Scientific title

Evaluation of the Binley cycleway: an economic analysis and model development to support investment in local government active travel policy

Short title

Evaluation of the Binley cycleway: an economic analysis

Protocol version

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Signatures

The undersigned confirm that the following protocol has been agreed and accepted and that the Chief Investigator agree to adhere to the signed University of Birmingham Sponsorship CI declaration.

I agree to ensure that the confidential information contained within this document will not be used for any other purpose other than the evaluation or conduct of the investigation without the prior written consent of the sponsor.

I also confirm that I will make the findings of the study publicly available through publication or other dissemination tools without any unnecessary delay and that an honest accurate and transparent account of the study will be given; and that any discrepancies form the study as planned in this protocol will be explained.

Chief Investigator

Emma Frew

Signature:  Date: 16th February 2023

Sponsor statement

Support of the University of Birmingham as Sponsor is a prerequisite for ethical approval to be granted by the University of Birmingham Research Ethics Committee. Therefore, ethical approval granted from the University of Birmingham REC will serve as confirmation of approval of the protocol by the Sponsor.

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Key study contacts

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Funder	This study is supported by funding from the National Institute for Health Research Public Health Research Programme (NIHR152858)
Committees	**Study Advisory Group** Chair: Councillor Chris McEwan Other members: Brian Ferguson, Chris McEwan, Petra Meier, John Williams, Anna Taylor, Magdalena Skrybant, Mubasshir Ajaz, Russell Turner, Miles Tight. **Public Advisory Group** Members: Mr Chris Rance, Ms Josephine Conneh, Eva Bennett

Study summary

Title

Evaluation of the Binley cycleway: an economic analysis and model development to support investment in local government active travel policy

Short title:

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Background

The population has become less physically active (PA) and more sedentary [1, 2]. Public health guidance states that adults should be achieving at least 150-300 mins of at least moderate intensity physical activity per week, yet objective measures show that only 57% of adults in England achieve these guidelines [3]. This is concerning given the compelling evidence that inactivity leads to poorer health and mortality [4].

The transport sector is increasingly being recognised for its potential impact on population levels of incidental PA and health and wellbeing [5-8]. Often referred to as 'active travel', this includes 'transport policy, systems and initiatives that promote patterns of walking, cycling and use of public transport' [9].

One type of 'active travel' policy is the development of cycling infrastructure, specifically cycle tracks that physically separate bikes from motor vehicles, as these can offer safety benefits and increase cycling and overall physical activity levels [10]. The benefits of this type of intervention are that it is population-based, so can achieve impact at scale, and can lead to improvements in physical activity overall, as well as specific cycling levels. The issue is that these types of infrastructure developments require considerable investment, and a greater understanding is needed on the relationship between costs and consequences across multiple sectors – this information will enable dialogue and a shared-understanding between the different stakeholders involved (health, transport) to inform a whole-system approach towards active travel policy.

Aims and Objectives

To generate evidence on the cost-effectiveness of altering cycling infrastructure, and to develop a methodological framework for fully capturing mortality, morbidity, environmental and equity effects that can be used to consider future active travel investments.

- To undertake a longitudinal population survey to understand how a new cycleway impacts on levels of cycling, overall physical activity, mode of travel, health and wellbeing (Work package (WP) 1)
- To determine the impact of the cycleway across different population subgroups (WP1)
- To estimate the cost-effectiveness and health equity impact of the cycleway from a local authority perspective (WP2)
- To develop an economic model that estimates the long-term cost effectiveness and health equity impact of the cycleway and accounts for multi-sectoral costs and outcomes. This model will be easily accessible for local authorities to inform future cycling investment decisions (WP 3).

Design

This research study consists of 3 integrated work packages involving: a population survey (WP1), a cost-effectiveness analysis accounting for multi-sectoral costs and consequences, and equity impact (WP2), and development of an economic model to inform on the value of future investment in cycling infrastructure that will be freely available for other local authorities to access (WP3).

Public Involvement

Our public advisory group have contributed to the study design. We have convened a panel of members of the public, along with residents who live in Coventry and representatives from community groups within Coventry to consult with at key points during the project. We will also regularly consult with our Centre Public Advisory Group from within the Centre for Economics of Obesity.

Dissemination

We will communicate the findings to key local authority organisations nationally and locally. Findings will help shape active travel policy.

Funding and support

Organisation	Funding or Other Support
National Institute for Health Research Public Health Research Programme	Provision of research related costs
National Institute for Health Research Professorship scheme	Financial contribution to researcher salary and support costs.

Roles of Study Sponsor and Funder

The University of Birmingham, as the sponsor, will assume overall responsibility for initiation and management of the study, and will control final decisions regarding all aspects of the study. The National Institute of Health Research, as the funder, will contribute financial support and facilitate dissemination of the results.

Roles and responsibilities of Study Team/Individuals and Committees

Study management

EF will have overall responsibility for the study. EF, DP, TH and EA will form the core study team and will meet monthly to oversee all aspects of the study. Study management meetings will be minuted with specific action points, timelines and persons responsible identified.

Stakeholder advisory group

An external stakeholder advisory group representing national and regional stakeholders including Sport England and the West Midlands Combined Authority, and PPI representatives will advise and oversee study processes. This group will meet once per year.

Public involvement

We have convened a group of public representatives who we will consult with at key points throughout the study (2-3 consultation meetings per year). We will also consult with public and community group representatives from Coventry who will meet once per year. In addition we have a PPI member of the stakeholder advisory group.

Protocol contributors

EF with the wider support of the co-investigators conceived and designed the study and drafted the original study protocol. The public advisory group were also involved in the development of the protocol. The study protocol has undergone multiple rounds of expert peer review as part of the funding process.

Keywords

Active travel, Physical Activity, Economics, Cycleway, health, costs

Project Plan

Gantt Chart_NIHR152858. Evaluation of the Binley cycleway: an economic analysis.

	Study Year	1												2												3												
	Calendar Year	2023												2024												2025												2026
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Activity*	Study Month No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
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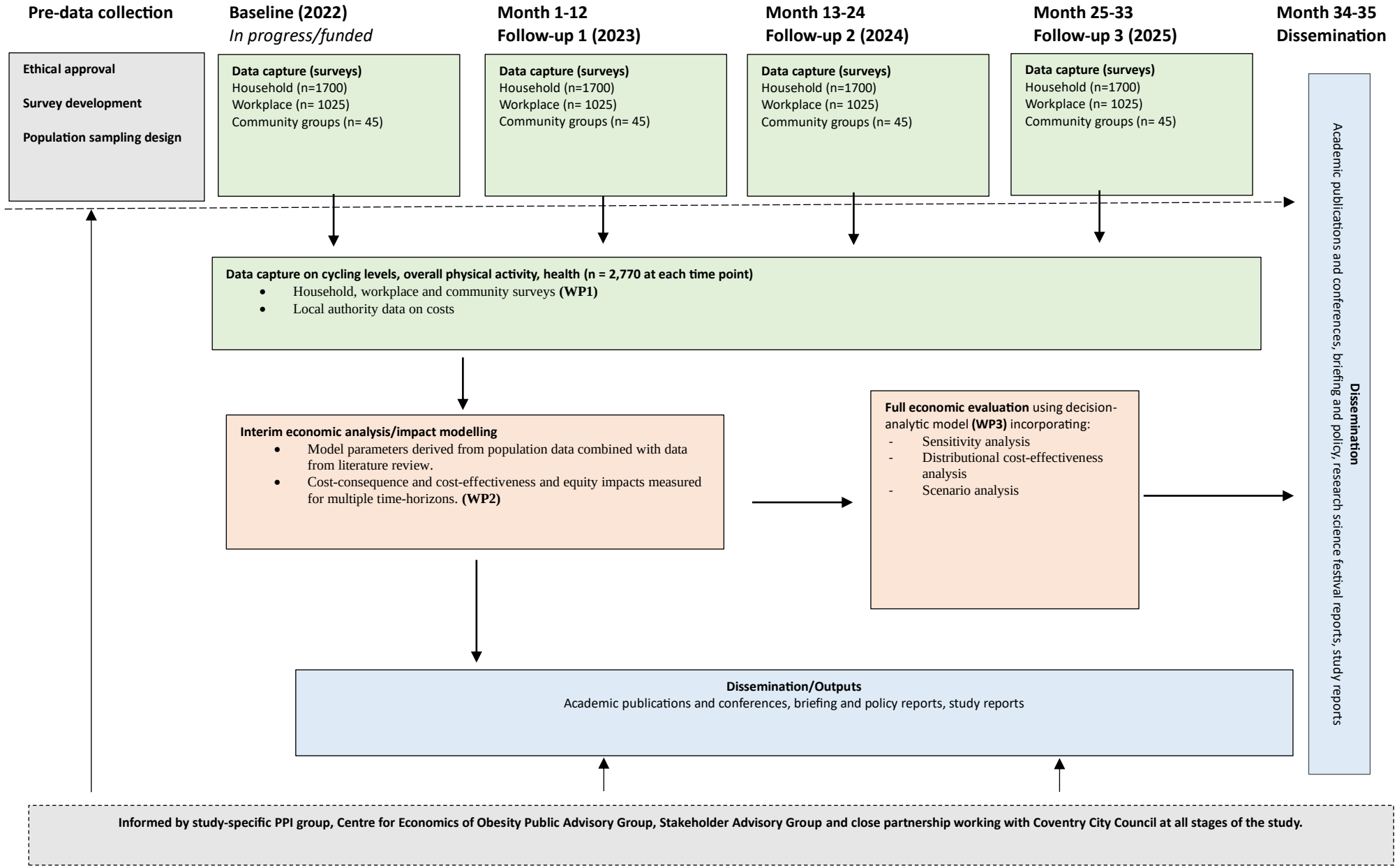
FU data collection 3																										■	■	■	■	■	■							
PPI meetings			■												■												■											
Stakeholder advisory group				■												■												■										
WP1 Pop'n survey analyses							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
WP2 CCA and CEA										■	■	■	■										■	■	■							■	■	■			
WP3 Economic modelling										■	■	■	■										■	■	■							■	■	■			
Report writing																																			■	■	
Reporting/Dissemination		■	■	■							■	■	■										■	■	■										■	■	
Festival of Science Workshop																																		■			

***Baseline data collection already completed**

Figure 1: Flow of participants and timing of data collection and analysis [NIHR152858]



Study Protocol

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1 Background

The population has become less physically active (PA) and more sedentary [1, 2]. Public health guidance states that adults should be achieving at least 150-300 mins of at least moderate intensity physical activity per week, yet objective measures show that only 57% of adults in England achieve these guidelines [3]. This is concerning given the compelling evidence that inactivity leads to poorer health and mortality [4].

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There is on-going and high-profile policy interest in active travel interventions. The recent Government Walking and Cycling Strategy, 'Gear Change', includes an ambition for 50% of journeys in towns and cities to be made by walking, cycling or wheeling by 2030 [11]. During COVID-19, the national government invested £2 billion in cycling infrastructure as a means to promote population PA levels[12]. The recent Levelling Up white paper recognised the need for local neighbourhoods that promote physical activity levels [13] and it is a key priority within the combined authority agenda as well as local authorities who are tasked with allocating limited resources towards active travel interventions. Key to these priorities is the need for economic evidence demonstrating value for money, and on how investment is addressing geographical inequalities in local areas. Our research addresses this directly by considering the impact of investment of cycling infrastructure about cycling and PA-levels and health and wellbeing. Coventry City Council are key research partners within the proposed work and have emphasised a need to get a better understanding of how investment is demonstrating value for money and on the development of scalable economic models to inform spending decisions.

1.2 Review of existing evidence

Reviews have highlighted issues of poor research design alongside cycling interventions, which have been mostly confined to "before and after" comparisons or to hypothetical scenarios of behaviour change[14]. These initiatives are typically conducted for policy purposes rather than research, with academic teams being involved only retrospectively and consequently being constrained in terms of research design[15].

Reviews have also highlighted that evaluations have considered either the perspective of the health care sector or an often-abstract societal perspective [16, 17]. In practice, however, these initiatives are often funded using a combination of public and non-public sector budgets and administered by local authorities who have institutional objectives and opportunity costs in investing in active travel interventions that are different from the health sector. In particular, local governments are faced with the challenge of maximizing value produced to their local populations from limited and often insufficient budgets, balancing resources to support statutory services, and with trying to achieve multiple objectives that span different sectors. These different perspectives dictate the need for evaluations to be comprehensive and flexible to produce robust evidence that is relevant to the decision-making context[18].

Health impact assessments (HIAs) are often used by local authorities to assess the health effects of policies. HIAs are often used to assess the health effects of a modal shift in transport behaviours as reductions in mortality, life expectancy – rarely do they account for improvements in morbidity and quality of life[19]. HIAs are useful to understand potential impacts but do not consider the costs of policy and this is where an economic evaluation is useful as it explicitly examines the potential impacts and costs in one framework and articulates the trade-offs between efficiency and equity.

Our research setting is Coventry City, chosen based on its diverse population and for the opportunity to evaluate a major cycling investment – the largest in the West Midlands region – the creation of a 6km segregated cycleway running from the City Centre to the City Hospital. This research has two key aims: to generate economic evidence for the Binley cycleway and to develop an economic model for local authorities to re-use to understand the economic value of future cycling investments. Coventry is the second largest city in the West Midlands after Birmingham with a population of 345,000. The national Sport England active lives survey (2020-21) reported fewer adults being physically active in Coventry compared to the West Midlands region and England[20]. We plan to work closely with Coventry Council as well as our PPI groups to ensure that our research captures overall impact on population physical activity levels, as well as population subgroups.

This study will add new evidence by assessing how the construction of the Binley cycleway is impacting on local population physical activity levels, health, and quality of life, and related inequalities, and offsetting this change in outcomes with the costs over the short and longer term.

1.3 Importance of the research in terms of improving the health of the public

Physical inactivity can lead to adverse health outcomes and places a burden on healthcare services. Approximately 6-10% of global mortality associated with non-communicable disease is due to physical inactivity [1]. Participating in PA promotes physical functioning and mental health outcomes. Yet despite this evidence, a large proportion of adults fail to meet PA guidelines [3] .

2 Research Aims

To generate evidence on the cost-effectiveness of altering cycling infrastructure, and to develop a methodological framework for fully capturing mortality, morbidity, environmental and equity effects that can be used to consider future active travel investments.

OBJECTIVES:

- To undertake a longitudinal population survey to understand how a new cycleway impacts on levels of cycling, overall physical activity, mode of travel, health and wellbeing (Work package (WP) 1)
- To determine the impact of the cycleway across different population subgroups (WP1)
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3 Research plan

3.1 Design

This research study consists of 3 integrated work packages involving: a population survey (WP1), a cost-effectiveness analysis accounting for multi-sectoral costs and consequences, and equity impact (WP2), and development of an economic model to inform on the value of future investment in cycling infrastructure that will be freely available for other local authorities to access (WP3).

The hypothesis is that creating a new segregated cycleway increases the current use of the corridor – part of which currently includes cycleway lanes, by local residents and workers. This increase in use will lead to an increase in cycling, active travel, and overall physical activity levels through the altering of the physical environment and addressing safety concerns and accessibility.

3.2 Planned Intervention

NAME: The Binley Cycleway

WHAT: A 6km two-way cycleway stretching from Coventry City Centre to Coventry Hospital, positioned between the path and the road, physically separated from both using kerbs. This cycleway fits within a broader transport strategy for the City of Coventry that is about making changes to the environment making it easier for people to get around the city through active travel and to create barriers to using the motor vehicle.

WHO: The cycleway has been developed and designed to accommodate the needs of people that do not usually cycle. The cycleway is aimed to reduce safety concerns and is being created to encourage cycling and improve population physical health, social inclusion, mental health, air quality and improve access to employment, education and leisure.

HOW: People on cycles will have priority over traffic entering and leaving the side roads. At traffic light junctions and roundabouts, the cycleway will by-pass them or have its own set of traffic lights to ensure safety through them. Bus stops and parking lay-bys will be repositioned within the overall highway to make space for the cycleway. New parallel crossings (zebra crossings for people on foot and cycle) will be installed, and roads will be narrowed.

WHERE: The route will serve > 35,000 households within each buffer zone. Using the route, residents and workers can go to the city centre, Coventry University, major public transport stations, a shopping arcade, Iceland, Lidl, Binley Business Park, Tesco and the University Hospital Coventry & Warwickshire. The cycleway route has been designed to replicate a bus route, passing through local residential areas to 'pick-up' as many local residents as possible.

WHEN and HOW MUCH: Due to the size of the scheme costing ~£8M, public consultation has happened in two phases covering different sections of the cycleway. The phase 1 and phase 2 consultation are complete (July 2022), some amendments were made to the design following feedback from residents. Construction on phase 1 has started (Spring 2022) and the whole cycleway is estimated to be fully complete by summer 2023.

MODIFICATIONS: Plans on the 'phase 2' section of the cycleway may have to be altered slightly in response to the public consultation, however it is likely that any modifications will be minor in nature and not alter the general route of the cycleway.

3.3 LONGITUDINAL POPULATION SURVEY: WORK PACKAGE 1

3.3.1 Research questions:

1. What is the impact of the cycleway on cycling levels and overall physical activity?
2. What is the impact of the cycleway on mode of travel along the cycleway route?
3. What is the impact of the cycleway on health and wellbeing?

3.3.2 Theoretical underpinning

This study has been designed using the APEASE criteria for assessing interventions [21] collecting and analysing data to answer questions linked to the practicability of the cycleway (is the intervention sustainable), effectiveness (measuring impact on cycling behaviours), cost-effectiveness (measuring the return on investment), side-effects (monitoring unintended consequences) and equity (differential impact on population subgroups). The target behaviour change is population cycling levels and overall physical activity. With respect to the COM-B targets[21], the cycleway will restructure the environment to create physical opportunity to cycle and is based on the feedback from the Coventry population that the main barrier to cycling is safety and fear of road traffic accidents. The focus of the longitudinal survey will be to collect data on people's capability, opportunity and motivation to cycle and cycling habits. These data will enable us to understand how changing the physical infrastructure to cycle impacts on cycling behaviours, and by also collecting data on capability and motivation to cycle, along with socio-economic characteristics, this will help us to understand differential impacts on different population subgroups. The intervention is focused on changing the physical opportunity to cycle, and the hypothesis is by altering the infrastructure available for cycling this will make it easier to cycle and increase motivation to cycle. By motivating people to try a behaviour this can increase their capability.

3.3.3 Methods

4.3.3.1 Data collection

WP1 has four data collection points: Baseline data collection (March – August 2022), follow-up 1 (March - August 2023), follow-up 2 (March - August 2024) and follow-up 3 (March - August 2025). Baseline data collection is already underway, and **this proposal is for funding to support data collection at follow-up points 1, 2 and 3.**

3.3.3.2 The survey instrument

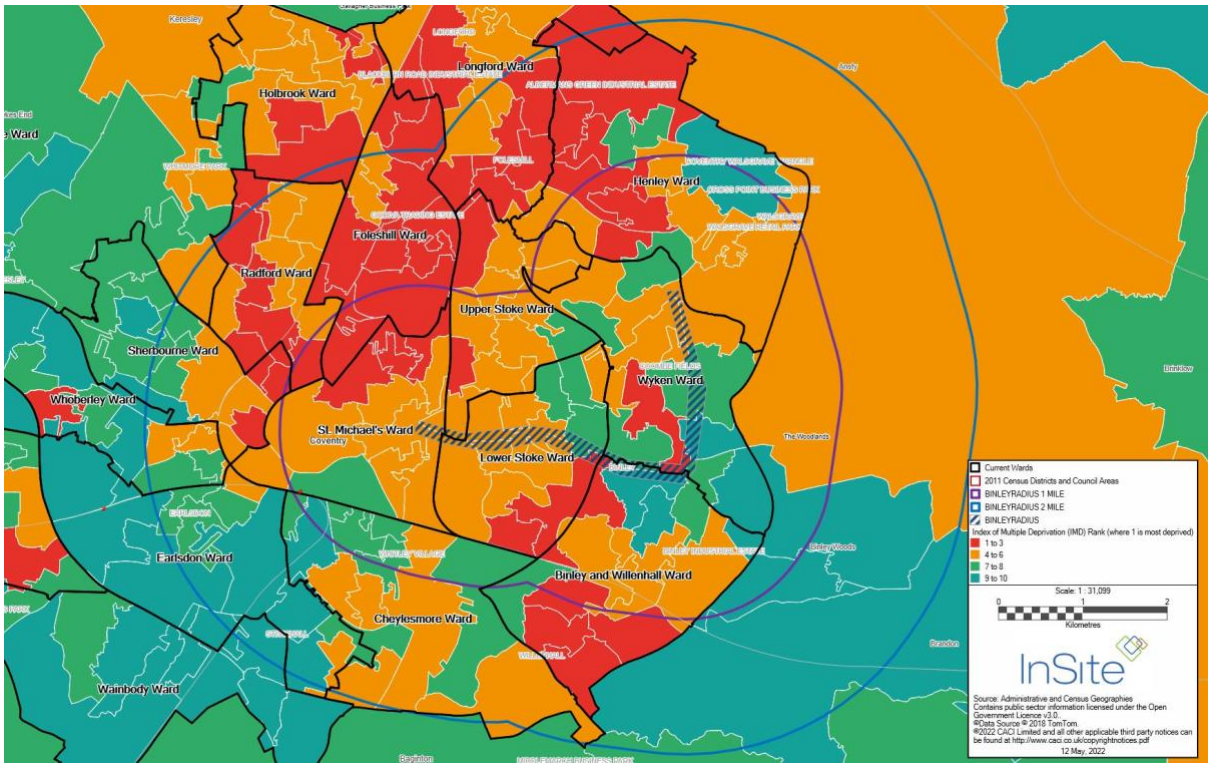
Data capture has been informed by our logic model (Figure 1). The model draws on published theory of how a cycleway affects different pathways to behaviour change [22].

The survey collects data on socio-demographics, including age, gender, socio-economic status (e.g., IMD and, employment), household composition; Health and wellbeing e.g., chronic conditions; Current levels of *overall* physical activity based on current physical activity recommendations for adults; Current levels of cycling (e.g., times a week), average trip length / time; Preferred mode of commute to workplace location; Current use of the corridor, average number of trips per day/week and length using the corridor; Perceived safety of the corridor; Car and bicycle ownership.

3.3.3.3 Sampling

The data will be collected using a market research company (M.E.L Research) using a hybrid approach consisting of a 'push to web' and a postal survey. The 'push to web' approach will send invite cards to residential addresses and invite citizens to complete the survey online. The postal survey will send letters including a paper version of the survey to return by post. An advantage of using both approaches will be to reach different demographics as we are aware from our local authority partners that not all citizens find online surveys accessible.

Based on Census and geographical data, 12 of the 18 city wards have been identified that will potentially be impacted by the intervention, given their proximity to the corridor. We have identified two buffer zones along the cycleway, the first buffer is defined within one-mile radius from the cycleway corridor and contains six wards (from East to West: St Michael's, Lower Stoke, Upper Stoke, Binley and Willenhall, Wyken and Henley) and are either crossed or adjacent/close to the Binley Cycleway and are expected to be impacted the most in terms of cycling behaviours. The other six wards will form the second buffer zone (between one and two miles from the corridor) and will include mostly Foleshill, Radford, Sherbourne, Whoberley, Earlsdon and Cheylesmore. These buffers have been carefully selected in collaboration with the transport and insight team at Coventry City Council who have in-depth knowledge of the geography of the local area in terms of the network of roads, access points and transport facilities



This type of graded-exposure approach was chosen after careful consideration as it was not possible to identify a suitable control site located further from the cycleway due to differences in local topography and socio-demographic characteristics of the population. Furthermore, comparability of the sites would have been compromised by confounding due to the different local initiatives currently implemented in the areas promoting active travel and cycling. The choice of buffer size (1 mile and 2 miles) was also based on previous research conducted in cities around the UK [35]. The cycleway runs from the city to the east side of the city boundary and given its location and the size of the surrounding areas, larger buffers would have meant including residents from neighbouring local authorities.

To measure and understand behaviour changes among the residents living and working in these buffer zones over a three-year period, while also maintaining the size and representativeness of the sample, a mixed-method (i.e. panel approach with replenishment with new participants) data collection approach will be used. This will enable us to measure changes occurring at the aggregate level over time and the within-individual mechanisms of change.

We will work with M.E.L Research to strata (IMD decile) random sample the following households from within each of the two buffer zones: 5,000 households will receive a postcard with details of how to access the online survey included. For another 5,000 households, a full postal pack will be sent with a covering letter, an 8-page questionnaire and a free post reply included. Based on previous experience [23], we expect a 7% and 10% response rate respectively for the two recruitment approaches. We expect this sampling strategy to enable us to collect data from 850 respondents, per buffer, at each data collection point. Based on a 20-25% drop-out rate assumption [24] at each subsequent follow-up point, that will enable us to have panel data on 500 respondents which is what was previously identified as an approximate sample size required to detect changes in cycling[25]. A prize draw will be included to help boost response rates of £150 shopping voucher per buffer zone. Postal mail reminders will also be sent if response rate is unbalanced between sampling wards.

The push-to-web approach described above will also be used to sample Coventry workers. Working with our partners within the local authority, we will circulate an email survey invite to selected employers which are located within the sampling area. Our estimate is that across the 9 workplaces, there are ~ 15,000 workers and based on a response rate of 7% (in line with the household surveys), this would give us 1,050 respondents per time point. The survey invite email will be circulated via internal newsletters and distribution lists and delivered to workers who will be able to access the online survey.

In order to ensure diversity and inclusivity in our sampling strategy, we will also reach out to community groups. These community groups have been purposively selected based on their proximity to the cycling corridor. In collaboration with our research partners, we have identified three community groups who we will work with: The Enterprise Club, a club set up to improve the quality of life of disabled people in Coventry; and the Woodside Family Hub who delivers information and support to families and young people in the area; and the John White Community Centre that serves the local community in Binley and offers facilities for catering and community groups. Based on feedback from our PPI applicants, postal surveys will be used with these community groups. There are approximately 50 members per group and assuming a response rate of 30% (personal communication with community hub lead), this will generate 45 responses per time point. We have requested costs to cover the time of the community group leads with helping us circulate the postal surveys that will have free-post reply included.

3.3.3.4 Consent procedure

All potential respondents will receive a participant information sheet and a completed consent form will be obtained prior to completing the survey. We will ensure that responses to the data collection instrument are never identifiable. The study has approval from the University of Birmingham Science, Technology, Engineering and Mathematics Ethical Review Committee [ERN_21-0208].

3.3.3.5 Data analysis

The primary behavioural outcome measure is change in physical activity. Secondary outcome measures are changes in overall cycling levels and usual mode of travel. Descriptive statistics will be used to explore the relationships between these behaviours and socio-demographic characteristics at baseline. Multivariable linear and logistic regression analyses will be used to evaluate the effect of exposure to the intervention (both within and between sampling buffers) on the behavioural outcome measures after controlling for covariates.

To determine the impact of the cycleway across different population subgroups, using the data collected within WP1, subgroup analyses will be performed to evaluate the distributional effects of the intervention across equity-relevant population subgroups. Equity-relevant characteristics will be defined based on input from the local authority, combined with the COM-B model that accounts for both motivation and capability to cycle. This will allow us to understand how and why the intervention is working, for example if a person does not own a bike then their physical capability to benefit from the intervention will be minimal. So we will identify subgroups based on the COM-B theory along with insight from the local authority team on which subgroups they are specifically interested in understanding impact, such as women, people with disabilities and people from low socio-economic groups[26].This will allow us to explore longitudinally, the impact of the cycleway upon people's ability to cycle and if that differs across different population groups.

All of the statistical analyses for WP1 will be conducted using STATA software[27].

3.3.3.6 Use of routine data

The use of routine data will be used to complement the analyses on the wider impact of the cycleway. Specific outcomes of interest will include measures of 'civic pride', local safety, perceptions of quality of public space, and ease of travelling around Coventry by car, public transport, bike and foot. These data are collected annually and at the household level allowing us to determine where households are located in relation to the buffer zones, and how outcomes are changing over time. As these data are not consistently available for all households and are costly, it will not be possible to link this routine data to the primary-collected data from the study population survey. The data will, however, give insight into the medium-long term outcomes indicated in our logic model that might not be picked up through our other outcome measures.

From a wider transport perspective, routine data will also be used to assess how modes of travel have altered over time at the City level. The Council do a cordon count every two years on all the routes in and out of the city centre covering private vehicles, public transport and cycling. This will enable an assessment on how the overall modal split across the city changes over time. The most recent survey was carried out in 2021, meaning that it will be repeated in 2023 and then again in 2025.

3.3.3.7 Output from WP1

The data collection and analysis will produce a stand-alone output from WP1 that will be shared with our research partners and disseminated through academic papers, conferences and social media, and will inform the analysis and model design within WP2 and WP3.

3.4 COST EFFECTIVENESS ANALYSIS – WORK PACKAGE 2

3.4.1 Research questions:

1. What is the cost-effectiveness of the cycleway from a local authority perspective?
2. What is the health equity impact of the cycleway?

3.4.2 Theoretical underpinning of cost-effectiveness and equity impact analysis

Economic evaluation is the analysis of the costs and consequences associated with comparative courses of action. Conventionally, within the health sector, extra-welfarist methods such as cost-utility analysis are adopted which are about maximizing health outcomes when offset against health care resources. Within a UK setting, health outcomes tend to be measured using Quality-Adjusted Life Years (QALYs) for which there are established thresholds to judge cost-effectiveness based on society's willingness to pay for a health improvement. Recent research with local government decision makers reports conventional CUA of limited use due the narrow focus on QALYs, health sector resources, and with a lack of focus on inequalities [28]. There is a call to think 'multidisciplinary' as public sector economists, to capture multi-sectoral costs and consequences, and to consider explicitly the distributional consequences. The design proposed within this study has been co-produced with Coventry City Council and will measure public sector costs, outcomes including health, broader wellbeing, and transport behaviours, and will include a health equity impact analysis.

3.4.3 Methods

3.4.3.1 Cost-consequence analysis

A cost-consequence analysis will first be conducted to estimate the economic impact of the Binley cycleway. This will combine and summarise information about the costs and outcomes in the form of a balance sheet which is ideal for presenting how costs and outcomes are distributed across multiple sectors. This method is relevant to this evaluation because the costs and outcomes are wide ranging, multiple perspectives are relevant e.g. transport and health.

The costs of the cycleway will include both the initial construction costs and the maintenance costs thereafter. Data to estimate these costs will be shared by our research partners, Coventry City Council. Outcomes to be presented within the CCA will include overall physical activity levels, cycling levels, mode of travel, and Quality of Life – Wellbeing (measured using the newly developed EQ-Health and Wellbeing instrument which has 9 items[29]), and these will be presented by buffer zone, and at follow-up point, to enable the decision-makers to see how outcomes have varied over time.

3.4.3.2 Cost-effectiveness analysis

The cost-effectiveness analysis will take a public sector perspective and will therefore include all costs and consequences that are relevant to public sectors – transport and health. The primary outcome for the cost-effectiveness analysis will be the mean difference in physical activity levels between the two buffer zones. A linear regression model will be fitted with physical activity at 3-years as the dependent variable, and baseline physical activity and socio-demographic and economic variables included in the model as covariates. As with the CCA, the costs will include initial construction costs and maintenance costs incurred over the

3 years. The CEA will offset the incremental difference in physical activity by the incremental difference in cost, between the two buffer zones, to generate an estimate for the cost-effectiveness expressed as 'cost per additional adult meeting the recommended PA levels'. A cost-utility analysis will link changes in physical activity to utility and mortality to enable an estimate of QALYs. All incremental costs and outcomes will be presented as adjusted difference in means with a 95% CI and p-value. Discounting will be applied at an annual 3.5% rate to both costs and benefits. The sensitivity of the results to missingness in the data will be explored and imputed using the most appropriate imputation technique.

3.4.3.3 Subgroup analyses

Using the population survey data (WP1), it will be important to measure the impact of the cycleway by subgroup. A key objective of the cycleway is to encourage non-cyclists to start cycling and so we will restrict our analyses to all participants who reported baseline levels of 'no cycling' to measure the cost-effectiveness within that particular population subgroup. In addition, we will conduct a break-even analysis to assess the number of additional regular cyclists required for the intervention cost to be offset.

3.4.3.4 Outputs from WP2

The results of the cost-consequence analysis and cost-effectiveness analysis will be shared with our research partners and disseminated through academic papers, conferences and social media, and will inform the model design within WP3.

3.5 MODELLING THE LONG-TERM ECONOMIC SUSTAINABILITY OF THE CYCLEWAY – WORK PACKAGE 3

Research questions:

1. What is the long-term cost-effectiveness of the Binley cycleway accounting for multi-sectoral costs and benefits?
2. What are the long-term equity implications of the Binley cycleway focusing on the distributional impact on health?

3.5.2 Theoretical underpinning of health economic model

The long-term cost-effectiveness and health equity impact of the intervention will crucially depend on the expected life cycle and maintenance costs of the intervention and how the change in physical activity behavior and health outcomes are maintained over time, by different population subgroups. In order to inform future policy actions directed at ensuring positive social returns on investment, long-term modelling will be required.

3.5.3 Methods

A decision-analytic model will be used to extrapolate the short-term intervention effects and economic estimates over the long term. To this end, open-access off-the-shelf health economic tool/s will be assessed for application. In particular, the HEAT tool developed by WHO [30] can be used for health economic assessments of population-level cycling promotion interventions. The HEAT is a quantitative tool which can estimate the monetary value of incremental benefits and risks (i.e., mortality) associated with changes in specific types of active travel-related behaviours (i.e., cycling and walking) and exposures (e.g., pollutants) in a specific geographical location and population over a defined period of time. As for the equity impact, open-access tools currently exist, such as the Integrated Transport and Health Impact Modelling Tool (ITHIM) [31] and the Impacts of Cycling Tool (ICT) [32] which can be used to assess the distributional impact of cycling interventions and will be also evaluated for application to this study. The authors of the identified off-the-shell tools will be contacted and permissions from them will be requested for adapting the underlying

models, as appropriate. In case of negative response or practical limitations with making these model changes, we will develop and adapt a physical activity decision-analytic model currently available to us which has been previously used to conduct public health economic evaluation of a population-level physical activity intervention in the UK[33].

3.5.3.1 Model parameters

Model parameters will be derived from statistical analysis of routinely collected data (e.g., Coventry Council traffic data and Sport England Active Lives datasets), review of the relevant published literature and national/local level statistics (e.g., from ONS and Public Health England).

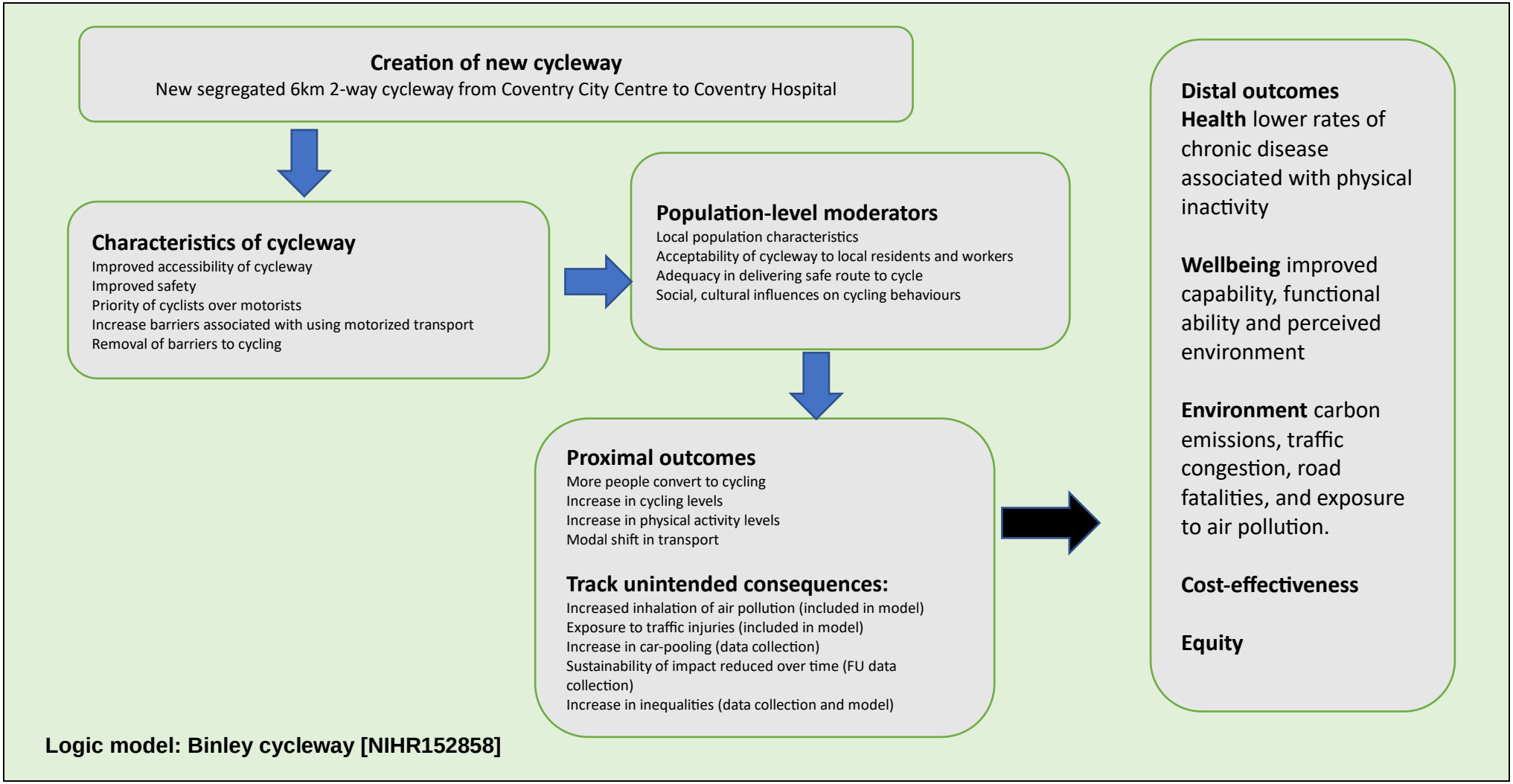
3.5.3.2 Model analysis

The societal costs and benefits expected under a no-intervention and an intervention scenario over multiple long-term time horizons will be estimated. These will include impacts on mortality, health-related quality of life, traffic-related outcomes, productivity and carbon emissions. A series of scenario analyses will be conducted to identify the minimum levels of additional cycling required for the long-term intervention costs to be offset and for achieving equity-neutral distributional impacts.

3.5.3.3 Sensitivity analysis

Deterministic sensitivity and further scenario analyses will be conducted to test the robustness of the base-case results to variations to key model parameters and assumptions. Probabilistic sensitivity analyses will be performed using Monte Carlo simulations by propagating the uncertainty through the model and allowing model parameters to vary simultaneously. This is to assess decision uncertainty and identify the probability of the cycleway being cost-effective and equity-neutral.

Figure 2: Study logic model for the impact of the new cycleway



Ethical/regulatory conditions

The planned study adheres to the UK Policy Framework for Health and Social care Research and involves collecting documentary and questionnaire data from members of the general population.

4.1 Assessment and management of risk

There is a risk associated with any active travel intervention related to increased cycling-related injury. The increase in fatality risk due to higher crash risk and exposure to air pollution as a result of increased cycling levels is incorporated within the HEAT model.

4.2 Research Ethics Committee (REC) review

The study involves collecting questionnaire data from members of the public and has already had full ethical approval from the University of Birmingham Science, Technology, Engineering and Mathematics Ethical Review Committee [ERN_21-0208].

4.3 Amendments

Amendments to the study protocol will be submitted to the Sponsor, the Funder and the Research Ethics Committee for review. Amendments will only be implemented when agreement from these parties has been gained. The amendment history will be tracked using version numbers and dates to identify the most recent protocol version.

4.4. Peer review

The funding application, including the detailed study plan, has undergone independent, expert and proportionate peer review in line with NIHR research funding guidelines. Following submission of the funding application at stage 1 we received feedback from the Funding Board. Following submission of the funding application at stage 2 we received feedback from 5 independent peer reviewers and further feedback from the Board. The study team responded to the feedback in detail, incorporating changes where required.

4.5 Public involvement

A PPI representative is part of the study team (EA). EA has advised on the development of the research plan in terms of with the public and advised on valuable background with respect to community groups in Coventry. We also have a public advisory group who belongs to the Centre for Economics of Obesity. During research plan development, we consulted with ths group, who have advised on strategies for recruitment. We will continue to consult this group and with an additional Coventry specific public advisory group (we anticipate approximately 1 consultation meeting per year).

4.6 Protocol compliance

Accidental protocol deviations will be documented and reported to the Chief Investigator and Sponsor. Protocol non-compliance will be reported without delay by research staff to the Chief Investigator, who will inform the Sponsor. The Chief Investigator will ensure that the issue is investigated and appropriate actions taken. The REC will be notified of any serious breach of its approval conditions, security, confidentiality, or any other incident that could undermine public confidence in the research.

4.7 Participant confidentiality and data protection

All study researchers will comply with the requirements of the Data Protection Act 2018, and all research staff involved in data collection will undergo/update Good Clinical Practice training. Data protection measures will adhere to the relevant policies and procedures of the University of

Birmingham. All study data collected on paper will be held securely, in a locked room or locked cabinet that is accessible only to the research team and relevant regulatory authorities. All study data in electronic form will be pseudoanonymised using ID numbers and held securely on encrypted machines protected by passwords. Files will be transferred via a secure server with user identifiers and passwords. Transcripts will be marked with unique and anonymised identifiers. All data will be held securely in the custody of the Chief Investigators for a minimum of 10 years after publication of the main study results, in accordance with the University of Birmingham Research Data Management Policy.

4.8 Indemnity

The University of Birmingham, as the Sponsor, has in force a Public Liability Policy which provides cover for claims for "negligent harm." The activities of this study are included in the coverage. No provision has been made for indemnity in the event of a claim for non-negligent harm.

4.9 End of study and archiving

Following the end of the study on 31st January 2026, data will be archived at the University of Birmingham for a minimum of 10 years.

4.10 Access to the final dataset

After publication of the main findings of the study, the Chief Investigator will consider external requests to gain access to anonymised data. The dataset will be preserved and available for this purpose for a minimum of 10 years following the end of the study. Those requesting data will be asked to provide a brief research proposal including the objectives, timelines, intellectual property rights, and expected outputs, and a Data Sharing Agreement between the University of Birmingham and the requestor will be drawn up. Requestors will be required to acknowledge the research team and funders as a minimum and consider co-authorship of any publications arising from the data. Permission for anonymised data to be shared for the purpose of future academic research will be sought from all participants via the informed consent form.

5. Dissemination

Data arising from the study will be owned by the University of Birmingham. The findings will enable further understanding of the ways in which local authorities can implement active travel policies to enhance population physical activity, and on how that results in improved health and wellbeing outcomes.

5.1 Anticipated outputs

Specifically, this project will generate the following outputs:

- It will enable a robust health economic assessment of the investment in the cycling infrastructure. This will generate important evidence to demonstrate the value of this type of investment from a health and broader societal perspective, that can be used to support future funding applications.
- It will generate a research framework that will increase the City Council's capacity to conduct future economic and social research to understand the impact of future actions on population health and wellbeing.
- In the long term, it will establish a monitoring system of cycling and physical activity behaviours in the city where the sustainability of the impact of investment, such as the Binley cycleway, is assessed over time. This will enable future analyses of the minimum levels of population behaviour change required to make such type of investments economically sustainable.

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