Free-to-use cycle provision schemes have potential to encourage cycling and reduce inequalities

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Abstract

Introduction

Cycling is an accessible, cheap way of incorporating health-promoting physical activity into everyday routines. One approach to facilitate engagement is to provide cycles through population-level approaches, such as commercial bike share schemes. However, these may increase health inequalities. An alternative is delivering cycle provision through not-for-profit and targeted schemes. However, there is a lack of peer-reviewed evidence on what comprises successful design and implementation.

Methods

An evaluation of two not-for-profit cycle provision schemes in Norfolk, England, is conducted: The Cycle Loan Scheme (CLS) aimed at the general population, and Welcome Wheels (WW) for refugees/asylum seekers. Quantitative measures assess the extent to which the schemes recruited and engaged groups of need (non-cyclists, women, over 55 years-of-age, living in deprived areas, not White British). Baseline and follow-up surveys established cycling frequency (absolute and change), and motivators, benefits, and barriers to taking part. Responses were compared across groups of need.

Results

At baseline, 87% of the 613 CLS participants were from a group of need, whilst 100% of WW participants (n=214) were. At follow-up, CLS participants (n=413) reported cycling a median of 5.5 hours a week (15 reported zero hours), an increase of 3.5 hours from baseline. Non-cyclists were less likely to engage than cyclists. WW participants (n=65) cycled a median five days per week at follow-up (all reported some cycling), an increase for 92%. Females were less likely to engage than males; all non-cyclists increased their cycling compared to 44% existing cyclists. Benefits of and barriers to engagement varied according to group of need.

Conclusions

Cycle provision schemes have potential to reduce health inequalities by encouraging cycling, particularly when tailored to need and local context, and when interventions are delivered by non-profit, community embedded organisations.

Application

A novel intervention framework is proposed to guide targeted interventions.

Keywords: Health inequalities, cycling, active travel, behavior change intervention, bike share, intervention

1. Introduction

Groups of people experiencing poor health relative to others due to their age, ethnicity, socio-economic background, where they live, or the religion they practise, are said to be subjected to health inequalities (Bleich et al., 2012). Addressing health inequalities by reducing the gap in health between the least and most disadvantaged in society is a public health priority (Public Health England, 2019). There is, however, some evidence that population-level approaches, which aim to improve overall public health across large numbers of people, may actually increase inequalities (Lorenc et al., 2013; Thomson et al., 2018). This could occur if interventions are less likely to be accessed, understood or engaged with by more vulnerable groups, such as the less affluent or educated (Frohlich and Potvin, 2008). Targeted interventions may be necessary to reduce inequality. These might reach fewer people but may reduce health inequalities by reaching those in most need, and could also result in higher effectiveness by successfully engaging the target audience, thus leading to a greater chance of behaviour change (White et al., 2009). A challenge is therefore not only to identify appropriate interventions but direct them appropriately.

Low levels of physical activity are associated with poorer health outcomes (Marmot, 2015) and in Western countries there is a strong social gradient in physical inactivity, with those in lower socio-economic groups being less active (Beenackers et al., 2012; Gidlow et al., 2006; Juneau et al., 2015). This gap increases with a range of characteristics including age (Farrell et al., 2014) and female sex (Roberts et al., 2016). A challenge is to promote physical activity behaviours that are attractive to all population groups. Cycling is an accessible, cheap way of incorporating health-promoting physical activity into everyday routines (Department of Health & Human Services, 2018), such as travelling to and from work (Department for Transport, 2020). The behaviour is low cost compared to motorised transport (Nieuwenhuijsen, 2020), and therefore holds potential to reduce health inequalities. Interventions may help encourage people to cycle more, thereby increasing their physical activity and improving their health (Ricci, 2015), while reducing obesity prevalence (Xu, 2019), risk of mortality, and costs to health services (Jarrett et al., 2012), and also reducing greenhouse gas emissions, improving air quality (Department for Environment Food and Rural Affairs (Defra), 2017). However, there is a paucity of evidence on which interventions may best encourage modal transport shift from driving to cycling, and evidence of the impact of cycling interventions on inequality is limited (Ogilvie et al., 2004).

One approach to facilitating cycling is through cycle provision schemes. This might be via a large-scale scheme, run commercially for financial profit, where any user can register and collect a cycle from various locations for a small daily or hourly hire charge. While there is some evidence to suggest that mass-hire schemes may attract more women than would normally cycle regularly (Buck et al., 2013; Goodman et al., 2014), data suggests that users are still typically male, younger, better educated and more affluent than the average population (Eren and Uz, 2020; Ogilvie and Goodman, 2012). Therefore, using a mass-sharing approach across a population risks increasing health inequalities.

An alternative approach to cycle provision is via non-commercial, not-for-profit schemes, where users are provided with a cycle, perhaps for an extended time period, either for free or for a small initial cost. Evidence suggests that not-for-profit schemes may help remove barriers to transport and encourage cycling at the population level, such as with the Urban Cycle Loan Scheme which engaged more than 2550 people in four London boroughs, and reported an increase in cycling among participants (London Cycling Campaign, 2015), and the Western Sydney Bicycle Loan Scheme, which recruited 262 people and reported increased physical activity among participants (Miskell et al.,

2010). However, schemes may be most effective at reducing inequalities if they are specifically targeted at groups of need experiencing them. Examples of such schemes include the Bike Project in London that donated cycles to refugees and enabled their access to work, education and exercise, while facilitating social inclusion (The Bike Project, 2019; Witty-Merrin et al., 2018) and the 'Big Birmingham Bikes' that loaned bicycles to people living in socio-economically deprived areas of the city (Ashden, 2020). Despite their promise, there is a lack of peer-reviewed evidence on what comprises successful design, implementation, and delivery of not-for-profit and targeted interventions.

This study considers two examples of not-for-profit cycle provision scheme delivered in Norfolk, England, by Norfolk County Council; firstly, a scheme available to the general population but delivered by two different providers in different locations, the 'Cycle Loan Scheme'; and secondly, a highly targeted scheme supporting newly arrived refugees, 'Welcome Wheels'. Using a pragmatic evaluation approach, we examine different contexts and approaches in design, implementation, and delivery, to enable critical reflection on the potential of cycle provision schemes for reducing inequalities by encouraging cycling in groups of need.

Firstly, we provide an overview of the methods and a description of the interventions. Then, results are presented, including the number and characteristics of participants and the extent to which they engaged with the schemes. Finally, the significance of the work is discussed along with strengths and limitations of the study, and a novel framework is proposed to guide the planning of population, behaviour change interventions for policymakers and practitioners.

2. Methods

2.1 Study area and interventions

Norfolk County Council (NCC), the local government organisation with statutory responsibility for public health in the English county of Norfolk, ran two cycle provision schemes where users were able to borrow a cycle, helmet, lock, and child seat (if required) for free. Users were permitted to keep the bike at their home and were given support, advice and training on its use where needed. The overall aim of both schemes was to increase levels of cycling in the county. The Cycle Loan Scheme (CLS) was run in Norwich (primary city of Norfolk) and the coastal town of Great Yarmouth in two stages: as a pilot between August 2016 and March 2017, and then for a longer phase between September 2017 and October 2021, when the provider in Great Yarmouth changed. The CLS scheme loaned cycles for a period of four weeks and was aimed at the general population. The other of these schemes, Welcome Wheels (WW), was based in Norwich and delivered by the same provider as the CLS scheme there, between March 2019 and October 2021. It loaned refurbished cycles to people from the refugee and asylum seeker community for as long as they needed them.

The components of each of these schemes are presented in Table 1, which is based on the Template for Intervention Description and Replication for Population Health and Policy interventions (TIDieR-PHP) checklist (Campbell et al., 2018).

To provide context to the study area, Norwich, with a population of approximately 200,000 (The Geographist, 2022) is relatively well-supported for cycling compared to other places in England, following significant funding for cycling infrastructure improvements in the last decade. It was one of only eight locations to receive a share of £191 million national government funding to invest in cycling infrastructure between 2013 and 2018 (Norfolk County Council, 2022a), and in 2020 it was awarded a further £32 million to spend on bus, cycling and walking schemes (Norfolk County

Council, 2022b). The city has a higher proportion of cyclists than most other cities in England: in 2014/15, nearly 7% of adults aged 16 years and older said they cycled at least five times per week for utility purposes, ranking it 4th highest nationally (Department for Transport, 2016). Great Yarmouth has a population of approximately 40,000 individuals (The Geographist, 2022). It has a smaller proportion of cyclists than Norwich, with 1.2% of adults saying they cycled at least five times per week for utility purposes, ranking it 93rd out of 324 authorities (Department for Transport, 2016). Both localities contain high levels of socioeconomic deprivation; according to the English Indices of Deprivation 2019, Norwich had higher levels of deprivation than 81% of other local authorities in England, whilst Great Yarmouth ranked as more deprived than 92% (Ministry of Housing Communities & Local Government, 2022).

2.2 Research design

We report on quantitative process measures to assess the extent to which the cycle provision schemes addressed cycling inequality (the 'equity' of these schemes). Firstly, the research identified the level of participation from people in 'groups of need'. Groups of need are defined here as non-cyclists (no cycling in the last year), women, people aged over 55, people living in the most socio-economically deprived 20% of local areas, or people who are not White British, all of whom are less likely to cycle (Cycling UK, 2019; Department for Transport, 2019a; Department for Transport, 2019b). Secondly, the study assessed the extent to which these groups engaged in the interventions, defined as the actual use of the loan cycle during the loan period. We also explored participant perceptions around motivation and barriers to taking part in the scheme and outcomes from taking part. The research questions for this study were:

1. Did the interventions recruit groups of need (participation)?
2. Did they engage groups of need (engagement)?
3. What are the perceived motivators for participation, barriers to engagement, and outcomes from taking part?

The process measures used in this study are displayed in the logic model in Figure 1. This model was a working document initially developed during discussions with stakeholders in the interventions to develop a shared understanding of their intended aims and methods of delivery.

160 ***Table 1.*** *Characteristics of the Cycle Loan Scheme (pilot, and main phases in Norwich and Great Yarmouth) and Welcome Wheels, based on the Template for*
161 *intervention description and replication for population health and policy interventions (TIDieR-PHP) checklist (Campbell et al., 2018).*
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1. Brief name	Cycle Loan Scheme pilot	Cycle Loan Scheme, Norwich	Cycle Loan Scheme, Great Yarmouth	Welcome Wheels, cycles for refugees and asylum seekers
2. Rationale	The free loan of a high-quality cycle with all the necessary equipment tailored for the user removes barriers to cycling and gives users a pleasant cycling experience. Cycling during the loan period develops their confidence and a positive attitude towards cycling, thereby increasing the likelihood of them cycling more after the loan period and changing their behaviour longer term. This leads to modal shift across the population.			The free loan of a cycle to refugees and asylum seekers on a limited weekly asylum allowance enables them to access education, training, friends, and carry out daily tasks. Cycling leads to improved health, reduced isolation, and increased integration. It encourages longer term active travel.
3. Resources	A new pedal bicycle[1] from the loan fleet for four weeks for free, tailored for the user; lights, lock, and helmet; demonstration of cycle, plus maintenance advice and cycle route information.	A new bicycle (pedal or electric cycle (e-cycle)[1]) from the loan fleet for four weeks for free, tailored for the user; lights, lock, and helmet; demonstration of cycle, plus maintenance advice and cycle route information.		A refurbished pedal bicycle[1] for as long as needed for free, tailored for the user; lights, lock, and helmet; demonstration of cycle; tailored packages and support (eg cycling lessons, confidence and mechanics training, regular drop-in sessions).
4a. Intervention design and management	Designed and managed by Norfolk County Council.			Designed by the provider in consultation with Norfolk County Council. Managed by Norfolk County Council.

4b. Funder	Department for Transport 'Sustainable Transport Transition Year' sustainable travel programme.	Department for Transport 'Access Fund' sustainable travel programme.		
4c. Intended audience	General population. Job seekers and those wishing to access training were identified as potential beneficiaries but not specifically targeted.			Refugees and asylum seekers only.
4d. Process for enrolling	Self-referral online. The process: complete 'Expression of interest' application, receive invite from provider to complete registration survey, reserve cycle on booking database, provider arranges appointment for participant to visit the bicycle store and pick up the cycle.			Third-party referral by four charities and several agencies working with asylum seekers and refuges in Norwich (including the Unaccompanied Asylum-Seeking Children Team (Norfolk County Council social work team), key/support workers and a number of foster carers).
4e. Cost	Free, subject to a refundable £10 security deposit on return.	Free, subject to a refundable security deposit on return (£10 pedal cycle, £50 e-cycle, rising to £50 and £100 from April 2020).	Free, subject to a refundable security deposit on return (£10 pedal cycle, £50 e-cycle).	Free.
4f. Marketing and promotion	Marketed locally by the provider; on websites and social media by Norfolk County Council; and at public events.	Marketed on a dedicated website and social media (Twitter, Instagram, Facebook) by Norfolk County Council; and at public events.		Word of mouth to the four charities and key workers.

4g. Exit routes from scheme	At the end of the four-week period, participants could purchase the bicycle at a discounted price, or purchase another new or reconditioned cycle from the provider.		At the end of the four-week period, participants could purchase the bicycle at a discounted price, or purchase another new cycle from the provider.	Participants could keep the bicycle for as long as they needed it.
5. Provider	Implemented and provided by two Community Interest Companies (CIC) – social enterprises – one in central Norwich (also a cycle shop) and one in central Great Yarmouth.	Implemented and provided by a Community Interest Company (CIC) – social enterprise – and cycle shop in central Norwich (same as Cycle Loan Scheme pilot)	Implemented and provided by a commercial cycle shop in Gorleston-on-Sea (3 miles from central Great Yarmouth).	Implemented and provided by a Community Interest Company – social enterprise – and cycle shop in central Norwich (same as Cycle Loan Scheme).
6. Location and scope	Greater Norwich and Great Yarmouth population.	Greater Norwich population.	Great Yarmouth population.	Greater Norwich refugee and asylum seeker community.
7. When	August 2016 to March 2017.	September 2017 to October 2021.	September 2017 to March 2020.	March 2019 to October 2021 (originally launched as a crowd-funded campaign in 2018).
8.1. Planned variation set out at design stage	Refinements to the administration and booking process and system.	Introduction of e-cycles after the pilot phase.	Introduction of e-cycles after the pilot phase. Change of provider between pilot and main phase of project from a social enterprise to commercial business.	None.
8.2. Unplanned variation after commencement	None.	None.	None.	None.

9.1. Delivery – strategies to ensure intervention was delivered as intended	Evaluation and monitoring: participant baseline follow-up surveys at the end of the loan period were requested and completed (follow-up 23% response rate – 24% Norwich, 22% Great Yarmouth).	Evaluation and monitoring: monthly reporting of outputs and expenditure to the Council to monitor delivery. Participant baseline and follow-up surveys at the end of the loan period (73% response rate) were requested and completed.	Evaluation and monitoring: participant baseline and three-month follow-up surveys at the end of the loan period were requested and completed, but response was low (follow-up 10% response rate).	Evaluation and monitoring: monthly reporting of outputs and expenditure to the Council to monitor delivery. Participant baseline and three-month follow-up (33% response rate) surveys were requested and completed.
9.2. Delivery - extent to which intervention was delivered as intended	Delivered as intended.	Delivered as intended.	Fewer cycles loaned than expected, limited engagement of the provider.	Delivered as intended.

163 1 A pedal cycle is propelled by operating the pedals. An electric cycle, or e-cycle, is a pedal cycle that is fitted with a motor to assist cycling that engages when the pedals are operated.

2.3 Data collection

2.3.1 CLS participant surveys and monitoring data

During the pilot phase (August 2016 and March 2017), participants completed a registration survey which included baseline questions on their age, ethnicity, gender, and home postcode; reasons for taking part; level of cycling experience; and frequency of cycling. They were asked to complete a follow-up survey after four-weeks when they returned their cycle; this asked about their cycling during the loan and any benefits they had experienced from the scheme. To understand intentions to cycle post-intervention, participants were also asked 'Which of the following do you plan to do within the next month?' and were given a list of options including 'buy a new cycle', 'buy a second-hand cycle', 'access a cycle another way', and 'none of the above'. NCC data protection policy stated that this data would only be stored for three years, so it is not possible to conduct new analyses but the summary findings and results from previous analyses are used to explore intervention design and participation (Research Question 1).

Participants of the main phase of the CLS in Norwich and Great Yarmouth completed a similar registration and follow-up survey. At the Norwich provider, follow-up was usually carried out online by the participant at a computer in the store. In Great Yarmouth, participants were given the link to the survey to complete in their own time. Data collected between September 2017 and November 2021 are used for this study.

In addition to survey data, the overall number of cycle loans and participation in the main phase of the CLS could be established from summary statistics from the online booking/registration process.

2.3.2 WW participant surveys

A different approach was adopted for the participants of WW since English was typically not their first language. A very simple questionnaire was administered to participants by the referrers to the scheme – four charities providing integration support to refugees and asylum seekers in Norwich (see 4d, Table 1) – enabling questions to be explained where necessary. The referrers had personally met the participants and were therefore able to pass on information they felt relevant to the scheme. As well as basic information about the size and type of cycle required, date of birth, first language, gender, and home postcode, referrers also noted any additional information in the questionnaire form, including the barriers to walking and cycling, how frequently they used a cycle, and what they hoped to use the WW cycle for. The data was shared with the provider, who contacted the referrer when a suitable cycle was available.

Follow-up survey data was collected by referrers with participants around three months after they had received their loan cycle. Initially, this was face-to-face during routine support meetings, but due to the Coronavirus pandemic, this was by telephone after March 2020. The questions included how frequently they had used the bicycle, what they had used it for, what their barriers to walking and cycling more were, and their general experiences of cycling. WW survey data collected between March 2019 and November 2021 is used for this study.

2.4 Data analysis

Descriptive statistics were used to identify recruitment of groups of need (participation, as per Research Question 1). Engagement in the schemes (Research Question 2) is reported in two ways: a) absolute frequency of cycling at follow-up, and b) change in frequency of cycling from baseline to follow-up. Furthermore, we identified 'lower users' or 'higher users' of the loan cycle at follow up with 'higher users' being those that cycled above the median value. Similarly, we identified groups of

'higher change' and 'lower change' with the 'higher change' group being those whose cycling had increased at the median value or above. We report the percentage of users in groups of need in the higher and lower categories. Due to small sample sizes for WW, we did not attempt to test differences for statistical significance.

Other data reported from questionaries, including reasons for taking part in the scheme, barriers to engagement, perceived benefits from taking part and future intentions to cycle, are explored to understand why participation and engagement may have varied according to group of need (Research Question 3). Where these were tick-box questions (benefits/motivators), the most common response by group of need is reported. Responses to open-ended responses about experiences of cycling while taking part in the schemes were used to determine barriers. Thematic analysis was used with an inductive approach, whereby the data were coded to identify potential reasons why participants had not used the cycle, and then these codes were grouped into salient themes. It was not possible to capture this information with the CLS pilot due to data protection restrictions, outlined in Section 2.3.1.

2.5 Ethical approval

Approval for this study was granted by the Faculty of Medicine and Health Sciences Research Ethics Committee at UEA (reference number 2016/17 14SE). Participant consent was obtained for their data to be shared with UEA and to use their data for the purposes of evaluation. All procedures were performed in compliance with relevant laws and institutional guidelines.

3. Results

3.1 Overall numbers participating using booking/registration summary statistics

Bicycles were loaned to 905 participants in total for the CLS pilot and main phases. The main phase of the scheme, between September 2017 and October 2021, saw the loan of bicycles to 767 people, 129 (17%) of which were e-cycles. The percentage of these that were loans from the Great Yarmouth provider fell from 41% in the pilot to 7% in the main phase of delivery when there was a change of provider. WW loaned cycles to 249 people between March 2019 and October 2021 following referrals for 309 people.

3.2 Survey results

3.2.1 Numbers of surveys completed

Of the 767 participants borrowing a cycle from the CLS during the main phase, 613 filled in registration (baseline) surveys and consented to their data to be used for analysis (80%). Of these, 413 (67%) also provided follow-up data. 18% of baseline and follow-up surveys returned were for e-cycle loans. For WW, surveys were completed for, and consent was given, by 214 recipients, with 65 (30%) providing follow-up data.

3.2.2 Participation by group of need

Characteristics of consenting participants taking part in the CLS pilot, CLS main phase and WW are shown in Table 2. The CLS had higher representation for women and not White British people compared to the local populations. The CLS pilot in Great Yarmouth had higher representation of people living in deprived neighbourhoods and the CLS main programme in Great Yarmouth was representative of people living in deprived neighbourhoods. CLS Norwich was not so successful in

recruiting from deprived neighbourhoods: 15% of participants were residents from the most deprived neighbourhoods, much lower than the figure of 39% across the resident population. Apart from the pilot phase in Norwich, CLS was not so successful in recruiting older people or non-cyclists; the latter is particularly the case in Yarmouth where rates of non-cycling are relatively high. Overall, 87% of participants recruited in the main phase of the CLS can be classified as being in a group of need, whilst 100% of WW participants were.

Welcome Wheels was aimed at refugees and asylum seekers, so none of the participants were White British. Participants were younger than CLS participants and the local population, they were predominantly male, and around one third lived in deprived neighbourhoods. Non-cyclists were well represented, possibly reflecting the difficulties this group may have experienced accessing a cycle in the last year.

***Table 2**. Demographics of cycle scheme participants in the study area: Cycle Loan Scheme (CLS) and Welcome Wheels (WW). Data is provided for the usual resident population of the study areas and England for comparison. Shaded rows represent groups of need.*

	CLS pilot (Norwich/Great Yarmouth)	CLS main (Norwich/Great Yarmouth)	WW	Norwich resident population[1]	Great Yarmouth resident population[1]	England resident population[1]
Number of users (figures in brackets by area for CLS)	138 (81/57)	613 (582/31)	214	132,512	97,277	53,012,456
Female, %	59 (62/56)	62 (63/48)	29	51	51	51
Not White British, %	18 (27/7)	24 (24/13)	100	15	7	20
Aged 55 years and above	>=45 yrs: 28 (32/23)	17 (16/19)	2	24	35	28
Residents in most deprived 20% of IMD[2]	41 (30/68)	16 (15/39)	35	39	40	20
Non-cyclists[3], %	49 (49/49)	35 (34/52)	88	49	67	61

1 Data from the 2011 Census. Source: UKCensusData.com (2012)

2 Index of Multiple Deprivation (IMD). Decile 1 = the 10% most deprived neighbourhoods (LSOAs) relative to other neighbourhoods in England. IMD data source: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019 and population https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimates.

3 Did not cycle in the last year. Data for Inner London, Norwich, Great Yarmouth, and England for May 2019-2020, from the Active Lives Survey https://activelives.sportengland.org/Result?queryId=43677

3.3 Participant engagement

Findings for the main phase of the CLS and WW are presented.

3.3.1 Level of the loan cycle use at follow-up

The median reported total absolute amount cycled by CLS participants in the last week of the loan period, according to the follow-up surveys, was 3.8 hours for new cyclists (i.e., former non-cyclists who reported no cycling in the last year at baseline, n=153), 6.8 hours for existing cyclists (i.e., those who reported cycling at least once in the last year at baseline, n=260) and 5.5 hours across all participants. Fifteen participants reported zero hours cycling at follow-up. Cycling for WW was reported in days rather than hours, with 5 days per week being the median number of days cycled at follow-up; all WW participants reported some cycling at follow-up.

Baseline non-cyclists, females and most deprived groups were less likely to be higher users in the CLS than cyclists, males and less deprived groups, whereas for WW this was only seen for females, where the difference was even greater (Table 3). There was very little difference between the other groups. All participants of WW were refugees from minority ethnic groups, aged less than 55 years old.

Table 3. *Characteristics of higher use of the loan cycle during the loan period for each group of need.*

		CLS			WW		
		n	Higher user group %	Difference[1] %	n	Higher user group %	Difference[1] %
Cyclist at baseline[2]	Non-cyclist	153	38	-19	58	59	2
	Existing cyclist	260	57		7	57	
Gender	Female	256	48	-4	19	42	-23
	Male	157	52		48	65	
Ethnicity	Not White British	104	51	1	65	58	_
	White British	307	50		0		
Age[3]	Older	67	51	1	0		_
	Younger	346	50		65	58	
Deprivation	Most deprived	66	47	-3	24	58	1
	Less deprived	347	50		35	57	

1 Difference between group of need and not

2 People were classified as non-cyclists if they reported no cycling in the last year at baseline.

3 Older = 55 years of age and older

3.3.2 Change in reported cycling duration at follow-up

For the CLS, the median reported difference in total amount cycled in the last week between baseline and follow-up was +3.8 hours for new cyclists (non-cyclists at baseline), +3.5 hours for existing cyclists and +3.5 hours across all participants. 94% (n=144) of the new cyclists reported an

increase in cycling between baseline and follow-up, compared to 83% (n=216) of existing cyclists and 87% (n=360) across all participants. None of the characteristics of CLS participants differed between the higher and lower change groups. For WW participants, all of the new cyclists (n=56) said they had increased their cycling between baseline and follow-up, compared to only 44% (n=4) of existing cyclists, and 92% (n=60) overall, whereby frequency was measured categorically by days per week or month.

3.3.3 Motivators, benefits, and barriers to taking part

Baseline survey data for the CLS main phase (data not available for the pilot) suggests that the most selected response to 'What are your main reason/s for wanting to borrow a bike?' for both the 215 non-cyclists and 398 existing cyclists responding, was to try before purchase, although the same number of non-cyclists also said they took part to improve their physical or mental health (Table 4). CLS participants mostly heard about the scheme by word of mouth (40% respondents) where it was recommended by family, friends, or work colleagues. For Welcome Wheels, when asked 'What will you use your bike for?', 'exercise' was the most-cited reason given by new cyclists and existing cyclists, although existing cyclists were just as likely to cite appointments, shopping and visiting friends.

Table 4*. The main motivators for, benefits, and barriers to engagement, measured according to baseline* cycling

	Scheme	Non-cyclist[1] (n, %)	Existing cyclist (n, %)
Motivators to use	CLS	Try before purchase (170, 79%) Improve physical or mental health (170, 79%)	Try before purchase (258, 65%)
	WW	Exercise (164, 88%)	Appointments (22, 88%) Exercise (22, 88%) Shopping (22, 88%) Visiting friends (22, 88%)
Benefits	CLS	Develop confidence (131, 86%)	Improve health (198, 76%)
	WW	Exercise (50, 89%)	Shopping (9, 100%)
Barriers to engagement	CLS	Driver attitude/traffic (6, 24%)	Cost of obtaining a cycle post-scheme (7, 30%)
	WW	Traffic/lack of separate cycle lanes (23, 70%)	Weather (3, 60%)

1 People were classified as non-cyclists if they reported no cycling in the last year at baseline.

This table includes data from tick box answers (motivators and benefits) and answers derived from themes in open responses (barriers).

At follow-up, CLS participants were asked 'Which of the following have you benefited from by using the loan bicycle?' and were presented with ten options, including 'other, please specify'. A total of 153 non-cyclists and 260 cyclists responded. Developing confidence was the most selected benefit of having a loan cycle for non-cyclists, whereas for cyclists, it was improving health (Table 4). When WW participants were asked 'What do you use your bike for?' and given eight options (including 'other'), exercise was the most selected use for the 50 non-cyclists who responded, whereas the

nine cyclists selected shopping. When asked 'What impact has the bike had on your day-to-day life?', all five responding WW cyclists and 35% of non-cyclists suggested the bike had given them independence to travel freely, where in many cases, travel would not have been possible without the loan bike.

CLS participants were asked to comment about their experiences of cycling while using the scheme, and 227 provided a response. Themes relating to positive participant experience included the value of good customer service and tailored advice (43 respondents, 39 of which were from a group of need), and having a good quality, appropriately sized cycle, with locks, panniers or child seats as required (25 respondents, 22 from a group of need). There were 48 comments about barriers to engaging in cycling (44 from a group of need and 25 non-cyclists). These responses were classified into the following themes: accidents, bike facilities (quality of lock, tool availability), problems with the bike (too heavy, difficult to handle, uncomfortable, not possible to have both panniers and child seat), driver attitude, traffic, health, time, childcare, the weather, cycle routes/lanes (lack of clarity, availability, quality), and cycle route information. The most cited barrier for non-cyclists was road traffic and/or the negative attitude of car drivers, whereas for cyclists the main barrier was cost of obtaining a cycle post-scheme (Table 4). WW respondents were simply asked the open-ended question 'What, if anything, stops you cycling and walking more?'. The most cited barrier for the 33 responding WW non-cyclists was having to cycle in traffic (70%), whereas for the five existing cyclists, it was the weather (60%).

3.3.4 Post intervention intentions

When asked about intentions to cycle post-intervention, 75% (114) of CLS baseline non-cyclist respondents and 82% (212) of existing cyclists said they planned to access a cycle in the next month. This suggests that the scheme increased intent to carry on cycling for those that did not cycle before taking part. At follow-up, 95% (62) of WW respondents agreed with the statement 'As a result of this activity or scheme, I am more likely to walk or cycle to get from place to place'.

4. Discussion

4.1 Significance of the work

Both not-for-profit loan schemes in this study successfully encouraged the active engagement of participants, shown by the use of the cycles they had borrowed and the increase in cycling for the majority between baseline and follow-up. However, our results suggest that a highly targeted scheme such as WW, which was aimed exclusively at a specific group of need, may offer the greatest potential for reducing inequalities by providing a particular group with the means to overcome barriers to their engagement.

Our findings support recommendations by White et al (2009) that targeted schemes may result in higher engagement. WW recruitment was through referrers identifying refugees and asylum seekers on low incomes without means of transport, rather than through other means of promotion or marketing publicly. Nevertheless, even the more generally marketed population-level CLS scheme showed some opportunity for more equitable use by groups of need compared to those who use mass-hire commercial schemes (Eren and Uz, 2020; Ogilvie and Goodman, 2012). This was particularly evident when a social enterprise, with a core ethos of positive social change, was involved in design, delivery, and recruitment. This aligns with a growing body of evidence on the

important role that social enterprises have in improving health equities in society, in this case by creating improved opportunities via access to transport (Suchowerska et al., 2020).

The CLS scheme gave people the opportunity to access a complete cycling experience: a quality cycle, fit for purpose, fitted to the rider, discussed with the rider, and with the necessary peripherals (lights, lock, helmet and child seat if needed). An anticipated mechanism in the CLS was to provide a 'high-quality' cycle, tailored for the user, to facilitate a pleasant cycling experience; this was an aspect of the scheme that was commented on by participants. This was further assisted by a loan experience that was seen as easy, friendly, low risk, and welcoming to inexperienced and experienced cyclists alike. The open-ended comments from participants also suggest that a key mechanism for successful engagement was making sure the interventions matched the needs of the participant – the right type and size of bikes, an e-cycle to overcome health problems, additional equipment such as panniers or child seats, help and advice. This need to tailor interventions to individual needs to be effective supports evidence from other studies (Ogilvie et al., 2007).

A key aspect of WW was at the recruitment stage as the referrers were familiar with the participant (family, home location, skills etc), and understood their needs and wider context of their lives, so were able to advise the provider and pass on information that enabled them to tailor the intervention appropriately. This was particularly relevant as the majority of WW participants had not cycled in the last year, if ever, so the scheme was made accessible to people who had potentially not ridden a bicycle, or who were not confident to ride on the road. The need to tailor an intervention by matching it to need is echoed in experiences from The Bike Project in London, where two key elements were having a women-only cycle training course and a buddy system, both of which helped participants overcome a lack of confidence to cycle alone and engage with the scheme (The Bike Project, 2019). Both schemes in our evaluation recruited a large proportion of people who did not cycle at baseline, and these participants went on to experience a larger increase in hours spent cycling than people who were already cycling at baseline. A larger scale, non-targeted scheme that does not take inequalities into account when identifying and matching need with provision, when recruiting and marketing, or when providing an intervention, may be less likely to reduce inequalities in health (Frohlich and Potvin, 2008; White et al., 2009).

A change in provider between pilot and main scheme for the Great Yarmouth element of the CLS, from a CIC to a commercial enterprise, located three miles from the town centre, led to the recruitment of low numbers compared to the pilot and to the scheme in Norwich, although a high proportion of these were from groups of need (~80%). Factors influencing levels of participation may be the appropriateness of the delivery models with different providers for the different social and economic environments in Great Yarmouth and Norwich (the former having higher rates of unemployment, deprivation, and cycle theft), and differential infrastructure and support (Cycling UK lists 11 cycling groups in Norwich, and one in Great Yarmouth[1]). It is also possible that delivery by organisations with social objectives, where providers actively promote the scheme within their community networks, may help increase participation and facilitate local ownership. Evidence from other schemes supports this; for example, The Bike Project (The Bike Project, 2019) and The Active Wellbeing Society (formally Big Birmingham Bikes) (The Active Wellbeing Society, 2021) are both non-profit, community-based organisations delivering cycle provision schemes that recruit and engage groups of need.

4.2 Relevance to policymakers and practitioners

[1] https://www.cyclinguk.org/groups-listing

While this study suggests that targeted interventions have the potential to address social inequalities in health and attract groups of need, the design and delivery of such interventions should be carefully considered by policymakers and practitioners to maximise participation and engagement. Based on the learnings of this study, we propose an intervention framework to guide such targeted interventions (Figure 2). As part of the design and delivery phase, three elements should be considered: firstly, the needs, purpose, and barriers; secondly, tailoring the intervention to need; and thirdly, the use of community groups and organisations. The key mechanisms for recruiting groups of need and enabling their engagement are outlined, considering necessary change in the wider context. The next steps for change are also detailed, and the long-term behaviour change outcomes that are the aim of such interventions are given. A key part of the framework is measuring processes and outcomes after recruitment and engagement. Illustrative examples from this study are shown in the blue shaded boxes of Figure 2.

Our framework covers four steps: the design and delivery of a programme to meet its identified aims, recruitment of the target audience, engagement of the target audience, and onward progression for change. It also considers monitoring and evaluation for continuous improvement. While this is not a definitive model, as interventions need to reflect local context and audience, it is intended to be used as a useful starting point.

1. The first step of our framework, design and delivery, encourages consideration of who might need the intervention, why they might need it (i.e., what purpose they would use it for), and barriers to their engagement. This can be used along with the existing evidence base to design a scheme that matches provision with need. The involvement of representatives of the local communities and deliverers is necessary at this stage, as they have knowledge and influence over what might work best.
2. The second step, the recruitment of participants, involves the application of appropriate strategies to reach and to appeal to the target audience identified in stage one, including highlighting the benefits of participation and how the intervention might help overcome barriers to engagement in cycling (Franckle et al., 2020).
3. The third step moves beyond the recruitment stage to actively enable participants to engage with the intervention, ensuring it is delivered in way that is acceptable to the different groups it engages with. Wider contextual change to the physical, social, or cultural landscape, which may require delivery through a package of further interventions, may also be necessary to help participants overcome certain barriers. For example, for some people, investment in physical infrastructure to provide segregated, traffic-free, routes for cycling may be needed to overcome fears of safety or lack of confidence in cycling alongside cars and other vehicles.
4. The fourth step is ensuring that appropriate exit strategies are in place to help participants embed longer term behaviour change. Affordability is one of several barriers that may prevent continued engagement post-scheme for some groups of need. For example, if a cycle loan scheme does not offer options to purchase cheap, second-hand bicycles, those without their own bike and/or on lower incomes may not be able to continue cycling. Through each of these stages, it is crucial to be mindful that evaluation and monitoring are necessary to not only to assess outcomes, but also to refine the design and delivery of the intervention.

4.3 Strengths and limitations

A strength of the study is that participant characteristics and outcomes were recorded for a large sample of participants in contrasting schemes along with follow-up data around cycling behaviour while taking part in the scheme, allowing the quantification of engagement. This allowed analysis to be undertaken to better understand how each of these schemes have worked in relation to the research questions, in different contexts, with different delivery models and intended audiences. This, in turn, has enabled the production of a novel intervention framework that can applied to help address social inequalities in health with behaviour change interventions.

Limitations include that obtaining follow-up information from the Welcome Wheels scheme was difficult due to the language barrier, which meant participations had to be talked through the questions, combined with the reduced opportunity for face-to-face contact during the coronavirus pandemic. This resulted in reduced sample numbers therefore limiting our ability to test for statistical significance in differences in the data. Across both studies, we do not have evidence on longer-term behaviour change: data on cycling intentions from the Welcome Wheels data is hypothetical, and data on cycling behaviour in the CLS was from self-reported surveys, which may be subject to error and bias. Further, the study was conducted in a non-metropolitan English setting and may not be generalisable to areas with substantially different environments, transport infrastructure or demographic structures. We did not carry out a cost effectiveness analysis of the projects due to lack of available data, but this could be an area of further research.

5. Conclusions

Our research suggests cycle provision schemes have potential to reduce health inequalities by encouraging cycling, particularly when provision and recruitment is specifically tailored to need and local context, and when interventions are delivered by non-profit, community embedded organisations. Schemes must however consider appropriate exit strategies to ensure longer-term engagement in cycling and behaviour change

6. References

Ashden, 2020. The Active Well-Being Society (formerly Big Birmingham Bikes) [Online]. Ashden, London. https://ashden.org/winners/birmingham-bikes/ (accessed 25 February 2020).

Baker, P. R., Francis, D. P., Soares, J., Weightman, A. L., Foster, C. 2015. Community wide interventions for increasing physical activity. Cochrane Database Syst Rev. CD008366. 10.1002/14651858.cd008366.pub2.

Beenackers, M. A., Kamphuis, C. B. M., Giskes, K., Brug, J., Kunst, A. E., Burdorf, A., Van Lenthe, F. J. 2012. Socioeconomic inequalities in occupational, leisure-time, and transport related physical activity among European adults: A systematic review. Int J Behav Nutr Phys Act. 9**,** 116. 10.1186/1479-5868-9-116.

Bleich, S. N., Jarlenski, M. P., Bell, C. N., Laveist, T. A. 2012. Health Inequalities: Trends, Progress, and Policy. Annu Rev Public Health. 33**,** 7-40. 10.1146/annurev-publhealth-031811-124658.

Buck, D., Buehler, R., Happ, P., Rawls, B., Chung, P., Borecki, N. 2013. Are Bikeshare Users Different from Regular Cyclists? A First Look at Short-Term Users, Annual Members, and Area Cyclists in the Washington D.C. Region. Trans Res Rec. 2387**,** 112-119. 10.3141/2387-13.

Campbell, M., Katikireddi, S. V., Hoffmann, T., Armstrong, R., Waters, E., Craig, P. 2018. TIDieR-PHP: a reporting guideline for population health and policy interventions. BMJ. 361**,** k1079. 10.1136/bmj.k1079.

Cycling Uk, 2019. Cycling UK's Cycling Statistics [Online]. Cycling UK, Guildford, UK. https://www.cyclinguk.org/statistics (accessed 8 September 2021).

Department for Environment Food and Rural Affairs (Defra), 2017. Improving air quality in the UK: tackling nitrogen dioxide in our towns and cities. Draft UK Air Quality Plan for tackling nitrogen dioxide. Defra, London. https://consult.defra.gov.uk/airquality/air-quality-plan-for-tackling-nitrogen-dioxide/supporting_documents/Draft%20Revised%20AQ%20Plan.pdf (accessed 13 May 2022).

[dataset] Department for Transport, 2016. Cycling to work (at local authority level). Table CW090. Department for Transport, https://www.gov.uk/government/statistical-data-sets/cw090-cycling-to-work-at-local-authority-level (accessed 6 May 2022).

[dataset] Department for Transport, 2019a. Proportion of adults that walk or cycle, by frequency, purpose and demographic, England, 2018-2019. Table CW0305. Department for Transport, https://www.gov.uk/government/statistical-data-sets/walking-and-cycling-statistics-cw (accessed 6 August 2021).

Department for Transport, 2019b. Walking and Cycling Statistics, England: 2019 report. Department for Transport, London. https://www.gov.uk/government/statistics/walking-and-cycling-statistics-england-2019 (accessed 17 March 2022).

Department for Transport, 2020. Gear Change: A bold vision for cycling and walking. DfT, London.

Department of Health & Human Services, 2018. 2018 Physical Activity Guidelines Advisory Committee Scientific Report Department of Health & Human Services, Washington DC. https://health.gov/sites/default/files/2019-09/PAG_Advisory_Committee_Report.pdf (accessed 13 May 2022).

Eren, E., Uz, V. E. 2020. A review on bike-sharing: The factors affecting bike-sharing demand. Sustain Cities Soc. 54**,** 101882. 10.1016/j.scs.2019.101882.

Farrell, L., Hollingsworth, B., Propper, C., Shields, M. A. 2014. The socioeconomic gradient in physical inactivity: Evidence from one million adults in England. Soc Sci Med. 123**,** 55-63. 10.1016/j.socscimed.2014.10.039.

Franckle, R. L., Dunn, C. G., Vercammen, K. A., Dai, J., Soto, M. J., Bleich, S. N. 2020. Facilitators and barriers to bikeshare use among users and non-users in a socioeconomically diverse urban population. Prev Med Rep. 20**,** 101185. 10.1016/j.pmedr.2020.101185.

Frohlich, K. L., Potvin, L. 2008. Transcending the Known in Public Health Practice. Am J Pub Health. 98**,** 216-221. 10.2105/ajph.2007.114777.

522 Gidlow, C., Halley Johnston, L., Crone, D., Ellis, N., James, D. 2006. A systematic review of the
523 relationship between socio-economic position and physical activity. Health Educ J. 65**,** 338-
524 367. 10.1177/0017896906069378.
525 Goodman, A., Green, J., Woodcock, J. 2014. The role of bicycle sharing systems in normalising the
526 image of cycling: An observational study of London cyclists. J Transp Health. 1**,** 5-8.
527 10.1016/j.jth.2013.07.001.
528 Jarrett, J., Woodcock, J., Griffiths, U. K., Chalabi, Z., Edwards, P., Roberts, I., Haines, A. 2012. Effect of
529 increasing active travel in urban England and Wales on costs to the National Health Service.
530 Lancet. 379**,** 2198-2205. 10.1016/S0140-6736(12)60766-1.
531 Juneau, C. E., Benmarhnia, T., Poulin, A. A., Côté, S., Potvin, L. 2015. Socioeconomic position during
532 childhood and physical activity during adulthood: a systematic review. Int J Public Health. 60**,**
533 799-813. 10.1007/s00038-015-0710-y.
534 London Cycling Campaign, 2015. Urban Cycle Loan Programme evaluation report Feb 2016. London
535 Cycling Campaign, London.
536 https://s3.amazonaws.com/lcc_production_bucket/files/13274/original.pdf?1556544165
537 (accessed 13 May 2022).
538 Lorenc, T., Petticrew, M., Welch, V., Tugwell, P. 2013. What types of interventions generate
539 inequalities? Evidence from systematic reviews. J Epidemiol Community Health. 67**,** 190-3.
540 10.1136/jech-2012-201257.
541 Marmot, M. 2015. The health gap: the challenge of an unequal world. Lancet. 386**,** 2442-2444.
542 10.1016/S0140-6736(15)00150-6.
543 [dataset] Ministry of Housing Communities & Local Government, 2022. English indices of deprivation
544 2019: File 10 Local Authority District Summaries (lower-tier). Ministry of Housing,
545 Communities & Local Government, https://www.gov.uk/government/statistics/english-
546 indices-of-deprivation-2019 (accessed 5 May 2022).
547 Miskell, S., Xu, W., Rissel, C. 2010. Encouraging community cycling and physical activity: A user
548 survey of a community bicycle loan scheme. Health Promot J Aust. 21**,** 153-154.
549 10.1071/he10153.
550 Nieuwenhuijsen, M. J. 2020. Urban and transport planning pathways to carbon neutral, liveable and
551 healthy cities; A review of the current evidence. Environ Int. 140**,** 105661.
552 10.1016/j.envint.2020.105661.
553 Norfolk County Council, 2022a. Cycling and walking [Online]. Norfolk County Council, Norwich, UK.
554 https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-
555 plans/norwich/city-centre-improvements/network-improvements/cycling-and-walking
556 (accessed 5 May 2022).
557 Norfolk County Council, 2022b. Transforming Cities Fund [Online]. Norfolk County Council, Norwich,
558 UK. https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-
559 plans/norwich/city-centre-improvements/improvement-projects/transforming-cities-
560 application (accessed 5 May 2022).
561 Ogilvie, D., Egan, M., Hamilton, V., Petticrew, M. 2004. Promoting walking and cycling as an
562 alternative to using cars: systematic review. BMJ. 329**,** 763-766.
563 10.1136/bmj.38216.714560.55.
564 Ogilvie, D., Foster, C. E., Rothnie, H., Cavill, N., Hamilton, V., Fitzsimons, C. F., Mutrie, N. 2007.
565 Interventions to promote walking: systematic review. BMJ. 334**,** 1204.
566 10.1136/bmj.39198.722720.BE.
567 Ogilvie, F., Goodman, A. 2012. Inequalities in usage of a public bicycle sharing scheme: Socio-
568 demographic predictors of uptake and usage of the London (UK) cycle hire scheme. Prev
569 Med. 55**,** 40-45. 10.1016/j.ypmed.2012.05.002.
570 Public Health England, 2019. PHE Strategy 2020-25. PHE, London.
571 Ricci, M. 2015. Bike sharing: A review of evidence on impacts and processes of implementation and
572 operation. Res Trans Bus Man. 15**,** 28-38. 10.1016/j.rtbm.2015.03.003.

573 Roberts, D., Townsend, N., Foster, C. 2016. Use of new guidance to profile 'equivalent minutes' of
574 aerobic physical activity for adults in England reveals gender, geographical, and socio-
575 economic inequalities in meeting public health guidance: A cross-sectional study. Prev Med
576 rep. 4**,** 50-60. 10.1016/j.pmedr.2016.05.009.
577 Suchowerska, R., Barraket, J., Qian, J., Mason, C., Farmer, J., Carey, G., Campbell, P., Joyce, A. 2020.
578 An Organizational Approach to Understanding How Social Enterprises Address Health
579 Inequities: A Scoping Review. J Soc Entrep. 11**,** 257-281. 10.1080/19420676.2019.1640771.
580 The Active Wellbeing Society, 2021. Big Birmingham Bikes [Online]. The Active Wellbeing Society,
581 Birmingham. https://theaws.co.uk/activities/big-birmingham-bikes/ (accessed 8 September
582 2021).
583 The Bike Project, 2019. Impact report 2019: getting refugees cycling. The Bike Project,, London.
584 https://thebikeproject.co.uk/pages/mission (accessed 13 May 2021).
585 The Geographist, 2022. 1000 Largest Cities and Towns in the UK by Population [Online]. The
586 Geographist, UK. https://www.thegeographist.com/uk-cities-population-1000/ (accessed 5
587 May 2022).
588 Thomson, K., Hillier-Brown, F., Todd, A., Mcnamara, C., Huijts, T., Bambra, C. 2018. The effects of
589 public health policies on health inequalities in high-income countries: an umbrella review.
590 BMC Public Health. 18**,** 869. 10.1186/s12889-018-5677-1.
591 [dataset] Ukcensusdata.Com, 2012. UK Census Data: Norwich. UKCensusData.com,
592 https://www.ukcensusdata.com/norwich-e07000148#sthash.rkFQMfcR.dpbs (accessed 18
593 November 2020).
594 White, M., Adams, J., Heywood, P. 2009. How and why do interventions that increase health overall
595 widen inequalities within populations?, in: Babones, S. J. (Ed.), Social Inequality and Public
596 Health. The Policy Press, Bristol, pp.: 65-82.
597 Witty-Merrin, A., Joshi, M., Dawes, J., Mein, G. 2018. Impact of bicycle provision on the health of
598 refugees in London: a qualitative study [Meeting abstract]. Lancet. 392**,** S94. 10.1016/S0140-
599 6736(18)32185-8.
600 Xu, D. 2019. Burn Calories, Not Fuel! The effects of bikeshare programs on obesity rates. Transp Res
601 D Transp Environ. 67**,** 89-108. 10.1016/j.trd.2018.11.002.

602