable product', panels of these students then played the games and fed back on game features as they were developed. These activities were followed by small group and 'think aloud' interviews with 10 adolescents aged 13–17 years recruited from a scout group; interviews were conducted to elicit more detailed feedback. Student evaluations and feedback collected during these interviews was used to inform the in-development digital intervention; students were asked about usability, acceptability and persuasiveness of support offered for behaviour change. Qualitative data was triangulated with objective records of digital intervention usage gathered from use of the intervention outside the lab to examine and measure engagement with the digital intervention as a whole, but also to identify which features of the intervention were not being used as intended. These issues were addressed in subsequent iterations, and the process repeated until the first full feature complete version of the app was ready. This was then used in the pilot study described in WP3.1.

The four games that formed LifeLab Plus are presented in the digital intervention logic model in *Figure 7*. The key findings of this exercise highlighted that theoretical and evidence-informed approaches, while crucial for initial development, were not sufficient to deliver an app that was meaningful and relevant to adolescents. Findings from the qualitative research and coproduction activities informed the integration of behaviour change components into each element of the app, for example, the 'Gutsy' game, to maximise engagement. Examining barriers to engagement in real-world contexts, beyond technical or navigational issues, researchers were able to enhance user engagement and increased the theoretical likelihood of sustained behaviour change. The process of app development combined the speed and agility of game design processes with the rigour of academic intervention design methods.

During the design process, consideration was also given to features that involved parents, since modelling effects of parental behaviour on adolescent behaviour are highly significant,[49] and improved social connectedness, since this is known to predict adolescent health risk behaviour.[50] Consequently, a website was designed for parents to accompany the EACH-B intervention. Time and resources prohibited development of a game component that enabled young people to compete with each other or play together, as they also prohibited development of an app for parents, though these would have enhanced the intervention.

Development of Healthy Conversation Skills curriculum

Building on findings from WP1.3/WP2.1, a HCS curriculum was developed for teachers from the existing HCS training. HCS-trained teachers provided the face-to-face component of the intervention.

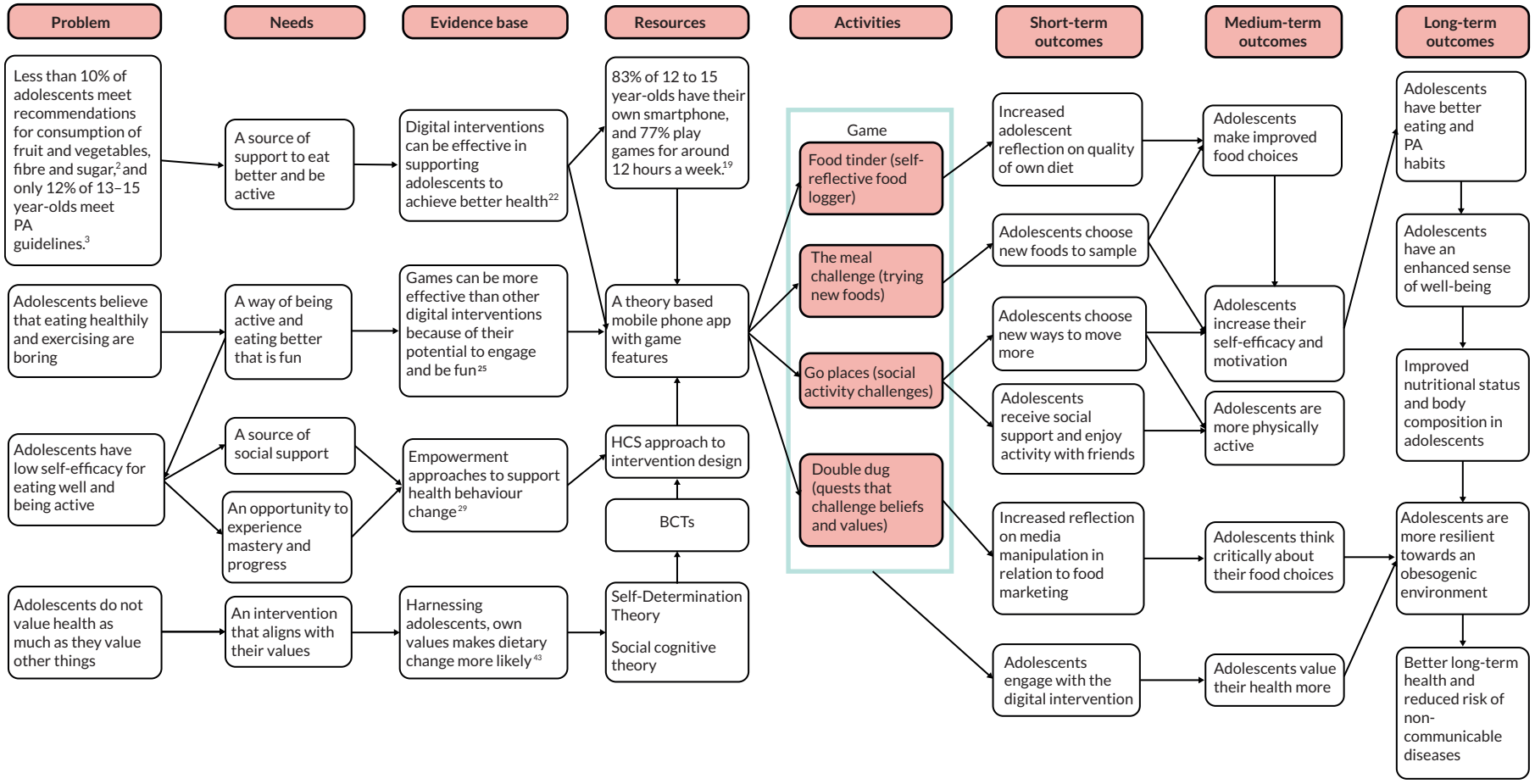

FIGURE 7 Logic model describing the problems and evidence base and the way that the four games within the app are hypothesised to address these problems and generate desirable outcomes.

Curriculum development was informed by interviews with teachers who took part in a pilot test of HCS during 2015–7. Interviews with 15 teachers from Hampshire secondary schools were carried out to explore how they had used the skills, any barriers to their use, what additional training needs they had and how an extended training programme might be delivered in schools. Findings from the interviews formed the basis for amendments to the HCS curriculum so that it was ready for use as part of the EACH-B intervention.

Healthy Conversation Skills training was delivered by the research team during Teacher Professional Development Days attended by science teachers whose pupils were due to undertake the LifeLab programme, where they received a short (1.5 hour) introduction to HCS. Two focus groups involving 14 teachers were convened during these professional development days to explore teachers' perceptions of how they could use the skills to support pupils to make lifestyle changes (including digital tool use) and how the HCS training programme could best be delivered in schools.

A reflexive thematic analysis was conducted using transcripts from these interviews and focus groups along with those from two interviews conducted with teachers following their participation in the EACH-B pilot RCT. Teachers from a range of different subject departments, and those representing different levels of experience, seniority and roles, were recruited.

The analysis found that teachers were enthusiastic about talking to their students about health in supportive and encouraging ways. They found opportunities to have these sorts of conversations. Conversations that happened in lessons were more generalised and focused on the practicalities of health and behaviour, whereas less-formal conversations that happened at lunchtime, in corridors or after school were more likely to provide opportunities for teachers to speak to students individually about the specific barriers they faced. Teachers had ideas about strategies that could help them to support their students' health, but, in reality, they felt powerless because they witnessed, on a daily basis, the breadth of environmental, individual, financial and social factors that made it more difficult for students to make healthy choices. Teachers also felt that school cultures and systems did not facilitate health behaviour change but, in fact, actively made it harder for teachers to support their students.

These findings led to amendments to the basic HCS curriculum that supported teachers to make the best use of the brief opportunities during lunchtime on in passing to speak to their students. It was also concluded that there was no obvious mechanism or time for delivering HCS training during school hours and in school, at least not for the duration of the EACH-B intervention trial. These findings were fed into discussions with wider stakeholder groups about methods of embedding support for health and well-being into education.

Pilot and main trial of LifeLab Plus intervention: research stream 3

Some text in this section has been reproduced with permission from Strommer *et al.*[33] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) licence, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/. The text below includes minor additions and formatting changes to the original text.

Research stream 3 focused on assessing the three-part intervention in a cluster-randomised trial informed first by a pilot trial[4] (*Figure 8*).

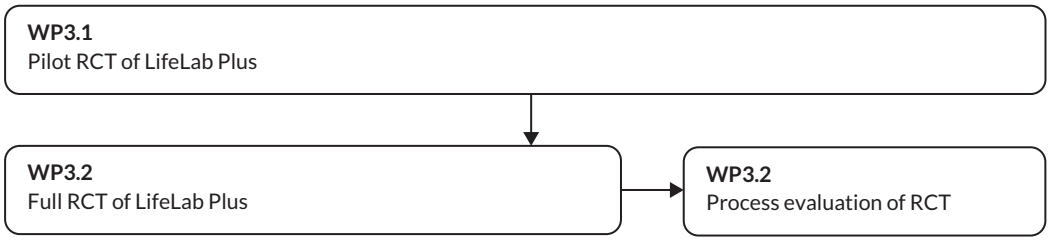

FIGURE 8 Showing the organisation of the WPs within RS3.

Pilot trial

In the autumn term of 2018, we recruited six schools to take part in the pilot trial, randomised such that three schools received the intervention and three the control. Data collection was successful in all schools, both at baseline and follow-up 4–6 months later. Consent rates differed marginally between the intervention arm (92%) and the control (87%). Over 85% of students in the intervention arm attended the LifeLab days in January/February 2019. The students' demographic data were transferred to the research team by all six schools. Methods for completing questionnaires, recording height and weight measurements and distributing GENEActivs were effective. Some challenges were identified in getting the teachers to participate in the teachers' professional development day or the online training that was made available to them. We identified various modifications to the procedures for recruiting schools, managing the data collection and downloading the app, and these were taken forward to the main trial.

Main trial

The main trial was a cluster-RCT to assess the effect of engagement with LifeLab, ongoing support from HCS-trained teachers and the smartphone app on the diet/PA of LifeLab students in publicly funded schools in South Central England, UK. Students in mid-level ability classes were recruited. The control group had none of these three interventions. Each school represented 1 cluster, and we aimed to recruit 50 schools and 2 classes in each school. The trial was powered to detect 0.25 standard deviation (SD) differences between the two arms for both of the two primary outcomes of diet quality score and total activity (minutes per day of low, moderate and vigorous activity). From previous data from schools interacting with LifeLab, we estimated an intraschool (class) coefficient of 0.035. With 46 schools, each sending 2 classes, ≈ 50 students (n = 2300), this provided 90% power at 0.025% significance level (accounting for 2 primary outcomes) to detect a 0.25 SD difference in diet quality score or number of steps between intervention and control schools. We aimed to recruit 50 schools allowing for dropout.

Outcome measures

Primary outcome measures: data were collected at baseline and follow-up. Coprimary outcomes of dietary quality and PA were assessed. Dietary quality was assessed using a 20-item food frequency questionnaire (FFQ) developed specifically for use with adolescents using data for boys and girls aged 11–18 years who took part in the NDNS.[51] Principal component analysis was applied to these data in order to identify 20 indicator foods which best describe better and poorer dietary quality of UK adolescents.[51,52] This FFQ has shown good comparison with important nutritional biomarkers, including 25-hydroxy vitamin D, total carotenoids, serum folate and vitamin C.[52] From the FFQ, a diet quality score was calculated, which was expressed as SD units. Using GENEActiv accelerometers, PA was assessed as minutes of daily low, moderate and vigorous PA, also described as total PA. At baseline and again at the 12-month follow-up, GENEActiv was worn for 7 days, and the output data averaged over this period, or the maximum period of valid data.

Secondary outcomes measures: these included self-reported frequency of PA from a modified version of the Youth Physical Activity Questionnaire (YPAQ) validated for use in 12- to 13-year-olds;[53] behavioural self-regulation and self-efficacy for healthy eating and PA (unpublished); and QoL and well-being measured by two age-appropriate tools: the CHU9D[54] and the Cantril Ladder.[55] Behavioural regulation and self-efficacy for PA will be assessed by the Behavioural Regulation for Exercise Questionnaire[56] and the PA section of the Self-Efficacy for Healthy Eating and Physical Activity measure (SE-HEPA).[57] Behavioural regulation and self-efficacy for diet will be assessed using the recently developed Confidence and Behavioural Autonomy scale. This is age-specific and has been validated against the healthy eating scales of the SE-HEPA and the Treatment Self-Regulation Questionnaire.[58] The original plan was to collect height and weight and calculate BMI z-scores, with and without adjustment for pubertal status;[59] this had to be abandoned immediately post-COVID-19 when the research team were no longer allowed into schools to collect data.

Harms/auditing: we did not expect the trial to give rise to any adverse events or harms. However, a risk assessment was completed and submitted as part of the ethical approval process. All staff involved in visiting schools had the enhanced level of Disclosure and Barring Service to work with children, were trained in safeguarding and awareness of eating disorders and had basic levels of awareness about dealing with someone who might become anxious for any reason during a data collection visit.

We started recruitment to the main trial in autumn 2019. By March 2020, baseline data had been collected from 224 students in 5 intervention schools, and 212 students in 5 control schools, a total of 436 students. Three intervention

schools had attended LifeLab. School closures initiated by the COVID-19 pandemic meant that all trial activities were officially suspended on 18 March 2020. This suspension lasted a year, during which the EACH-B team continued to engage with young people and to collect insights, by holding focus groups with 10 groups of young people every 3 weeks. These data were collected with a view to informing the EACH-B trial going forward.

Changes resulting from the pandemic, not only to the trial but also in schools, students' lives and behaviours, we were unable to use the baseline data from the 11 schools that had been collected before the school closures. The trial was restarted from scratch in March 2021 (soon after schools reopened in February 2021). Various adaptations had to be made to the data collection procedures because of the infection control practices adopted in schools. Data acquisition was transferred online, enabling it to be performed in the classroom under the supervision of the teacher, or even at home for students who were isolating. However, we had to stop the collection of height and weight measurements, as we were unable to send research staff into the schools and could not ask teachers to perform the measurements for us. Added to which, social distancing meant that it was not possible to take these measurements. Changes also had to be made to the intervention. For many months, it was not possible to bring students into the hospital to attend the LifeLab day, so we arranged for it to be delivered in school, with the EACH-B team providing instructions and delivering the equipment to schools. Changes were made to the app to reflect changes to students' lifestyles as a result of the pandemic.

Randomisation of the schools was conducted externally by the Clinical Trials Unit in Southampton. A minimisation algorithm was used, aiming to balance the schools on free school meal provision, General Certificate of Secondary Education (GCSE) results and whether the schools had sent students to LifeLab in the previous 2 years. Over the subsequent 2 years, 49 schools were recruited and randomised to the trial, and baseline data collection took place in 45 of them. Four schools dropped out after randomisation (two intervention and two control), citing staffing shortages and pressures of the pandemic as the reasons. All 45 schools successfully completed the follow-up 1 year after baseline data collection. The statistician analysing the data was blinded to the allocation until all analyses were completed.

After the pandemic, we found that consent rates had dropped from those seen in the pilot trial. We received approval from the ethics committee to change from opt-in to opt-out consent for the data collection, which was granted, made easier by the fact that we were no longer collecting body measurements. We still required opt-in consent to obtain the demographic data for each student from the schools. Baseline data were obtained from 2065 students (81%) of those eligible. Consent rates were lower in the initial 15 schools (8 intervention and 7 control) that used opt-in rather than opt-out consent. Apart from that, the main reason for non-participation was absence from school. Follow-up took place 1 year after baseline. As this was inevitable in a new school year by which time students had moved to different classes and school absences post pandemic nationally have been much higher than pre pandemic, the follow-up rates were not as high as in the pilot trial. Of those who took part at baseline, 1127 students completed the follow-up. Thus, we achieved a follow-up rate from baseline of 55%. Details are provided in the Consolidated Standards of Reporting Trials (CONSORT) diagram (*Figure 9*).

All students were asked to wear a GENEActiv watch to record PA over the course of 1 week following the baseline data collection. The students were not keen to wear the watch as they did not look good. Some 1153 students provided GENEActiv data for a minimum of 3 days that could be used in the analysis (56% of those completing the baseline data). At follow-up, 732 students had sufficient activity data for use, but only 570 (28% of those recruited at baseline) of those also had usable baseline data.

Opt-in consent for the demographic data resulted in data for fewer students than had provided questionnaire data using the opt-out procedure. Of the 2072 students who provided baseline questionnaire data, demographic data were available for 1332 (64%).

Despite the minimisation algorithm used for the randomisation of schools, there were some imbalances in the baseline data between two arms of the trial. Notably, and worryingly, there was a 0.22 SD difference (adjusted for clustering) in the diet quality score between the two groups. This variable forms one of the two primary outcomes, and a difference of this size is almost as large as the 0.25 SD that the trial was powered to detect in this measure at follow-up. This complicates the interpretation of the analysis. Clearly, cluster-randomised trials have a higher risk of imbalance than

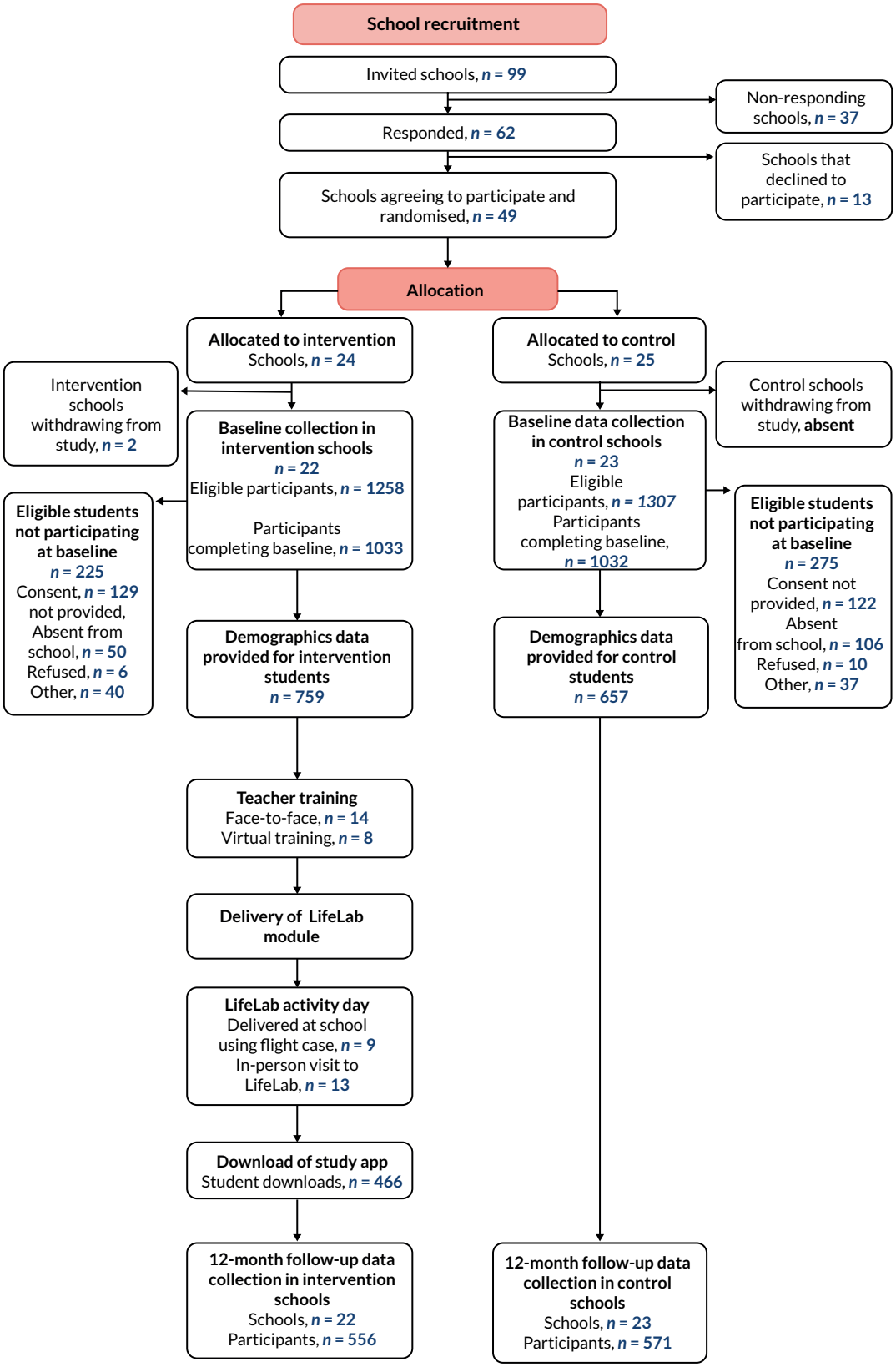

FIGURE 9 The CONSORT diagram for EACH-B trial.

individually randomised, as the randomisation is at school level, and only 45 schools took part (comprising over 2000 individual students). *Figure 10* shows the imbalance.

Full details of the baseline characteristics are presented in *Table 4*, which shows the baseline characteristics of all those students who provided data for the baseline survey.

From the table, one can see that the major difference at baseline between the two groups was in the diet quality score. The difference is greatest in those who did not take part at follow-up (data not shown), though it is still apparent in those who took part at both time points. Differences in the PA data between groups were much less marked as shown in *Figure 11*.

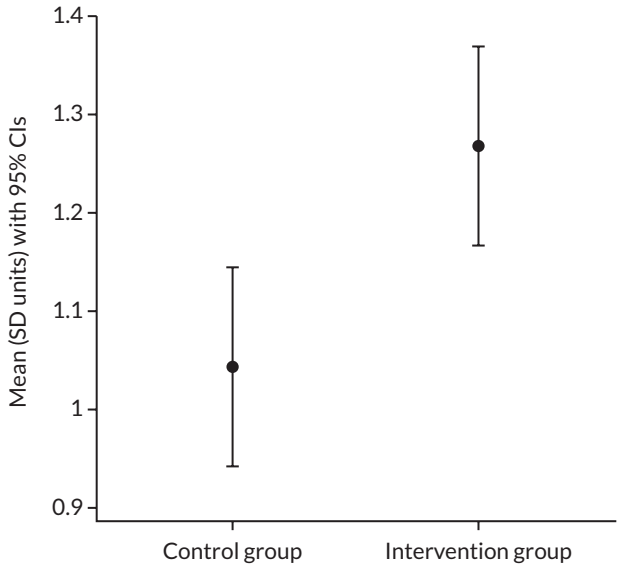

FIGURE 10 Graphical representation of the baseline means for quality of diet and CIs by randomised groups.

TABLE 4 Participant characteristics at baseline by randomisation group

	Control, *N* = 1032		Intervention, *N* = 1033	
	N	Mean/median/*n* (%)	*N*	Mean/median/*n* (%)
Age at baseline, years – median (IQR)	1030	13.0 (12.8–13.3)	1029	13.0 (12.8–13.3)
Gender [n (%)]				
Boys		294 (48.4)		366 (50.8)
Girls		314 (51.6)		355 (49.2)
Ethnic group [n (%)]				
White		551 (91.1)		634 (88.7)
Other		54 (8.9)		81 (11.3)
Income Deprivation Affecting Children Index (IDACI) score – median (IQR)	557	0.09 (0.05–0.18)	643	0.12 (0.06–0.19)
Primary outcomes				
Baseline diet quality score – mean (SD)	1030	1.04 (1.67)	1032	1.27 (1.65)
Total PA (minutes/day) – mean (SD)	565	317.2 (65.6)	569	311.3 (71.0)

continued

TABLE 4 Participant characteristics at baseline by randomisation group (*continued*)

	Control, *N* = 1032		Intervention, *N* = 1033	
	N	Mean/median/*n* (%)	*N*	Mean/median/*n* (%)
Other dietary outcomes				
Water: drinks 1 l or more per day [n (%)]				
No		551 (53.5)		518 (50.3)
Yes		478 (46.5)		512 (49.7)
Fizzy drinks: drinks 1 l or more per week [n (%)]				
No		809 (78.6)		821 (79.7)
Yes		220 (21.4)		209 (20.3)
Crisps: consumes more than 250 g per week [n (%)]				
No		627 (60.9)		649 (62.9)
Yes		402 (39.1)		382 (37.1)
Chips: consumes more than 500 g per week [n (%)]				
No		783 (76.1)		814 (79.0)
Yes		246 (23.9)		216 (21.0)
Fruit and vegetables: consumes fewer than five portions per day [n (%)]				
No		659 (64.1)		710 (68.9)
Yes		369 (35.9)		320 (31.1)
Well-being indicators				
Self-efficacy (standardised) – mean (SD)	1023	−0.04 (1.00)	1027	0.04 (1.00)
Motivation (standardised) – mean (SD)	1023	−0.07 (1.00)	1027	0.07 (1.00)
CHU9D (standardised) – median (IQR)	1017	−0.22 (−0.82 to 0.66)	1024	−0.22 (−0.82 to 0.52)
Cantril Ladder (standardised) – mean (SD)	1015	0.01 (1.04)	1024	−0.01 (0.96)
PA self-efficacy (standardised) – mean (SD)	987	0.02 (0.99)	1011	−0.02 (1.01)
PA self-determination, Relative Autonomy Index (standardised) – mean (SD)	1032	−0.02 (1.01)	1033	0.02 (0.99)
Other PA variables				
Total moderate and vigorous activity (minutes/day) – median (IQR)	565	41.7 (27.9–57.4)	569	39.9 (26.9–58.6)
Vigorous intensity duration (minutes/day) – median (IQR)	565	3.19 (1.48–6.65)	569	3.22 (1.47–6.96)
Inactive duration (minutes/day) – mean (SD)	565	614.8 (73.6)	569	616.0 (80.2)
Sleep duration (minutes/day) – mean (SD)	565	507.9 (48.2)	569	512.3 (49.0)
24-hour intensity distribution (counts) – mean (SD)	565	−2.20 (0.20)	569	−2.19 (0.20)
Proxy 24-hour daily activity (mg) – median (IQR)	565	33.9 (27.9–40.1)	569	32.6 (27.2–40.8)
Met 60-minute moderate/vigorous guideline [n (%)]				
No		444 (78.6)		431 (75.7)
Yes		121 (21.4)		138 (24.3)

IQR, interquartile range.

Note
Some of the variables are reported as standardised for ease of interpretation.

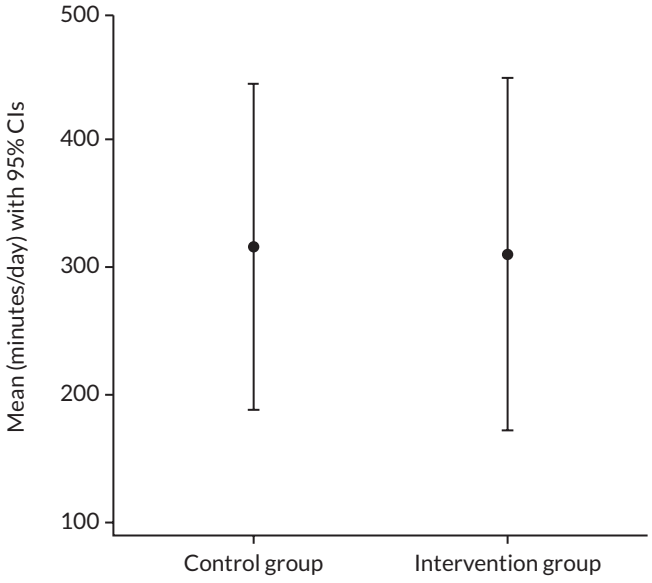

FIGURE 11 Graphical representation of the baseline means for PA and CIs by randomised groups.

The main analysis was conducted using all the data available using an intention-to-treat approach. Multilevel models were used to account for clustering. Multiple linear regression analysis was used to compare all continuous outcomes from the follow-up data, and a Poisson model with robust standard errors and a log-link function for the one binary outcome under consideration. These simple analyses compared the outcomes at follow-up between the two arms, but further models were adjusted for the baseline responses for the outcome measure under consideration; this was particularly important for the diet quality score given the imbalance at baseline. Given the low response for the demographic data, these variables were not included in the main models so as to retain as much data as possible. Three continuous PA variables had to be logged to provide variables that were approximately normally distributed.

A crude (unadjusted and ignoring clustering) analysis of variables at follow-up showed some small differences between the two arms of the trial, but nothing of particular note. There was no apparent effect of the intervention in either of the two primary outcomes as shown in *Figures 12* and *13*.

The unadjusted findings are presented in the first column of differences/relative risk (RRs) in *Table 1*.

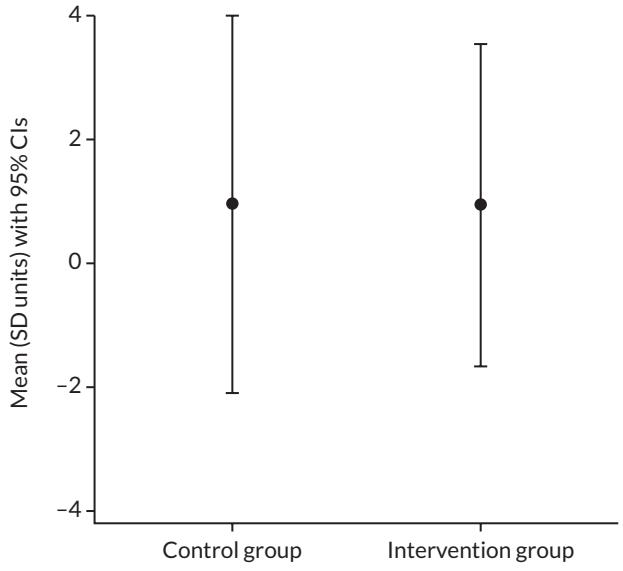

FIGURE 12 Unadjusted mean diet quality scores (SD) at follow-up.

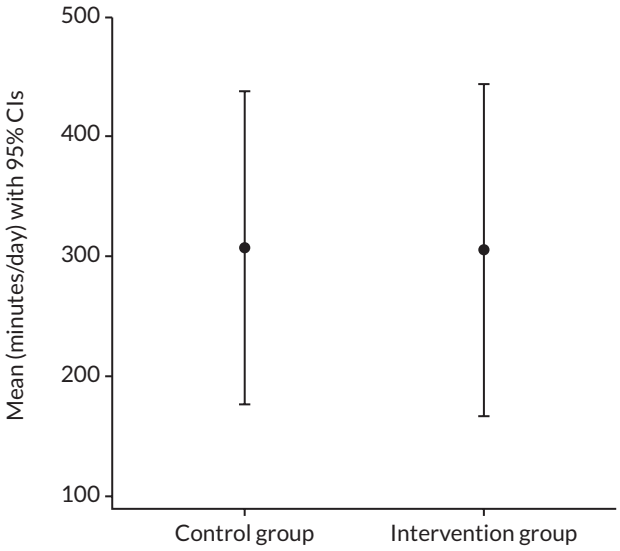

FIGURE 13 Comparison PA (minutes/day) between the two groups at follow-up.

The multilevel models taking account of clustering and adjusting for the baseline values of the outcome variable in question showed little in the way of differences between the two groups (see second column of differences/RRs in *Table 1*). For the diet quality score, the difference at follow-up after adjustment for baseline was −0.10 (95% CI −0.28 to 0.09) SDs, and for total, PA was 8.65 (95% CI −7.79 to 25.1) minutes per day. These difference are small and of little consequence.

In terms of the various secondary outcomes, the largest difference was seen for consumption of crisps (a binary variable indicating consumption of more than 250 g per week or not). The RR associated with the intervention for consuming this amount was 0.74 (95% CI 0.62 to 0.89). Similarly, but not quite so strikingly, the RR for consuming more than a litre of fizzy drinks per week was 0.77 (95% CI 0.57 to 1.03). These were the most marked findings associated with the intervention, but given that these were two of many secondary outcomes, we feel we cannot conclude that this is solely due to the intervention. The baseline differences in relation to overall diet add to the complication of interpreting the results, despite adjusting for the baseline levels.

For the PA secondary outcomes, few differences were associated with the intervention. Of some interest is the finding that the intervention was associated with a 41% increase in the proportion of students meeting the 60-minute activity guideline [RR = 1.41 (95% CI 0.99 to 2.03)]. However, none of the other PA outcomes showed any effect of the intervention, so it is hard to conclude that this is other than a chance finding.

We considered a missing data analysis, but the amount of missing data was large, and most unlikely to be random. The large difference in one primary outcome at baseline is the major challenge in interpreting these data, and this raises questions about the viability of cluster-randomised trials in school settings and maybe elsewhere. This imbalance arose despite the use of a minimisation algorithm. Participation and follow-up rates were remarkably similar between the two arms.

As noted above, we altered the consent process to be opt-out part way through the trial, though in order to obtain the demographic data (gender, date of birth, home postcode, ethnicity), opt-in consent was required. The opt-in consent rate was 64%. From the postcodes, we obtained the Income Deprivation Affecting Children Index (IDACI) for each child. These provide the decile of deprivation in which each child lives. Although Southampton is in the wealthy south of the country, Southampton, Portsmouth and the Isle of Wight, from where many of the schools were recruited, are in the poorest quarter of local authority areas in England. A graph of the IDACI scores at baseline from those whose parents provided consent is below.

Figure 14 shows that the distribution of IDACI scores were skewed towards the most advantaged students, despite the underlying population, including some very deprived areas. It is likely that those parents who opted in for transfer of the demographic data were drawn from the more advantaged sections of the population. However, when we consider those who were followed up, the graph is even more skewed as shown in *Figure 15*.

These graphs (see *Figures 14* and *15*) indicate some of the challenges in recruiting from schools. Consent is required from parents for key data, and those least in need of the intervention are more likely to take part. However, even with consent, the dropout disproportionally occurs among those from the more disadvantaged backgrounds. Targeting the more advantaged makes it even harder to show an impact from an intervention focusing on health behaviours; at the outset, these students are more likely to have better health behaviours, due to their advantages, so change is both less necessary and harder to observe.

Further, as shown in *Table 5*, those who opted in for the demographic data collection and who took part at both baseline and follow-up had slightly lower IDACI scores (less deprived) than those not followed up in both intervention and control groups. Throughout *Table 5*, it is clear that the intervention group is somewhat more deprived than the

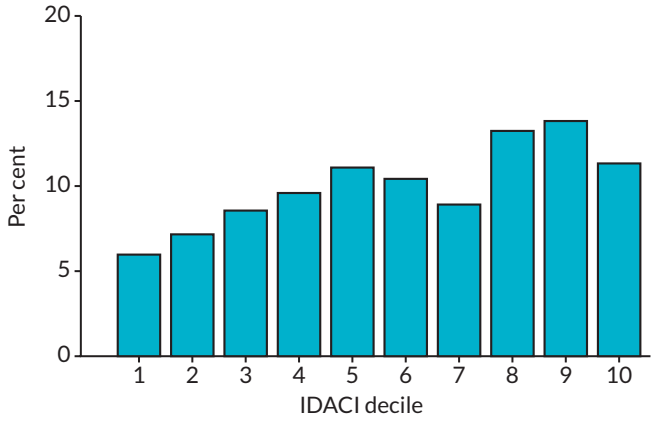

FIGURE 14 Distribution of IDACI scores for participants at baseline.

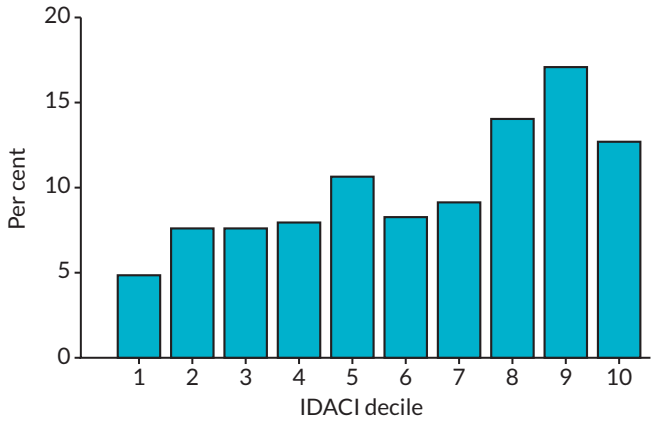

FIGURE 15 Distribution of IDACI scores for participants at follow-up.

TABLE 5 Income Deprivation Affecting Children Index scores for control and intervention groups by follow-up status

	Control		Intervention	
	N	Median (IQR)	*N*	Median (IQR)
All seen at baseline	557	0.09 (0.05–0.18)	643	0.12 (0.06–0.19)
All seen at baseline and follow-up	273	0.07 (0.05–0.18)	317	0.10 (0.06–0.17)
All not included in follow-up.	284	0.10 (0.06–0.17)	326	0.13 (0.07–0.21)

IQR, interquartile range.

control group. However, none of these differences were particularly marked. Given the poor follow-up rates and the low proportion of participants with demographic data, further analyses of subgroups were not attempted, as they would be biased and hard to interpret.

In terms of compliance with the intervention, this was complicated by the fact that nine schools delivered the LifeLab day in the schools (due to the pandemic). Some 392 students who participated in the baseline survey were in those 9 schools, and we do not have attendance data at school on the day for them. The experience of LifeLab was thus different for these students than for the remaining 641 students who participated in the baseline in intervention schools. Of these, 561 (88%) participated in the LifeLab day in the hospital setting. All participants will have had some exposure to the modules of work leading up to and following the LifeLab day (unless they were absent from school for many weeks).

We cannot assess compliance with delivering the healthy conversations intervention component among the students, as that depended on opportunistic interactions with a teacher trained to use the skills to have an appropriate conversation. Teachers said that this was hard to do in a busy school day, and the conversations were obviously not recorded. Unfortunately, uptake of the app was very low. Despite most students downloading the app, often during the LifeLab day at the hospital, only 228 (22% of those in the intervention arm at baseline) opened it and logged in. These 228 students used the app an average of 2.2 sessions with a duration per session of 17.7 minutes. This low level of engagement with the app is unlikely to have impacted on the students' health behaviours. Given the complexities of assessing compliance with the intervention, a more sophisticated analysis has proved impossible, and again the imbalance at baseline makes any analysis difficult to interpret.

Engaging Adolescents in Changing Behaviour process evaluation

The EACH-B process evaluation examined the implementation, context and mechanisms of impact of the LifeLab Plus intervention. A mixed-methods approach was employed, drawing on the Medical Research Council (MRC) guidance on process evaluation of complex interventions. Fifty-one interviews with students, teachers and parents were conducted and analysed using thematic analysis. Quantitative data reported numbers of students who attended LifeLab and downloaded the app.

The results showed that 87.9% of eligible students attended LifeLab, and 45.7% of eligible students downloaded the app. Participants had positive experiences of LifeLab and the teacher training, despite the pandemic preventing in-person delivery for some schools. Students engaged in a limited way with the app. Parents had positive views of the research but little knowledge of the intervention. Students valued learning about their own health, and teachers were enthusiastic about supporting their students' health but struggled to find opportunities to do so.

Research describing the research team's perceptions of the process of delivering and evaluating the intervention concluded that schools are appropriate settings in which to implement health interventions, but that research must benefit teachers and students (a description of this research is provided in *Report Supplementary Material 1*). Most students did not engage with the app because they were not presented it in a way that motivated them to use it. Careful consideration of the design of apps is required to encourage students to use them. Parents should be involved in research in ways that are accessible to them.

Discussion and study limitations

Conducting trials in schools is challenging at the best of times, but EACH-B was conducted through the pandemic. The trial was successfully completed, which, given the difficulties faced in getting schools to do anything extra in such unusual times, is remarkable. However, the results are disappointing in that we have been unable to demonstrate an effect of the intervention on the two primary outcome measures or a range of secondary variables (psychological measures and other assessments of PA). The process evaluation has given greater insights than the main trial itself and has enabled us to conclude that while schools are undoubtedly a good setting for delivery of public health interventions, interventions have to offer something meaningful to both students and staff to be effective.

Description of the data, findings and analysis methods

Through systematic review and meta-analysis, we have established that digital platforms and social media are key to engagement of young people and that school-based interventions can be successful in improving health behaviours and as part of an obesity prevention strategy but require engagement from key stakeholders, parents and teachers in particular. Despite primary evidence that food environments can be influential in shaping young people's diets, findings from our review of the impact of the consumer environments were inconsistent; intervention studies are required to clarify associations with diet.

Our qualitative data formed a large part of that generated by the EACH-B programme. A thematic analysis of interview and focus group data collected as part of the intervention development identified that any work with young people had to meet their needs for autonomy, competence and relatedness. These needs were taken into the guiding principles on which the EACH-B intervention was based and have formed the basis for all the work with young people that we have gone on to do since. Game jams and think-aloud interviews generated data that helped develop game features for the smartphone application. Parents were keen to be involved and aware of what their young people were involved in at school but struggled to communicate. Teachers were committed to supporting students' health and well-being but felt they were fighting a battle against a wider food environment that they could not win.

Qualitative data collected during the process evaluation of the pilot and main trials illuminated the opportunities and issues with running trials in schools. Schools remain excellent locations to reach young people across the SES spectrum, and teaching staff are fully committed to supporting their students to take part in research. Young people also appear to enjoy taking part in research, particularly if the activities are meaningful to them. The issue in schools is the competing demands of the curriculum and national exams on both staff and students. It is clear from our analysis of interviews and group discussions that research has to represent a 'gift' as well as an 'ask' if it is to be run successfully in schools.

Baseline and follow-up assessments of dietary and PA outcomes pilot and main trials provided most of the quantitative data generated by the EACH-B programme. Multiple regression analyses of the data from the 2065 students involved showed no clear differences in dietary quality and levels of PA in the intervention students and the control students. Interpretation of these data was complicated, however, by the fact that the randomisation process failed to balance the two groups of students at baseline. Those in the intervention group have substantially higher dietary quality before the intervention than those in the control group. This meant that we were highly unlikely to see any effect of the intervention on young people's diets. This trial was cluster-randomised, and the consent for individual participation had to be obtained after randomisation, which is not ideal. Cluster-randomised trials randomise small numbers of units and can therefore lead to imbalance at baseline. Usage data from the smartphone application was also inconclusive in that less than one-quarter of the young people engaged with the app features. We have no way of knowing what impact it might have had on their diet and PA had they used it, but take from this that a smartphone application has to offer more than our gamified app did to engage young people in the first place.

General limitations of the programme

The EACH-B programme has caused us to reflect on the viability of running cluster-randomised trials in school settings. The large difference in one primary outcome at baseline is the major challenge in interpreting the data from the trial. This imbalance arose despite the use of a minimisation algorithm. Participation and follow-up rates were remarkably similar between the two arms, but dropout between baseline and follow-up was particularly likely among students from more disadvantaged families. Because we required opt-in consent to the process of collecting demographic data, we only achieved this from 64% of students, with the most disadvantaged students being least likely to provide consent. These processes and the way they select out students likely to be most in need of intervention and support indicate some of the challenges of running trials in schools. Working with the more advantaged students makes it even harder to show an impact from an intervention focusing on health behaviours; at the outset, these students are more likely to have better health behaviours, due to their advantages, so that impact of the intervention is both less necessary and harder to observe.

The concept of the EACH-B intervention was supported by our review, which showed that school-based interventions can be effective in supporting healthier behaviour in young people.[22] At the time of developing the EACH-B intervention, there was strong evidence from multiple reviews that interventions delivered in schools could increase

PA in adolescents,[60] improve sexual health and prevention bullying and smoking.[61] There was less evidence that school-based interventions could improve diet, but we planned to use what was known about how to address other health behaviours. Key factors in the effectiveness of published interventions were that they were integrated into school settings and curricula and tailored precisely to the target populations, as we achieved in EACH-B. Other key factors that were not present in the delivery of the EACH-B intervention were that effective interventions were embedded within the school, families and the local community, delivered by school co-ordinators or became a feature of school policy. None of these was the case with the EACH-B intervention. These may be reasons why the EACH-B intervention may not have been successful. Alternatively, it may be that our trial was so challenging to conduct, given the impact of the pandemic and consequent school absence, that we may not have conducted an evaluation that would have detected any change. There are important lessons for us about how best to evaluate interventions in these complex settings.

In terms of compliance with the intervention protocol, this was complicated by the fact that nine schools delivered the day in the schools; pandemic restrictions meant they were unable to come into the hospital where LifeLab is situated. Some 392 students who participated in the baseline survey were in those 9 schools and had an experience of LifeLab that was different from that of the remaining 641 students who took part in the baseline in intervention schools of whom the 561 (88%) participated in the LifeLab day in the hospital setting. Our inability to conduct the planned cost-effectiveness evaluation of LifeLab Plus was caused by imbalances in a primary outcome measure at baseline and in differential loss to follow-up of groups of students. This made the outcome data impossible to draw conclusions from and observed between groups that differences in other secondary outcomes were too small to be of consequence. We have discussed this as a limitation in the study above at length. It is difficult to see how we could have prevented this imbalance produced as a result of the randomisation. Despite conducting four separate evidence reviews, we were unable to identify cost-effectiveness data from previous digital or other types of intervention with adolescents.

We had no way of assessing exposure of students to healthy conversations aimed to support behaviour change but have to assume it was low. The nature of these conversations is that they depend on opportunistic interactions, in the case of EACH-B, with a teacher trained to use the skills. Our process evaluation identified that teachers found this hard to do during a busy school day. Equally, exposure to the games, challenges and materials in the smartphone application was also low. Despite most students downloading the app, less than a quarter of them opened it and logged in. These students used the app an average of twice for less than 20 minutes per session. As such, the app is unlikely to have impacted on students' health behaviours. Had we been able to pilot for longer or more extensively, we may have identified issues with the app that resulted in the disappointing level of engagement with it and therefore of exposure to this component of the intervention. On the other hand, issues with engagement may simply reflect the fundamental problem inherent in creating a digital experience that is sufficiently exciting and meaningful to young people that it will compete with social media for their attention.

Despite the fact that the trial did not enable any conclusion to be reached about the effectiveness of the EACH-B intervention, the EACH-B programme still represents a significant contribution to understanding adolescent health behaviour and how best to engage young people in looking after themselves. Its comprehensive approach, combining intervention development, rigorous evaluation, stakeholder engagement and extensive knowledge translation have produced a series of initiatives which are already demonstrating impact in research and policy in this crucial area of public health.

Modifications to the delivery of the Engaging Adolescents in Changing Behaviour programme, intervention and trial during the first 2 years of the COVID-19 pandemic

Recruitment and data collection for the RCT was paused in March 2020 due to the UK national lockdown in response to the pandemic and was resumed in March 2021. During this year-long period, other projects were conducted using a combination of EACH-B and additional funding.

We successfully restarted EACH-B following the lockdowns and school closures due to the pandemic. Schools did not start back properly until February 2021. Our engagement with schools throughout, our work with the saliva testing programme and our discussions with adolescents conducted in a companion project Teenagers and COVID-19 (TeC-19)

led to us being ready to restart the trial quickly. The intervention and data collection procedures were successfully adapted to cope with the challenges of the pandemic.

Data collection: our plans for data collection were for members of the study team to visit each school and oversee the data collection. Schools were not willing to have visitors, so the data collection procedures were modified to be conducted by the class teacher, with the students entering the data directly online. We suspended collecting height and weight measurements. Students who were isolating at home due to the pandemic could complete the data collection from devices at home, with instruction and support from the teacher. EACH-B team members were available for teachers to consult in the event of difficulty. The GENEActivs for activity assessment were delivered to schools by the EACH-B team and were distributed by teachers and retrieved from students after use.

The intervention: we modified our procedures to minimise risk to school staff and students and our own team. (1) The teacher professional development moved online. It was adapted to explain the changes to the data collection procedures and the delivery of the intervention. More support was provided to the teachers in terms of training in HCS. (2) Through the COVID-19 saliva testing programme, an online version (https://lifelabonline.org/course/index.php?categoryid=56) of the LifeLab modules was developed. This enabled students to work through the LifeLab lessons in a self-directed manner and so allowed any students who were at home isolating to be able to participate. (3) LifeLab is situated in Southampton General Hospital, and the hospital would not allow visitors onto the site, nor did schools or parents want to send children to a hospital. The LifeLab team developed a portable LifeLab day so that the activities could be conducted in schools. The equipment was delivered to the school in large flight cases containing full instructions for their use. (4) The app that was part of the intervention was adapted to reflect the COVID-19 pandemic. This included avatars wearing face masks and provision of more support for solitary exercise.

Conclusions and recommendations

Impact and learning

The EACH-B programme aimed to design, implement and evaluate a multicomponent health behaviour change intervention for young people in the UK all of which it has achieved. This work has been conducted on time and on budget (a 12-month no-cost extension, covering the period 1 January 2024–31 December 2024 was awarded due to delays in the project caused by the COVID-19 pandemic). The programme allowed us to engage thousands of young people in meaningful health research, across the development work, the RCT, the process evaluation and various satellite projects.

Production of a series of outputs and activities for dissemination to schools meant the following have been distributed to all schools who took part in EACH-B:

- a 10-minute professionally produced documentary-style film detailing the aims and key findings of EACH-B
- a poster describing the findings of EACH-B
- lesson plans for schools to deliver lessons to their students to discuss and evaluate the findings, and to conduct an analysis of data similar to those collected as part of EACH-B.

Engagement with the stakeholder community, including young people, is being continued through the NxtGen Researcher Training Programme and the UKRI-funded Pathways to Health Consortium.

Main success of the programme

The EACH-B programme successfully developed and tested a complex intervention to improve the diets and PA levels of young people aged 12–14 years. Despite running through the years of the COVID-19 pandemic, the programme met all of its objectives and completed the trial in schools. Collecting data from 45 schools and over 2000 students during such a challenging time for schools is a recognised success for the programme. Evidence synthesis and stakeholder engagement informed a sophisticated process of intervention development, generating data that not only informed elements of EACH-B but also provided a basis for all our knowledge translation and subsequent research with young people. Our process evaluation of the trial has been remarkably informative about both challenges and opportunities inherent in working in schools. We have contributed 18 published papers in peer-reviewed journals, another 2 which are with journals awaiting editorial decisions, a huge number of conference presentations and posters and 4 doctoral theses, and, in addition, a host of other less-traditional research outputs. Our research indicates that interventions have to support young people's basic need for autonomy, competence and relatedness to be effective and that the key to involving young people in promoting their health and well-being is to offer activities that are meaningful and that support them in achieving their aspirations for the future.

Implications for decision-makers

Creating meaningful engagement opportunities is the basis for all dissemination, engagement with decision-makers, including establishing the UKRI-funded Pathways to Health Consortium, an extensive network of local government and third-sector stakeholders involved with young people across Southampton and the Wessex region. The consortium continues to work with local infrastructure, such as the NIHR Health Determinant Research Collaboration in Southampton, to involve young people in local policy and practice decision-making. Another substantial success is the NxtGen Researcher training, a programme designed by young people for young people to develop their skills in generating evidence-based policy ideas, to understand the science behind the health messages they see and hear, collect data from peers, and have confidence to advocate for change (see *Patient and public involvement and engagement*). Our latest roll-out of this training programme culminated in a youth jury where young people cross-examined policy-makers from the Hampshire and Isle of Wight ICB and ICP on youth health policy and practice,

producing collective learning and a Young People's Manifesto for Change. The manifesto contains twelve policy recommendations based on young people's research and evidence which aim to improve young people's health and well-being. The document was agreed and endorsed by health leaders for the ICB and ICP with responsibility for health and social care policy and implementation in the UK. The NxtGen Researcher Training Programme is being rolled out to other under-represented groups in urban and rural settings, and our young people have been commissioned by Southampton City Council to develop a Southampton Youth Voice service. In this way, EACH-B has already had impact on youth health policy and practice and has, therefore, extensive implications for decision-makers.

Recommendations for research

The *major recommendation* from our work on the EACH-B programme is that activity intended to motivate young people in improving their health and well-being has to be *meaningful* to them and *engaging*. Activities have to offer them something they value. What we have established is that young people do indeed value health and well-being but that other parts of their lives have a more immediate imperative. Developing friendships and social networks, establishing themselves as autonomous and competent human beings, are both of higher priority for them than protecting themselves from ill health that they may experience as older adults.

Many hours of conversation in interviews, focus groups and group work with young people have suggested that the way forward is to support young people in activities and towards goals that matter to them and to do this in experiential, 'hands-on' ways. This is what we mean by activities that are meaningful to them, engaging and providing them with skills or other capacities that they value. Our NxtGen Researcher Training Programme is an illustration of this principle.

We have a number of specific recommendations for research that draw on this approach to working with young people:

Recommendation for research number 1

We as a community need to *find effective ways to support young people in meaningful and engaging activities*, such as LifeLab and the NxtGen Researcher Training Programme. There is substantial evidence that young people do not find interventions that make direct appeals to them to improve their health and well-being engaging. Our systematic reviews identified that their effectiveness is therefore limited. We need to find new ways to make these appeals more engaging.

Recommendation for research number 2

We need to *develop new methods for evaluating the long-term impact* of these activities on their health and well-being. The trial of the EACH-B intervention was designed using classic trial design principles. There is increasing evidence that such designs are not appropriate for evaluating impact of large-scale public health interventions where so few of the conditions in which the research is taking place can be controlled. Woods-Townsend is currently involved in piloting methods of using routinely collected data to track outcomes for young people who have been through programmes such as LifeLab and the NxtGen Researcher Training Programme. Funders of research need to support new ways of evaluation outcomes for interventional programmes like these.

Recommendation for research number 3

Involve young people as researchers in studies that are about young people's health and well-being. Young people are more likely to speak openly to other young people about issues that concern them than they are to adult researchers with whom they may have no prior relationship. If we involve young people in setting the RQs to be answered as well as designing the interventions, then we may have more success in developing interventions in addressing issues which are actually important to young people in a way that they will actually engage with.

Recommendation for research number 4

Build research consortia of local government and third-sector organisations to develop and test system-wide solutions to young people's health and well-being. *Do this work with young people*. EACH-B worked primarily with schools and the local educations and public health departments. Insights from the other stakeholders were sought but only at specific time points. Establishing the Pathways to Health Consortium in 2023 enabled more consistent and active engagement in improving policy and practice in young people's health and well-being. EACH-B communications with

parents were largely ineffective. Working with this large consortium to develop the intervention from the start of the programme might have situated the intervention in schools in an environment which was more genuinely enabling of behaviour change.

Recommendation for research number 5

Continue to conduct public health research in schools but *recognise that schools will not be able to facilitate this unless it meets their curriculum needs*. Research studies have to offer address education priorities if schools have to be able to justify making time for them in a packed national curriculum; teachers enjoyed and understood the value of healthy conversations with their students but simply could not find time for them. While teachers and schools might recognise challenges for young people in terms of health, unless it meets their curriculum needs or other priorities, such as mental health which they are increasingly mandated to address, they aren't going to be able to justify giving curriculum time to the research we want to do.

Recommendation for research number 6

Digital platforms are clearly important in delivering public health interventions to young people. They are central to young people's lives and hence cannot be ignored. We need, however, to *understand much better how to use and engage with young people's online lives*. Our learning is that nothing that health researchers could design by way of new smartphone applications will compete with social media for young people's attention or is likely to have the resources to be agile and responsive to constantly changing trends as the most engaging apps are. We need more research to help us understand how we can work with young people in a digital space to give them the support for their health and well-being they actually want and can use.

Research team capacity building

The EACH-B programme of research has contributed to the career progression of its team members by providing space, time and support for members to develop their own related projects. These projects have involved the acquisition of a diverse range of skills in the field of research and public engagement, as well as several PhD projects.

Four team members have completed PhDs as part of the EACH-B programme – Taylor Rose, Sarah Shaw, Sara Simao and Sarah Jenner. They used a range of methods to explore in greater detail how young people can be better supported to live healthier lives. The titles of these theses are listed in *Publications*. Following completion of her PhD, *Taylor Rose* went on to take up a job as a scientific writer based in London. *Sarah Shaw* is now working as a senior research fellow at the MRC Epidemiology Unit, Cambridge, to pursue postdoctoral research using novel technologies to examine the influence of the food environment on the diets of young people. *Sara Simao* left the University of Southampton to take up a role with the University of Manchester and is now employed as a research fellow on a cancer screening trial. *Sarah Jenner* is near to completion of her PhD but has already achieved work of such novelty and substance that she has been awarded a permanent lectureship at the University of Southampton in the School of Health Sciences and is carrying out postdoctoral research, extending her PhD work based on use of AI-assisted analysis of textual data.

Other members of the team who have used their experience working on the EACH-B programme as a launch pad for their careers include *Sofia Strommer*, who left the group in 2022 to become the first behavioural scientist employed by *Oura*, an international enterprise who manufacture finger rings that contain sensors to monitor health behaviours. Sofia now leads a team of behavioural scientists at *Oura*. *Christina Vogel*, whose research into food environment policy led to her being offered a chair at City University, London, where she is now Acting Director of the Centre for Food Policy. *Millie Barrett*, a public health nutritionist who managed the EACH-B trial for the first 2 years is now a senior research fellow at the Centre for Food Policy, at City University, where she works with Professor Vogel on evaluating the implementation of food policy that supports young mothers – the Healthy Start initiative. *Judit Varkonyi-Sepp*, while working as our programme manager for the entire course of the programme, completed her stage 2 Health Psychologist qualification and secured herself the first-ever Health Psychology post in our local NHS trust working in an acute setting with the Clinical Psychology team. *Laila Khawaja*, a sociologist who ran the trial for the final year, has taken up a research fellow post with NIHR ARC Wessex, working on research into management of long-term conditions. Investment by the NIHR in the EACH-B programme has in this way produced a cadre of high-quality, well-trained researchers who have gone on to take up academic positions across the UK.

During the course of the EACH-B programme, three of the team have been awarded personal chairs. *Kath Woods-Townsend* is now Professor of Science Education and Engagement, and *Mary Barker* Professor of Psychology and Behavioural Science at the University of Southampton. *Christina Vogel* is now Professor of Food Policy at City University, London.

The team as a whole has developed significant capacity in participatory research methods such that they are regularly approached to advise on community participatory action research projects across the country. As part of this, they have also become expert in using creative methods for collecting and disseminating data. The expertise contained in the team is the basis for the UK Community of Practice we have established to support research with young people. The EACH-B programme has not only increased scientific capacity, however. One of the major outputs of the programme has been the development and delivery of the Southampton NxtGen Researcher Training Programme, which equips young people with a range of basic research skills to allow them to identify issues, generate RQs based on those issues, collect and analyse data to answer those questions and then to disseminate finding and advocate for change. We have found that training young people in research gives them an evidence base to their calls for change, which makes them more credible, less easy for those in power to dismiss and generally more confident about their place in the world. We are in the process of finalising the material for this programme and getting it accredited by the Royal Society for Public Health so that this capacity-building programme is available to all young people.

Equality, diversity and inclusivity

Our NIHR-funded programme of research EACH-B aimed to uphold principles of equality, diversity and inclusivity. Our vision was to be clear, open and fair to everyone in all that we did, ensuring effective engagement with the diversity of people standing to gain from, use or enable our research outcomes.

We aimed to achieve:

1. a diverse mix of people driving and contributing to our research
2. inclusive attitudes and behaviours across our centre and facility, working in collaboration with our wider partner organisations
3. a welcoming and enabling research environment for all
4. to be known and valued as fair, open and supportive to all.

We worked hard to achieve these aims throughout the 7 years of the study. We believe that we recruited a general and representative sample of young people to the study, but data on demographic characteristics required 'opt-in' consent from parents and consequently shows a bias towards those of higher SES. This is disappointing and has caused us to reflect at length on the need to identify alternative means of evaluating interventions in schools.

Climate, health and sustainability statement

Our research aimed to mitigate health inequalities, including an emphasis on increasing plant-based food consumption and active travel for young people. In this way, we ensured our work not only aimed to advance health outcomes but also contributed to a sustainable future. We used remote data collection wherever possible to reduce travel emissions but also being mindful of collecting high-quality data. We have adopted virtual collaboration tools to reduce travel. The research team was committed to embedding sustainability across all stages of research and contributing to a health system that is both equitable and environmentally responsible.

Additional information

CRediT contribution statement

Mary Barker (https://orcid.org/0000-0003-2976-0217): Conceptualisation (lead), Funding acquisition (lead), Supervision (lead), Methodology (equal), Investigation (lead), Writing – original draft (lead), Writing – editing and reviewing (equal).

Sarah Jenner (https://orcid.org/0000-0002-4644-5027): Data curation (supporting), Formal analysis (lead), Investigation (equal), Writing – original draft (equal), Writing – editing and reviewing (equal).

Kath Woods-Townsend (https://orcid.org/0000-0003-3376-6988): Conceptualisation (equal), Funding acquisition (equal), Supervision (equal), Methodology (equal), Resources (lead), Writing – original draft (equal), Writing – editing and reviewing (equal).

Judit Varkonyi-Sepp (https://orcid.org/0000-0002-7269-0261): Project administration (lead), Writing – editing and reviewing (supporting).

Millie Barrett (https://orcid.org/0000-0002-1981-1976): Data curation (equal), Supervision (equal), Project administration (equal), Formal analysis (equal), Investigation (lead), Writing – editing and reviewing (support).

Lisa Bagust: Project administration (equal), Resources (equal), Writing – editing and reviewing (support).

Donna Lovelock (https://orcid.org/0009-0008-5355-6439): Project administration (equal), Resources (equal), Writing – editing and reviewing (support).

Sarah Shaw (https://orcid.org/0000-0002-2206-6858): Resources (equal), Methodology (equal), Validation (equal), Data curation (equal), Formal analysis (equal), Investigation (lead), Resources (equal), Writing – editing and reviewing (support).

Patricia Coakley: Data curation (lead), Software (equal).

Naomi Leonard (https://orcid.org/0009-0004-7279-3254): Writing – editing and reviewing (support).

Laila Khawaja (https://orcid.org/0000-0002-3409-3247): Data curation (support), Formal analysis (equal), Investigation (equal), Writing – editing and reviewing (support).

Hamid Homatash (https://orcid.org/0000-0002-6267-4444): Methodology (equal), Resources (equal), Software (equal), Data curation (equal), Formal analysis (equal), Writing – editing and reviewing (support).

Leanne Morrison (https://orcid.org/0000-0002-9961-551X): Conceptualisation (equal), Funding acquisition (equal), Supervision (equal), Methodology (lead), Writing – editing and reviewing (equal).

Danielle Lambrick (https://orcid.org/0000-0002-0325-6015): Methodology (equal), Resources (equal), Software (equal), Data curation (equal), Formal analysis (equal), Resources (equal), Writing – editing and reviewing (support).

Wendy Lawrence (https://orcid.org/0000-0003-1264-0438): Funding acquisition (support), Methodology (equal), Formal analysis (equal), Writing – editing and reviewing (support).

David Farrell (https://orcid.org/0000-0001-9615-0254): Conceptualisation (equal), Funding acquisition (equal), Methodology (equal), Resources (equal), Software (equal), Data curation (equal), Formal analysis (equal), Writing – editing and reviewing (support).

Christina Vogel (https://orcid.org/0000-0002-3897-3786): Methodology (equal), Validation (equal), Formal analysis (equal), Investigation (equal), Writing – editing and reviewing (support).

Mary Christina Horsfall: Project administration (equal), Resources (equal), Writing – editing and reviewing (support) PPIE (equal).

Sofia Strömmer (https://orcid.org/0000-0001-7344-1630): Conceptualisation (support), Funding acquisition (support), Supervision (equal), Methodology (equal), Formal analysis (equal), Investigation (lead), Writing – editing and reviewing (equal).

Neelam Kalita (https://orcid.org/0000-0002-0973-0160): Methodology (equal), Formal analysis (equal), Investigation (equal), Writing – editing and reviewing (support).

Joanne Lord (https://orcid.org/0000-0003-1086-1624): Funding acquisition (equal), Supervision (equal), Methodology (equal), Writing – original draft (equal), Writing – editing and reviewing (equal).

Janis Baird (https://orcid.org/0000-0002-4039-4361): Funding acquisition (equal), Supervision (equal), Methodology (equal), Investigation (lead), Writing – original draft (equal), Writing – editing and reviewing (equal).

Hazel Inskip (https://orcid.org/0000-0001-8897-1749): Conceptualisation (equal), Funding acquisition (lead), Supervision (equal), Methodology (lead), Formal analysis (lead), Visualisation (lead), Writing – original draft (equal), Writing – editing and reviewing (equal).

Ross Anderson: Software (equal), Formal analysis (support).

Cara Black: Data curation (support), Formal analysis (support).

Lyall Campbell: Software (support), Formal analysis (support).

Debbie Chase: Conceptualisation (support), Funding acquisition (equal).

John Clarke: Conceptualisation (support), Funding acquisition (support).

Claire Colbain: Resources (lead).

Cyrus Cooper: Conceptualisation (equal), Funding acquisition (equal).

Keith Godfrey: Conceptualisation (equal), Funding acquisition (equal).

Marcus Grace: Conceptualisation (support), Funding acquisition (support).

Mark Hanson: Conceptualisation (support), Funding acquisition (support).

Stephanie Hughes: Investigation (support), Formal analysis (equal).

Paul Little: Conceptualisation (equal), Funding acquisition (equal).

Jackie Nuttall: Software (support).

Olu Onyimadu: Methodology (lead), Formal analysis (lead).

Andrew Reid: Software, Formal analysis (support).

Sian Robinson: Conceptualisation (equal), Funding acquisition (support).

Taylor Rose: Investigation (lead), Formal analysis (lead).

Sara Simao: Investigation (support), Formal analysis (support).

Mary Steele: Investigation (support), Formal analysis (support).

Russel Viner: Conceptualisation (support), Funding acquisition (support).

Beth White: Resources (support).

Other contributions

Naomi Leonard: PPIE (lead)

Mary Christina Horsfall: PPIE (equal).

Ros Horlock: PPIE (equal).

Rosie Mackay: PPIE (equal).

Emma O'Rourke: PPIE (equal).

Paula Twynham: PPIE (equal).

Acknowledgements

Our greatest thanks go to all the schools, teachers, students and parents who took part in the EACH-B programme, as well as all the research staff, study managers, PhD students, data managers, finance managers, research nurses and admin staff who made EACH-B possible. We are truly grateful for all your support over the 7 years this programme ran.

We are grateful to our programme co-applicants – Debbie Chase, John Clarke, Cyrus Cooper, Keith Godfrey, Marcus Grace, Mark Hanson, Paul Little, Jo Lord, Leanne Morrison, Sian Robinson, Russell Viner. Their support, advice and expertise has been essential to the successes of the EACH-B programme.

We would also like to thank our PSC members – Marcus Munafo, Graham Moore, Rebecca Playle and Rachel Long – for their steadying hand and constant encouragement. Finally, we would like to thank the institutions that have provided funding and support for EACH-B: the University of Southampton, University Hospital Southampton and the NIHR. Our NIHR programme managers over the years – Vasileios Kontogiannis, Fiona Giles, Lisa Klaourakis (later Rodermund), Thomas Hutchinson and Erin Beattie – have always been responsive and positive no matter what we have asked them to do for us. Thank-you to them too.

Acknowledging the use of Artificial Intelligence (AI) tools

Artificial Intelligence was used for writing assistance in preparation of this report.

Data-sharing statement

All data requests should be submitted to the corresponding author for consideration. Access to anonymised data may be granted following review.

Ethics statement

Full ethical approval was granted on 21 July 2019 from the University of Southampton's Faculty of Medicine Ethics Committee (Ethics ID 49226).

Information governance statement

The University of Southampton is committed to handling all personal information in line with the UK Data Protection Act (2018) and the General Data Protection Regulation (EU GDPR) 2016/679. Under the Data Protection legislation, the University of Southampton is the Data Controller, and you can find out more about how we handle personal data, including how to exercise your individual rights, here: https://www.southampton.ac.uk/about/governance/information-publications/data-protection-information-breach, and the contact details for our Data Protection Officer here: data.protection@soton.ac.uk.

Disclosure of interests

Full disclosure of interests: Completed ICMJE forms for all authors, including all related interests, are available in the toolkit on the NIHR Journals Library report publication page at https://doi.org/10.3310/GJMB4821.

Primary conflicts of interest: Kath Woods-Townsend has an unpaid position on the Royal Society for Public Health – Education Sector Advisory Panel, is a co-opted school governor at Mount Pleasant Federation and a Parent Trustee – HISP Multi Academy Trust.

Sarah Shaw has an unpaid role as a member of the Executive Committee for the International Society for Behavioral Nutrition and Physical Activity.

David Farrell has taken fees from consulting paid into his company Paidia Consulting Ltd from the following Caution Your Blast (digital transformation agency), Freie Universität Berlin, Foreign Commonwealth and Development Office, Ivy Rock (digital transformation agency), London Borough of Merton, London Borough of Croydon.

Christina Vogel had a non-financial research collaboration with a national UK supermarket chain but has no other declarations.

Janis Baird was a member of the NIHR Public Health Research Committee for 4 years from 2019 to 2023.

Copyright and credit statement

Every effort has been made to obtain the necessary permissions for reproduction, to credit original sources appropriately and to respect copyright requirements. However, despite our diligence, we acknowledge the possibility of unintentional omissions or errors, and we welcome notifications of any concerns regarding copyright or permissions.

Publications

Journal articles

Rose T, Barker M, Jacob CM, Morrison L, Lawrence W, Strömmer S, *et al*. A systematic review of digital interventions for improving the diet and physical activity behaviors of adolescents. *J Adolesc Health* 2017;**61**:669–77. https://doi.org/10.1016/j.jadohealth.2017.05.024

Strömmer S, Barrett M, Woods-Townsend K, Baird J, Farrell D, Lord J, *et al*. Engaging adolescents in changing behaviour (EACH-B): a study protocol for a cluster randomised controlled trial to improve dietary quality and physical activity. *Trials* 2020;**21**:859. https://doi.org/10.1186/s13063-020-04761-w

Strömmer S, Lawrence W, Shaw S, Simao SC, Jenner S, Barrett M, *et al*. Behaviour change interventions: getting in touch with individual differences, values and emotions. *J Dev Orig Health Dis* 2020;**11**:589–98. https://doi.org/10.1017/S2040174420000604

Jacob CM, Hardy-Johnson PL, Inskip HM, Morris T, Parsons CM, Barrett M, *et al*. A systematic review and meta-analysis of school-based interventions with health education to reduce body mass index in adolescents aged 10–19 years. *Int J Behav Nutr Phys Activ* 2021;**18**:1–22. https://doi.org/10.1186/s12966-020-01065-9

Strömmer S, Shaw S, Jenner S, Vogel C, Lawrence W, Woods-Townsend K, Barker M. How do we harness adolescent values in designing health behaviour change interventions? A qualitative study. *Br J Health Psychol* 2021;**26**:1176–93. https://doi.org/10.1111/bjhp.12526

Shaw S, Simao SC, Jenner S, Lawrence WT, Woods-Townsend K, Vogel CA; EACH-B Study Group. Parental perspectives on negotiations over diet and physical activity: how do we involve parents in adolescent health interventions? *Public Health Nutr* 2021;**24**:2727–36. https://doi.org/10.1017/S1368980021000458

Shaw S, Crozier S, Strömmer S, Inskip H, Barker M, Vogel C. Development of a short food frequency questionnaire to assess diet quality in UK adolescents using the National Diet and Nutrition Survey. *Nutr J* 2021;**20**:1–11. https://doi.org/10.1186/s12937-020-00658-1

Kalita N, Cooper K, Baird J, Woods-Townsend K, Godfrey K, Cooper C, *et al*. Cost-effectiveness of a dietary and physical activity intervention in adolescents: a prototype modelling study based on the Engaging Adolescents in Changing Behaviour (EACH-B) programme. *BMJ Open* 2022;**12**:052611. https://doi.org/10.1136/bmjopen-2021-052611

Strömmer ST, Sivaramakrishnan D, Shaw SC, Morrison K, Barrett M, Manner J, Jepson R. Young people's experiences of COVID-19 messaging at the start of the UK lockdown: lessons for positive engagement and information sharing. *BMC Public Health* 2022;**22**:1–19. https://doi.org/10.1186/s12889-022-12755-3

Shaw S, Barrett M, Shand C, Cooper C, Crozier S, Smith D, *et al*. Influences of the community and consumer nutrition environment on the food purchases and dietary behaviors of adolescents: a systematic review. *Obes Rev* 2023;**24**:e13569. https://doi.org/10.1111/obr.13569

Vogel C, Shaw S, Strömmer S, Crozier S, Jenner S, Cooper C, *et al*. Inequalities in energy drink consumption among UK adolescents: a mixed-methods study. *Public Health Nutr* 2023;**26**:575–85. https://doi.org/10.1017/S1368980022002592

Shaw S, Muir S, Strömmer S, Crozier S, Cooper C, Smith D, *et al*. The interplay between social and food environments on UK adolescents' food choices: implications for policy. *Health Promot Int* 2023;**38**:daad097. https://doi.org/10.1093/heapro/daad097

Jenner S, Stanescu S, Barker M. 'Nobody knows young people like young people do!'. *Psychologist* 2023;**36**:24–5. URL: www.bps.org.uk/psychologist/nobody-knows-young-people-young-people-do

Barrett M, Shaw S, Jenner S, Hardy-Johnson P, Stanescu S, Woods-Townsend K, *et al*. Creating meaningful knowledge exchange between young people and public health practitioners: what role can researchers play? *Perspect Public Health* 2024;**144**:212–4. https://doi.org/10.1177/17579139241230852

Shaw S, Crozier S, Cooper C, Smith D, Barker M, Vogel C. What role do adolescents' independent food purchasing choices play in their dietary quality? *medRxiv* 2024:2024-10. https://doi.org/10.1101/2024.10.17.24315666

Jenner S, Raidos D, Anderson E, Fleetwood S, Ainsworth B, Fox K, *et al*. Using large language models for narrative analysis: a novel application of generative AI. *Method Psychol* 2025;**12**:100183. https://doi.org/10.1016/j.metip.2025.100183

Shaw S, Crozier S, Cooper C, Smith D, Barker M, *et al*. The association between adolescents' independent food purchasing and dietary quality differs by socioeconomic status: findings from a pilot study. *PLOS ONE* 2025;**20**:e0312903. https://doi.org/10.1371/journal.pone.0312903

Jenner S, Barker M, Strömmer S, Shaw S, Khawaja L, Barrett M, *et al*. Mixed-methods process evaluation of the EACH-B intervention in UK secondary schools: delivery fidelity, stakeholder responses and contextual influences. *BMJ Public Health* 2025;**3**:e002491. https://doi.org/10.1136/bmjph-2024-002491

Descriptions of papers in draft and yet to be published are given in *Supplementary Materials 1–6*.

Conference presentations

Barker M. *A Lifecourse Perspective on When and How to Intervene to Promote Early Human Development: Introduction*. Royal Society 'Frontiers of Science' meeting, Milton Keynes, 1 July 2017.

Barker M. *Preconception Health and Engagement in Behaviour Change*. Alberta Health Services Conference, Canada, 1 November 2018.

Strommer S. *The Development of a Questionnaire to Measure Confidence and Behavioural Autonomy for Healthy Eating in Adolescents*. UK Society for Behavioural Medicine, Birmingham, 12 December 2018.

Kalita N. *Engaging Adolescents in Changing Behaviour: Does It Provide a Cost-effective Use of Resources from UK Perspective?* Wessex Public Health Conference, Southampton, 15 March 2019.

Strommer S. *Supporting Health Behaviour Change Through Mobile Applications: Opportunities and Challenges*. 'Mobile Apps and Sensors in Surveys' inaugural workshop, University of Mannheim, Mannheim, 15 March 2019.

Strommer S. *Using the Person-based Approach to Develop and Optimise Successful Health Behaviour Change Interventions*. Wessex Public Health Conference, Southampton, 15 March 2019.

Inskip H. *Preconception Health: What, Why, How, When and for Whom?* Richard Doll Seminar Series, Oxford, 4 June 2019.

Hardy-Johnson P. *A Systematic Review and Meta-analysis of School-based Educational Interventions to Improve Body Composition in Adolescents*. Conference Poster, International Society of Behavioral Nutrition and Physical Activity Conference, Prague, Czech Repub, 4 June 2019.

Stommer S. *Aligning Diet and Physical Activity Interventions with Adolescent Values*. International Society for Behavioural Nutrition and Physical Activity, Prague, 6 June 2019.

Strommer S. *What Do Adolescents Value and How Do We Use Their Values to Maximise Their Engagement with Health Behaviour Interventions? Assess Diet Quality in UK Adolescents*. Southampton Medical and Health Research Conference, 11 June 2019.

Barker M. *Preconception and Adolescent Diet: Importance for Lifelong Health*. Opening of Centre of Excellence in Food and Diet Research, Kristiansand, 3 September 2019.

Jacob C. *A Systematic Review and Meta-analysis of School-based Educational Interventions to Improve Body Composition in Adolescents*. Society for Social Medicine annual meeting, Cork, 4 September 2019.

Shaw S. *Development of a Short Food Frequency Questionnaire to Assess Diet Quality in UK Adolescents*. Federation of European Nutrition Societies Conference (FENS), Dublin, 17 October 2019.

Barker M, Lawrence W. *Complex Interventions and Study Designs: Moving Developmental Origins of Health and Disease Forward*. DOHaD Congress, Melbourne, VIC, Australia, 20 October 2019.

Barker M, Lawrence W. *Behavioural Change Interventions*. Oral presentation, Developmental Origins of Health and Disease Congress, Melbourne, VIC, Australia, 23 October 2019.

Barker M, Lawrence W. *How Can We Improve Engagement in Health and Clinical Research?* Developmental Origins of Health and Disease Congress, Melbourne, VIC, Australia, 25 October 2019.

Barker M. *Improving Human Health: Why We Do Research*. Invited talk at McMaster University, Canada, 26 November 2019.

Barker M. *Behaviour Change to Improve Maternal and Child Health*. Invited talk at University of Toronto, Toronto, Canada, 29 November 2019.

Inskip H, Barker M. *'Waving Through A Window' Photographic Exhibition*. Dissemination event, Photographic exhibition, New Forest Art Gallery, New Milton, 8 January 2020.

Horsfall MC. *EACH-B PPI Members Participating in NIHR Southampton Biomedical Research Centre Science Day*. NIHR Southampton Biomedical Research Centre Southampton, Southampton, 17 January 2020.

Jenner S. *TEC19 Photography Competition*. Dissemination event. Instagram. URL: www.instagram.com/tec19study/?igs. May 2020

Shaw S. *Parental Perspectives on Negotiations Over Diet and Physical Activity: How Do We Involve Parents in Adolescent Health Interventions?* International Society of Behavioral Nutrition and Physical Activity online Conference, 17 June 2020.

Shaw S. *Development of a Short Food Frequency Questionnaire to Assess Diet Quality in UK Adolescents Using the National Diet and Nutrition Survey*. International Society of Behavioural Nutrition and Physical Activity, 9 June 2021.

Shaw S. *Exploring the Complex Relationship Between Adolescents' Social Environments and Their Use of Physical Food Environments: A Qualitative Study*. International Society of Behavioural Nutrition and Physical Activity, 9 June 2021.

Shaw S. *The Influences of the Community and Consumer Nutrition Environment on the Food Purchases and Dietary Behaviours of Adolescents: A Systematic Review*. Nutrition Society Summer Conference, 30 June 2021.

Strommer S. *Prevalence of, and Attitudes Towards, Energy Drink Consumption Among UK Adolescents*. Southampton Faculty of Medicine conference, 18 October 2021.

Shaw S. *Using Mobile Ecological Momentary Assessment to Understand Adolescents' Use of the Food Environment and Relationships With Their Independent Food Purchases and Diet*. International Society for Behavioural Nutrition and Physical Activity, 19 May 2022.

Shaw S. *The Combined Role of the Social and Food Environments on Adolescent Food Choice: A Qualitative Study*. International Congress for Developmental Origins of Health and Disease, 29 August 2022.

Strommer S. *Harnessing Adolescents' Values for Food Choices: Cocreating Food Determinants Maps*. European Health Psychology Conference, Bratislava, 24 September 2022.

Barker M. *Engaging Young People in Improving Their Health*. University of Agder, Norway Seminar series, 30 January 2023.

Barker M. *Engaging Adolescents in Changing Health*. Aston University, Birmingham, 9 March 2023.

Barker M. *Family and Society Level Aspects of Multi-generational Influences of Nutrition: Contextualising Diet*. National Institutes of Health Office of Nutrition Research (USA) website. URL: https://videocast.nih.gov/watch/cc75947c-d5db-11f0-9cf9-12c45c580ad9 (accessed 19 May 2026).

Shaw S. *The Role of the Physical Food Environment on the Diet-related Behaviours of Adolescents: A Mobile Ecological Momentary Assessment Study*. International Society for Behavioural Nutrition and Physical Activity (ISBNPA) conference, Uppsala, 17 June 2023.

Leonard N. *Big Issues: Young People's Health and Wellbeing Research Priorities*. Faculty of Medicine Conference, University of Southampton, 28 June 2023.

Black C. *Balancing Inequalities: A Board Game for Young People from Coastal Communities to Discuss Plausible Futures*. Serious Games Societies Annual GALA conference, Dublin, 29 November 2023.

Jenner S. *Using Story Completion to Understand Adolescent Use of Social Media to Shape and Express Identity and Food Choice*. University of Southampton School of Psychology conference, University of Southampton, November 2023.

Jenner S. *Using Story Completion to Understand Adolescent Use of Social Media to Shape and Express Identity and Food Choice*. 'Inspiring Narratives, Weaving Stories' conference, University of Westminster, London, May 2024.

Khawaja L. *Engaging Adolescents in Changing Behaviour: Lessons Learned from a School-based RCT*. University of Southampton Faculty of Medicine conference, University of Southampton, June 2024.

Conference workshops

Leonard N. *Young People Leading the Journey: Our Young Researcher Training Programme (YRTP)*. Children and Childhoods Conference, University of Suffolk, Ipswich, 10 July 2024.

Black C. *Making Lemonade from Lemons: Balancing Inequalities and Exploring the Plausible Futures of Young People Through a Board Game*. International Creative Research Methods Conference, Manchester, 9 September 2024.

Leonard N. *Young People Leading the Journey: Our Young Researcher Training Programme (YRTP)*. International Creative Research Methods Conference, Manchester, 9 September 2024.

Conference posters

Jenner S. *Identity-based Adolescent Health Interventions: A Systematic Review*. International Society for Behavioural Nutrition and Physical Activity (ISBNPA) Conference, Uppsala, June 2023.

Jenner S. *Using Story Completion to Understand Adolescent Use of Social Media to Shape and Express Identity and Food Choice*. University of Southampton Doctoral College Poster Showcase, University of Southampton, November 2023.

Jenner S. *What Can We Learn from Using Large Language Models for Narrative Analysis of Story Data?* Institute for Life Sciences AI in health research poster session, University of Southampton, December 2023.

Leonard N. *Big Issues: Young People's Health and Wellbeing Research Priorities*. Institute for Life Sciences (IFLS) and Southampton Institute for Arts & Humanities (SIAH) adolescent health poster session, University of Southampton, 13 June 2024.

Black C. *When Life Gives you Lemons: Exploring the Futures of Young People Through a Board Game*. Institute for Life Sciences (IFLS) and Southampton Institute for Arts & Humanities (SIAH) adolescent health poster session, University of Southampton, 13 June 2024.

Jenner S. *Using Story Completion to Understand Relationships Between Identity, Social Media and Adolescent Food Choices*. European Health Psychology Society (EHPS) conference, Cascais, September 2024.

Films, blogs and photographs

Barker M. *Teens Experiences of COVID-19*. The Policy Pod, episode 3. University of Southampton. URL: https://publicpolicy.podbean.com/e/teens-experiences-of-covid-19-tec-19/

Leonard N, Barker M. Young People's Professional Advisory Group. *The Big Issues: Young People's Health and Wellbeing Research Priorities*. University of Southampton; May 2023. URL: https://sotonac.sharepoint.com/teams/FELSResearchandEnterpriseHub/Shared Documents/Forms/AllItems.aspx?id=%2Fteams%2FFELSResearchandEnterpriseHub%2FShared Documents%2FYPPAG-Layout-FINAL-2June2023%2Epdf&parent=%2Fteams%2FFELSResearchandEnterpriseHub%2FSharedDocuments

Black C, Leonard N, Taylor O, Prescott A. *Engaging Children and Young People in Research: Community of Practice Inaugural Meeting*. NIHR ARC Wessex; 2023. URL: www.arc-wx.nihr.ac.uk/blogs-1/community-of-practice-inaugural-meeting.

Doctoral theses

Rose T. *Supporting Pregnant Women to Improve Their Diet and Physical Activity Behaviours*. Southampton: University of Southampton; 2019.

Shaw S. *The Individual and Interrelated Roles of Social Environments and Physical Food Environments on the Food Purchasing and Dietary Behaviours of Adolescents*. Southampton: University of Southampton; 2023.

Correia S. *Optimising Nutrition Interventions for Young People: The On-It Study*. Southampton: University of Southampton; 2024.

Jenner S. *Shaping the Self: Identity and Food Choices in Adolescence*. Southampton: University of Southampton; 2025.

Details of all additional research and dissemination activities are given in *Appendix 2*.

References

1. 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* 2011;**33**:527–35. https://doi.org/10.1093/pubmed/fdr033
2. Bates B, Lennox A, Prentice A, Bates C, Page P, Nicholson S, *et al*. *National Diet and Nutrition Survey: Results from Years 1–4 (Combined) of the Rolling Programme (2008/2009–2011/12) Executive Summary*. Public Health England; 2014. URL: https://www.gov.uk/government/statistics/national-diet-and-nutrition-survey-results-from-years-1-to-4-combined-of-the-rolling-programme-for-2008-and-2009-to-2011-and-2012 (accessed 14 October 2025).
3. Townsend N, Wickramasinghe K, Williams J, Bhatnagar P, Rayner M. *Physical Activity Statistics 2015*. URL: https://research-information.bris.ac.uk/en/publications/physical-activity-statistics-2015/ (accessed 14 October 2025).
4. Kelder SH, Perry CL, Klepp KI, Lytle LL. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *Am J Public Health* 1994;**84**:1121–6. URL: https://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.84.7.1121 (accessed 14 October 2025).
5. Craigie AM, Lake AA, Kelly SA, Adamson AJ, Mathers JC. Tracking of obesity-related behaviours from childhood to adulthood: a systematic review. *Maturitas* 2011;**70**:266–84. https://doi.org/10.1016/j.maturitas.2011.08.005
6. Hanson MA, Bardsley A, De-Regil LM, Moore SE, Oken E, Poston L, *et al*. The International Federation of Gynecology and Obstetrics (FIGO) recommendations on adolescent, preconception, and maternal nutrition: 'think nutrition first'. *Int J Gynaecol Obstet* 2015;**131**:S213–53. https://doi.org/10.1016/S0020-7292%2815%2930034-5
7. Davies S. *Annual Report of the Chief Medical Officer, 2014, The Health of the 51%: Women*. 2015. URL: https://assets.publishing.service.gov.uk/media/5a80cc0ae5274a2e8ab52380/CMO_annual_report_2014.pdf (accessed 14 October 2025).
8. Kapur A. Links between maternal health and NCDs. *Best Pract Res Clin Obstet Gynaecol* 2015;**29**:32–42. https://doi.org/10.1016/j.bpobgyn.2014.04.016
9. Hanson M, Barker M, Dodd JM, Kumanyika S, Norris S, Steegers E, *et al*. Interventions to prevent maternal obesity before conception, during pregnancy, and post partum. *Lancet Diabetes Endocrinol* 2017;**5**:65–76. https://doi.org/10.1016/S2213-8587(16)30108-5
10. Davies SC. *Annual Report of the Chief Medical Officer, 2014, The Health of the 51%: Women*. 2015. URL: https://assets.publishing.service.gov.uk/media/5a80cc0ae5274a2e8ab52380/CMO_annual_report_2014.pdf (accessed 14 October 2025).
11. Viner RM, Ross D, Hardy R, Kuh D, Power C, Johnson A, *et al*. Life course epidemiology: recognising the importance of adolescence. *J Epidemiol Community Health* 2015;**69**:719–20. https://doi.org/10.1136/jech-2014-205300
12. Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Allen NB, *et al*. Our future: a Lancet commission on adolescent health and wellbeing. *Lancet* 2016;**387**:2423–78. https://doi.org/10.1016/S0140-6736(16)00579-1
13. Pearson N, Braithwaite R, Biddle SJ. The effectiveness of interventions to increase physical activity among adolescent girls: a meta-analysis. *Acad Pediatr* 2015;**15**:9–18. https://doi.org/10.1016/j.acap.2014.08.009
14. Kelishadi R, Azizi-Soleiman F. Controlling childhood obesity: a systematic review on strategies and challenges. *J Res Med Sci* 2014;**19**:993–1008. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC4274579/pdf/JRMS-19-993.pdf (accessed 14 October 2025).

15. Hale DR, Fitzgerald-Yau N, Viner RM. A systematic review of effective interventions for reducing multiple health risk behaviors in adolescence. *Am J Public Health* 2014;**104**:e19–41. URL: https://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.2014.301874 (accessed 14 October 2025).
16. Chen JL, Weiss S, Heyman MB, Cooper B, Lustig RH. The efficacy of the web-based childhood obesity prevention program in Chinese American adolescents (Web ABC study). *J Adolesc Health* 2011;**49**:148–54. https://doi.org/10.1016/j.jadohealth.2010.11.243
17. Neumark-Sztainer DR, Friend SE, Flattum CF, Hannan PJ, Story MT, Bauer KW, *et al*. New moves: preventing weight-related problems in adolescent girls: a group-randomized study. *Am J Prev Med* 2010;**39**:421–32. https://doi.org/10.1016/j.amepre.2010.07.017
18. Campbell R, Starkey F, Holliday J, Audrey S, Bloor M, Parry-Langdon N, *et al*. An informal school-based peer-led intervention for smoking prevention in adolescence (ASSIST): a cluster randomised trial. *Lancet* 2008;**371**:1595–602. https://doi.org/10.1016/S0140-6736(08)60692-3
19. Statista. *Children Owning Mobile Phones in the UK 2024, by Age*. 2024. URL: www.statista.com/statistics/1326211/children-owning-mobile-phone-by-age-uk/ (accessed 14 October 2025).
20. Chen JL, Wilkosz ME. Efficacy of technology-based interventions for obesity prevention in adolescents: a systematic review. *Adolesc Health Med Ther* 2014;**5**:159–70. URL: www.tandfonline.com/action/showCitFormats?doi=10.2147/AHMT.S39969 (accessed 14 October 2025).
21. Morrison LG. Theory-based strategies for enhancing the impact and usage of digital health behaviour change interventions: a review. *Digit Health* 2015;**1**:595335. https://doi.org/10.1177/2055207615595335
22. Rose T, Barker M, Jacob CM, Morrison L, Lawrence W, Strömmer S, *et al*. A systematic review of digital interventions for improving the diet and physical activity behaviors of adolescents. *J Adolesc Health* 2017;**61**:669–77. https://doi.org/10.1016/j.jadohealth.2017.05.024
23. Wouters P, Van Nimwegen C, Van Oostendorp H, Van Der Spek ED. A meta-analysis of the cognitive and motivational effects of serious games. *J Educ Psychol* 2013;**105**:249–65. https://doi.org/10.1037%2Fa0031311
24. Hinsliff G. Why Pokémon go really is a National Health Service. *The Guardian*, 22 July 2016. URL: www.theguardian.com/commentisfree/2016/jul/22/pokemon-go-health-service-silly-mobile-phone-game-parenting-holy-grail (accessed 14 October 2025).
25. DeSmet A, Van Ryckeghem D, Compernolle S, Baranowski T, Thompson D, Crombez G, *et al*. A meta-analysis of serious digital games for healthy lifestyle promotion. *Prev Med* 2014;**69**:95–107. https://doi.org/10.1016/j.ypmed.2014.08.026
26. Grace M, Bay J. Developing a pedagogy to support science for health literacy. *Asia-Pacific Forum Sci Learn Teach* 2011;**12**:1–13. URL: www.eduhk.hk/apfslt/download/v12_issue2_files/foreword.pdf (accessed 14 October 2025).
27. Grace M, Woods-Townsend K, Griffiths J, Godfrey K, Hanson M, Galloway I, *et al*. Developing teenagers' views on their health and the health of their future children. *Health Educ* 2012;**112**:543–59. https://doi.org/10.1108/09654281211275890
28. Lawrence W, Black C, Tinati T, Cradock S, Begum R, Jarman M, *et al*. Making every contact count: longitudinal evaluation of the impact of training in behaviour change on the work of health and social care practitioners. *J Health Psychol* 2016;**21**:138–51. https://doi.org/10.1177/1359105314523304
29. Black C, Lawrence W, Cradock S, Ntani G, Tinati T, Jarman M, *et al*. Healthy conversation skills: increasing competence and confidence in front-line staff. *Public Health Nutr* 2014;**17**:700–7. https://doi.org/10.1017/S1368980012004089
30. Little P, Stuart B, Hobbs R, Kelly J, Smith ER, Bradbury KJ, *et al*. An internet-based intervention with brief nurse support to manage obesity in primary care (POWeR+): a pragmatic, parallel-group, randomised controlled trial. *Lancet Diabetes Endocrinol* 2016;**4**:821–8. https://doi.org/10.1016/S2213-8587(16)30099-7

31. Little P, Stuart B, Francis N, Douglas E, Tonkin-Crine S, Anthierens S, *et al*.; GRACE Consortium. Effects of internet-based training on antibiotic prescribing rates for acute respiratory-tract infections: a multinational, cluster, randomised, factorial, controlled trial. *Lancet* 2013;**382**:1175–82. https://doi.org/10.1016/S0140-6736(13)60994-0

32. Little P, Stuart B, Hobbs FR, Moore M, Barnett J, Popoola D, *et al*. An internet-delivered handwashing intervention to modify influenza-like illness and respiratory infection transmission (PRIMIT): a primary care randomised trial. *Lancet* 2015;**386**:1631–9. https://doi.org/10.1016/S0140-6736(15)60127-1

33. Strömmer S, Barrett M, Woods-Townsend K, Baird J, Farrell D, Lord J, *et al*. Engaging adolescents in changing behaviour (EACH-B): a study protocol for a cluster randomised controlled trial to improve dietary quality and physical activity. *Trials* 2020;**21**:1–13. https://doi.org/10.1186/s13063-020-04761-w

34. Jacob CM, Hardy-Johnson PL, Inskip HM, Morris T, Parsons CM, Barrett M, *et al*. A systematic review and meta-analysis of school-based interventions with health education to reduce body mass index in adolescents aged 10 to 19 years. *Int J Behav Nutr Phys Act* 2021;**18**:1. https://doi.org/10.1186/s12966-020-01065-9

35. Shaw S, Barrett M, Shand C, Cooper C, Crozier S, Smith D, *et al*. Influences of the community and consumer nutrition environment on the food purchases and dietary behaviors of adolescents: a systematic review. *Obes Rev* 2023;**24**:e13569. https://doi.org/10.1111/obr.13569

36. Kalita N, Cooper K, Baird J, Woods-Townsend K, Godfrey K, Cooper C, *et al*. Cost-effectiveness of a dietary and physical activity intervention in adolescents: a prototype modelling study based on the Engaging Adolescents in Changing Behaviour (EACH-B) programme. *BMJ Open* 2022;**12**:e052611. https://doi.org/10.1136/bmjopen-2021-052611

37. Yardley L, Morrison L, Bradbury K, Muller I. The person-based approach to intervention development. *J Med Internet Res* 2015;**17**:e30. https://doi.org/10.2196/jmir.4055

38. Yardley L, Ainsworth B, Arden-Close E, Muller I. The person-based approach to enhancing the acceptability and feasibility of interventions. *Pilot Feasibility Stud* 2015;**1**:37. https://doi.org/10.1186/s40814-015-0033-z

39. Little P, Stuart B, Hobbs FD, Moore M, Barnett J, Popoola D, *et al*. An internet-delivered handwashing intervention to modify influenza-like illness and respiratory infection transmission (PRIMIT): a primary care randomised trial. *Lancet* 2015;**386**:1631–9. https://doi.org/10.1016/s0140-6736(15)60127-1

40. DeSmet A, Thompson D, Baranowski T, Palmeira A, Verloigne M, De Bourdeaudhuij I. Is participatory design associated with the effectiveness of serious digital games for healthy lifestyle promotion? A meta-analysis. *J Med Internet Res* 2016;**18**:e94. https://doi.org/10.2196/jmir.4444

41. Strömmer S, Shaw S, Jenner S, Vogel C, Lawrence W, Woods-Townsend K, *et al*. How do we harness adolescent values in designing health behaviour change interventions? A qualitative study. *Br J Health Psychol* 2021;**26**:1176–93. https://doi.org/10.1111/bjhp.12526

42. Shaw S, Simao SC, Jenner S, Lawrence WT, Woods-Townsend K, Vogel CA, *et al*. Parental perspectives on negotiations over diet and physical activity: how do we involve parents in adolescent health interventions? *Public Health Nutr* 2021;**24**:2727–36. https://doi.org/10.1017/S1368980021000458

43. Strömmer S, Lawrence W, Shaw S, Correia Simao S, Jenner S, Barrett M, *et al*. Behaviour change interventions: getting in touch with individual differences, values and emotions. *J Dev Orig Health Dis* 2020;**11**:589–98. https://doi.org/10.1017/S2040174420000604

44. Vogel C, Shaw S, Strömmer S, Crozier S, Jenner S, Cooper C, *et al*. Inequalities in energy drink consumption among UK adolescents: a mixed-methods study. *Public Health Nutr* 2023;**26**:575–85. https://doi.org/10.1017/S1368980022002592

45. Shaw S, Muir S, Strömmer S, Crozier S, Cooper C, Smith D, *et al*. The interplay between social and food environments on UK adolescents' food choices: implications for policy. *Health Promot Int* 2023;**38**:daad097. https://doi.org/10.1093/heapro/daad097

46. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, *et al*. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 2013;**46**:81–95. https://doi.org/10.1007/s12160-013-9486-6

47. Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychol* 2009;**28**:690–701. https://doi.org/10.1037/a0016136

48. Gardner B, Lally P, Wardle J. Making health habitual: the psychology of 'habit-formation' and general practice. *Br J Gen Pract* 2012;**62**:664–6. https://doi.org/10.3399/bjgp12X659466

49. Bauldry S, Shanahan MJ, Macmillan R, Miech RA, Boardman JD, O Dean D, Cole V. Parental and adolescent health behaviors and pathways to adulthood. *Soc Sci Res* 2016;**58**:227–42. https://doi.org/10.1016/j.ssresearch.2016.02.006

50. Blum RW, Lai J, Martinez M, Jessee C. Adolescent connectedness: cornerstone for health and wellbeing. *BMJ* 2022;**379**:e069213. https://doi.org/10.1136/bmj-2021-069213

51. Shaw S, Crozier S, Strömmer S, Inskip H, Barker M, Vogel C; EACH-B Study Team. Development of a short food frequency questionnaire to assess diet quality in UK adolescents using the National Diet and Nutrition Survey. *Nutr J* 2021;**20**:1–11. https://doi.org/10.1186/s12937-020-00658-1

52. Crozier SR, Inskip HM, Barker ME, Lawrence WT, Cooper C, Robinson SM; SWS Study Group. Development of a 20-item food frequency questionnaire to assess a 'prudent' dietary pattern among young women in Southampton. *Eur J Clin Nutr* 2010;**64**:99–104. https://doi.org/10.1038/ejcn.2009.114

53. McCrorie PRW, Perez A, Ellaway A. The validity of the Youth Physical Activity Questionnaire in 12–13-year-old Scottish adolescents. *BMJ Open Sport Exerc Med* 2017;**2**:e000163. https://doi.org/10.1136/bmjsem-2016-000163

54. The University of Sheffield. *The Development of a Paediatric Health Related Quality of Life Measure for Use in Economic Evaluation: The Child Health Utility 9D (CHU 9D)*. 2020. URL: www.sheffield.ac.uk/scharr/sections/heds/mvh/paediatric (accessed 14 September 2020).

55. Levin KA, Currie C. Reliability and validity of an adapted version of the Cantril Ladder for use with adolescent samples. *Soc Indic Res* 2014;**119**:1047–63. https://doi.org/10.1007/s11205-013-0507-4

56. Markland D, Tobin V. A modification to the behavioural regulation in exercise questionnaire to include an assessment of a motivation. *J Sport Exerc Psychol* 2004;**26**:191–6. https://doi.org/10.1123/jsep.26.2.191

57. Steele MM, Burns LG, Whitaker BN. Reliability and validity of the SE-HEPA: examining physical activity–and healthy eating–specific self-efficacy among a sample of preadolescents. *Health Educ Behav* 2013;**40**:355–61. https://doi.org/10.1177/1090198112459190

58. Williams GC, Minicucci DS, Kouides RW, Levesque CS, Chirkov VI, Ryan RM, Deci EL. Self-determination, smoking, diet and health. *Health Educ Res* 2002;**17**:512–21. https://doi.org/10.1093/her/17.5.512

59. Mirwald RL, Baxter-Jones AD, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. *Med Sci Sport Exerc* 2002;**34**:689–94. https://doi.org/10.1097/00005768-200204000-00020

60. Van Sluijs EM, McMinn AM, Griffin SJ. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *BMJ* 2007;**335**:703. https://doi.org/10.1136/bmj.39320.843947.BE

61. Busch V, de Leeuw JRJ, de Harder A, Schrijvers AJP. Changing multiple adolescent health behaviors through school-based interventions: a review of the literature. *J Sch Health* 2013;**83**:514–23. https://doi.org/10.1111/josh.12060

Appendix 1 Full list of patient and public involvement and engagement activities

2018

- The NIHR Southampton Biomedical Research Centre Young People PPI group advised us on the EACH-B branding and banner designs.
- We held engagement sessions with the ukactive Kids Council. We participated in public events that involved young people, running 'game jams' and other creative activities to get input into our game design work.
- We created our own Twitter/X (X Corp., Bastrop, TX, USA) account, linked with both the NIHR and NIHR Southampton BRC.

2019

- In February, 80 students (aged 12–15) installed the app and completed a feedback questionnaire, leading to app updates. Additionally, over seven visits, 1000 pupils (aged 13–14) play-tested the latest app version at GCU.
- In March, *BBC Radio Solent* broadcasted from LifeLab, interviewing students on healthy living.
- Worked with a public engagement fellow from the Public Engagement with Research Unit (PERu) grant to collect public views on health research priorities, gathering hundreds of responses.
- Game jams were held in various locations, funded by PERu.
- In June, an Adolescent Health Research forum was set up, meeting monthly.
- The LifeLab annual showcase took place in the summer.
- In July, a parent–student game jam with 215 families helped co-design activities for a parent-support app.
- A September PPI event recognised members' contributions.
- A photography project, funded by PERu, saw a professional photographer work with six students to explore food and exercise through photography. The project led to a photobook and public exhibition covered by local media.

2020

- In response to COVID, in March, 2 group discussions with young people advised on the TeC-19 study, later expanding to 8 groups (80 young people, aged 12–18) discussing pandemic impacts on health and well-being. Findings were published (see *Appendix 2*).
- A photography competition invited TeC-19 participants to capture their COVID-19 experiences, with photos shared via Instagram (Menlo Park, CA, USA) and UoS web pages.
- Funding was secured to conduct the TeC-19 study with collaborators in Canada, Ethiopia, Ghana and South Africa (more details in *Appendix 2*).

2021

- Patient and public involvement input on consent and data collection in schools contributed to an ethics amendment, making EACH-B an 'opt-out' trial.
- EACH-B lay parent advisors presented at the NIHR Southampton BRC showcase.

2022

- We created films ('Why take part in research' and 'Why I do PPI') in collaboration with Robin Creative Media (RCM), LifeLab, teachers, students and EACH-B staff. Students from two Southampton schools volunteered to take part in filming, which included interviews in school and at LifeLab. The films were shared via UoS social media and YouTube (YouTube, LLC, San Bruno, CA, USA).
- Planning for a Young Person's Professional Advisory Group (YPPAG) began in May. In September, nine 14- to 17-year-olds were employed for 12 weeks to develop health research strategies at UoS, advising external researchers.

2023

- The EACH-B parents' group provided strategic input for the year's no-cost extension.
- A second YPPAG cohort tested LifeLab's YRTP, with RCM helping young participants create training films.
- EACH-B stakeholders contributed to the UKRI-funded Pathways to Health Consortium through Culture of Neighbourhoods Consortium. Over 30 young people helped develop and test the young researchers' training, and 100 young people across Southampton explored health themes through creative workshops.
- A board game, *Lemonade: When Life Gives You Lemons*, was developed for PSHE lessons, based on a successful academic exercise used in low-resource communities. It was tested in Isle of Wight schools and is being integrated into the PSHE curriculum.

2024

- The Hampshire & Isle of Wight Youth Jury aimed to enhance youth influence on health and social care policy. Fifteen young researchers, trained as part of the YRTP, engaged with the ICB and ICP, conducting research to identify key health issues.
- The Youth Jury produced 12 evidence-based policy recommendations, forming the *Young People's Manifesto for Change*.
- Young researchers presented the manifesto at an ICP assembly, leading to policy implementation plans on the part of the ICB.
- The manifesto was later presented to, and the 12 recommendation adopted by, the Hampshire & Isle of Wight Children and Young People's Partnership Board and ICP Joint Committee.
- Policy-makers praised the quality of youth-led research, ensuring long-term improvements to young people's health and care across the region.

Appendix 2 Additional research and dissemination activities undertaken during break in the programme initiated by the COVID-19 pandemic

Teenagers and COVID-19

Additional funding was awarded by the University of Southampton Institute for Life Sciences for a study looking at young people's experiences of the COVID-19 pandemic, focusing on the three main periods of local and national lockdown. This study used a qualitative longitudinal methodology to explore young people's perspectives of the pandemic over the 12 months spanning March 2020–March 2021.

Young people across the UK were recruited via a combination of methods, including snowball sampling. Young people were initially recruited through personal and professional contacts by members of the research team. These young people were asked to recruit a group of their friends to take part in a series of focus groups. This ensured that participants felt comfortable speaking openly with each other about their lives and experiences. Each member of the research team was assigned a friendship group to oversee for the duration of the study. This meant that the researchers were able to develop rapport and trust with the participants. A total of 80 young people took part in online focus groups using Zoom (Zoom Video Communications, San Jose, CA, USA). Most of the participants took part in seven focus groups across the 12-month period and, during each of these seven 'study weeks', also submitted photographic diaries using Snapchat (Snap Inc., Santa Monica, CA, USA), Discord (San Francisco, CA, USA) or e-mail, detailing their daily lives, thoughts and emotions. Creative methods, such as story completion and photo elicitation, were used during the focus groups to encourage the young people to talk about topics which may have been difficult for them to speak about due to the sensitive nature of the study.

The TeC-19 study found that over the first year of the pandemic, the young people in this study moved through a landscape of emotions from shock and surprise to anxiety and uncertainty and, for many of them, finally resignation and acceptance. This trajectory varied as young people varied in their ability to cope and develop resilience to the negative impacts of the pandemic on every aspect of their lives. Specifically, this variation appeared to reflect differences in their individual capacity to cope; the quality of their relationships with family and friends; features of their home, school and other environments; and how supportive these were. Young people who were able to find ways to manage their boredom and other challenges to their well-being caused by pandemic closures and restrictions on movement; who had good relationships with family with whom they were confined at home; who had close, mutually supportive friendships; and who had access to what they needed to succeed with online education were better able to cope and hence showed evidence of developing resilience. They emerged from the year excited about a return to in-person social interaction, many of them describing feeling better prepared to face future challenges.

Recent data indicate a significant rise in mental health issues among young people since the pandemic. However, labelling them as a 'lost generation' oversimplifies a complex situation and may inadvertently shape their self-perception. Instead, we should recognise that survivors of this period may emerge more resilient due to their experiences. There is a disconnect between acknowledging that resilience stems from both individual and environmental factors and our approach to supporting young people. While much has been written about the decline in young people's mental health, interventions often focus solely on building individual skills, overlooking the importance of social support, family systems and peer connections. Young people who had access to these resources, along with technology, were better positioned to develop resilience. Even those with fewer resources have gained unique experiences in tackling adversity. To support young people manage the inevitable world 'shocks' and crises that have and will follow the COVID-19 pandemic, we need to:

1. create structures that allow young people to have a voice and exercise control over their lives
2. stop focusing all our attention on individual coping skills and resilience building courses

3. understand young people's engagement with culture in the sense in which they define it, for example, social media, music, gaming, and appreciate the role it plays in maintaining their health and well-being
4. facilitate the methods that young people use to maintain social connectedness, many of which are alien to adults
5. address the problem in our education system from which we have managed to strip all ways of supporting love of learning
6. stop the narrative of a 'lost generation'.

International teenagers and COVID-19

The TeC-19 study was replicated by researchers in Canada, Ghana, South Africa, Ethiopia and India. Each team replicated a similar procedure to the UK researchers. Young people were recruited to take part in focus group discussions online or in person, depending on local and national COVID-19 restrictions in place in each location.

The key findings were collated from all study sites involved in the International TeC-19 study. Overarching findings were:

- Young people initially enjoyed increased time with their families.
- Later in the pandemic, many reported feeling stressed, 'numb', bored, lonely and frustrated.
- Arguments at home led to physical, sexual and psychological abuse.
- Many young people were forced to take on more adult responsibilities.
- Young people feared COVID-19 infection, death of grandparents, loss of parental income.
- Girls felt 'caged'.
- Many were worried about disrupted schooling and the impact of this on their futures.
- Many young people suffered with anxiety, depression, substance use and behavioural problems, as well as altered sleep, eating and PA patterns.

Hampshire and Isle of Wight COVID-19 saliva testing programme

The COVID-19 saliva testing programme began as a Southampton-focused pilot and was then commissioned to be delivered across Hampshire and the Isle of Wight. Initially focusing on households, the potential benefits of engaging and delivering the programme to the schools was quickly realised. With our expertise in engaging in education and our relationships with schools, members of the EACH-B team became hugely valued in the saliva testing programme. We developed educational resources to support teachers in engaging their students with the public health messages, and through the new LifeLab online platform (developed as a result of the saliva testing programme), we were able to disseminate these easily. Our involvement with the COVID-19 saliva testing programme brought us in contact with a range of national and local stakeholders and further enhanced the reputation of LifeLab within the education community building relationships and trust. A total of 73 schools, including 27,374 students and 70,166 school staff, participated in the saliva testing programme. Anecdotally, engagement in the testing programme was believed to have improved school attendance in Southampton during the pandemic.

EME
HSDR
HTA
PGfAR
PHR

Part of the NIHR Journals Library
www.journalslibrary.nihr.ac.uk

Published by the NIHR Journals Library