Feasibility of a randomised controlled trial of financial incentives to promote alternative travel modes to the car

Kate Garrott a,*, Louise Foley a, Steven Cummins b, Jean Adams a, Jenna Panter a

a MRC Epidemiology Unit, University of Cambridge, Cambridge, UK
b Department of Public Health, Environments and Society, London School of Hygiene and Tropical Medicine, London, UK

ABSTRACT

Introduction: Alternatives to the car, such as walking, cycling and public transport can integrate physical activity into everyday life. Interventions promoting alternatives to the car targeting individual behaviour have shown modest effects, and supportive environments appear important.

Methods: This mixed-method study assesses the scientific and operational feasibility of conducting a randomised controlled trial (RCT) of individual financial incentives within a supportive physical environment. We invited residents of Northstowe, Cambridgeshire, UK who had not previously claimed financial incentives to complete a baseline questionnaire assessing socio-demographic characteristics and travel behaviour. On completion, households were randomly assigned to (1) control – claimed incentives online; (2) intervention - received incentives via email; and (3) intervention plus - received greater value incentives via email. We assessed incentive use via questionnaires at three and six months. Longitudinal qualitative interviews at baseline, three months and six months elicited views of incentives and factors influencing use.

Results: 99 residents from 88 households (household response rate: 88/475 (19%)) completed the baseline questionnaire and were randomised at household level. The local authority delivered all incentives. Compared to the control group, incentive use was higher in the intervention and intervention plus groups at six months, but there was little difference between intervention and intervention plus group. Qualitative data suggests that incentives worked by prompting existing intentions, raising awareness of alternative travel modes and to a lesser degree by reducing travel cost. This resulted in some new leisure travel behaviour, but most often to subsidise existing travel. Qualitative data suggests that existing travel preferences and environmental conditions influenced incentive use.

Conclusion: It is feasible to deliver an RCT in collaboration with a local authority and future trials should account for recruitment challenges. Reducing the effort required to obtain incentives increased their use, but future research should investigate the surrounding enabling environmental contexts.

ARTICLE INFO

Keywords:
Financial incentive
Physical activity
Randomised controlled trial
Active travel

1. Introduction

Physical activity is important for the prevention of coronary heart disease, diabetes and other physical and mental health conditions, and the promotion and maintenance of active lifestyles is a prominent goal of UK health policy (Lee et al., 2012). Replacing...
motorised transport with active transport modes is one approach to incorporating physical activity into daily routines (Sahlqvist et al., 2012), which is beneficial for individual and planetary health (Lee et al., 2012; Haines, 2017).

Existing reviews suggest the best available evidence of effectiveness in promoting a shift in travel mode is for individual-level interventions and these tend to include provision of information and education (Ogilvie et al., 2004). There is evidence that targeted behaviour change programmes, particularly for those most motivated can be effective, but financial, environmental or policy interventions are less often evaluated (Ogilvie et al., 2004). A more recent review focused on a range of individual, as well as financial, environmental or policy interventions for active travel and the authors compared incentives (‘carrots’) and disincentives (‘sticks’), finding that interventions with incentives are more commonly evaluated (Xiao et al., 2022).

Overall, financial interventions include incentives and disincentives involving a payment to or withdrawal of monetary resources from an individuals’ budget (Martin et al., 2012) and are becoming more commonplace (Hunter et al., 2019). As well as their direction, financial interventions vary across a number of dimensions, including their magnitude, certainty and frequency (Adams et al., 2014). Their contingency on achieving specified behavioural outcomes is likely to influence their effectiveness and mechanism of action (Cordova et al., 2021). Non-contingent financial interventions are hypothesised to operate by prompting, reciprocity or positive re-enforcement (Thogersen, 2009; Cordova et al., 2021; Kane et al., 2004) whereas contingent interventions motivate individuals via the financial gain or loss associated with the behaviour (Jochelson, 2007).

The evidence-base on financial interventions for travel is in its infancy, primarily focusing on disincentives, for example, road user charging, demonstrating their effectiveness for decreasing driving behaviour (Xiao et al., 2022; Martin et al., 2012). The literature focusing on non-contingent positive financial incentives is limited (Xiao et al., 2022) but they may be effective for those not currently engaged in the target behaviour (Cordova et al., 2021). The evidence largely focuses on the provision of free or reduced price public transport tickets (Bamberg, 2006; Mackey et al., 2019; Stepaniuk et al., 2008; Thogersen, 2009; Fuji and Kitamura, 2003; Green et al., 2015) or bikes (Fyhri and Fearnley, 2015; Hemmingsson et al., 2009), within multi-component interventions (Goodman and Anise, 2006; Fyhri and Fearnley, 2015; Bamberg, 2006). Some evidence suggests that changes to incentive value and multiple incentives have potential to raise awareness and appeal (Thogersen, 2009; Kane et al., 2004), but this has not been fully explored. Such incentives may also require different levels of effort or ‘agency’ from the intended recipient, and some theories suggest that interventions designed to demand lower levels of effort are more effective and equitable (Adams et al., 2016).

Evidence suggests that elements of the social and physical environment such as social support, land use mix, the proximity of amenities and the directness and connectivity of routes for walking and cycling are consistently associated with overall physical activity and active travel (Wendel-Vos et al., 2007). As such, embedding healthy design principles focusing on the social and physical environment is endorsed in World Health Organisation recommendations for town and city planning (World Health Organization, 2019). Implementing individual-level interventions within supportive environments encourages utilisation of the environment, yet the evidence base exploring the intersection between individual-level and environmental interventions is limited (National Institute For Health And Care Excellence, 2018).

In 2016, a Healthy New Town programme implemented in ten localities was funded by the National Health Service in England, which aimed to improve population health and reduce health inequalities (NHS England, 2018) by creating a supportive social and physical environment. Northstowe, a new housing development in Cambridgeshire, UK, received Healthy New Town funding and implemented a design code supportive of pedestrians and cyclists during construction (South Cambridgeshire District Council, 2014). Alongside the supportive environment, the local authority delivers financial incentives to encourage alternatives to the car, presenting a real-world opportunity to manipulate intervention exposure and investigate the intersection between individual-level and environmental interventions.

Natural experiments are an appropriate solution to evaluate population health intervention where manipulating intervention exposure is not possible by researchers (Craig et al., 2012). However, where possible, well conducted randomised controlled trials (RCT) offer best available evidence. The implementation of an RCT within a real-world setting is an opportunity to bridge the gap between observational and experimental approaches, often referred to as pragmatic RCTs (Hotopf, 2002). Therefore, we aimed to assess the feasibility of co-delivering an RCT with the local authority and transport providers. The strong study design will enhance the internal validity meanwhile implementation within a real world setting will enhance its external validity (Hotopf, 2002; Relton et al., 2010).

The objectives of this study were:

1) To assess the feasibility of delivering an RCT assessing change in delivery and value of a package of financial incentives and assess the recruitment, response and retention that could be expected in future studies;
2) To assess the use and acceptability of incentives and their feasibility to bring about change in travel behaviour;
3) To understand the potential explanations and mechanisms for behaviour change associated with the intervention (or lack thereof).

2. Methods

2.1. Study design

This was a mixed-methods, three-arm RCT. Participants were randomised to control, intervention or intervention plus groups. All participants gave written informed consent and completed online questionnaires at baseline, three and six months post baseline and a subsample completed remote semi-structured interviews at the same time points. The School of Humanities and Social Sciences Research Ethics Committee, University of Cambridge provided ethical approval (HVS/2019/2778). A full protocol is available.
2.2. Setting

Northstowe, located 8 miles north of Cambridge, UK is a new town with 10,000 new homes planned. The building is taking a phased approach, and 908 homes were occupied at the beginning of the study in October 2021. The town is located adjacent to existing public transport infrastructure (Fig. 1), which provides access to Cambridge city and local rail stations (Ogilvie et al., 2016). At the time of the study, all homes were within 1 mile of the bus stop. Public facilities included two schools, open spaces, children’s play parks and outdoor leisure facilities, eg, gym equipment, sports court, table tennis tables. There were no shops or other leisure amenities in Northstowe (for example, cafes, restaurants, libraries) during the study, and a local community centre closed during the study.

2.3. Eligibility

Eligible individuals were those (1) living in Northstowe; (2) living in a household that had not previously claimed financial incentives; (3) aged over 16 years. Up to four household members could participate. We estimated that at baseline 900 homes would be occupied and approximately 50% were eligible. We aimed to recruit and retain 132 participants to the study.

2.4. Recruitment

Local authority partners generated a list of eligible households and shared the list with the research team, adhering to a pre-agreed data transfer contract. We posted an invite letter with four unique usernames and passwords, participant information sheet and questionnaire hyperlink to all eligible households. We distributed promotional material via posters, social media channels and community events. Due to recruitment challenges, we extended recruitment from two weeks to two months and conducted additional promotional activities. Over two days in November 2021 (10:00–15:30), six researchers knocked on all eligible households that had not responded to the questionnaire to check awareness and answer any outstanding questions. We spoke to residents from 262/411 (64%) eligible households approached.

2.5. Intervention

Acknowledging that there are a number of steps of action needed on the pathway to use incentives, the intervention was designed to reduce the effort (or agency) needed to access the incentives (Adams et al., 2016) and vary the dose available. Table 1 describes the incentives according to the group allocation.

**Intervention:** Participants in the intervention group received the financial incentives (Box 1) directly via email, reducing the effort required to access them. Intervention group participants owning $\leq 1$ car at baseline received a 50% waiver of the annual management charge (AMC) payable by all households to contribute towards greenspace maintenance.

**Intervention plus:** Participants received all incentives of a greater value directly via email. Participants owning $\leq 1$ car at baseline received a 100% waiver of the AMC.

**Control:** Consistent with existing practice, residents in Northstowe could claim four travel incentives. Once claimed, the cost of the financial incentives was funded by the home developers. Residents were notified via a welcome pack, social media, posters and

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**Fig. 1.** Map of Northstowe within proximity to nearby transport infrastructure (Cambridgeshire Guided Busway), surrounding villages (Longstanton, Oakington, Cottenham) and Cambridge.
community events. To receive the incentives, residents completed an online form, and selected up to one of each incentive. All Northstowe households pay 100% of the AMC (£121.24 in 2021).

2.6. Randomisation

Randomisation occurred at the household level using a 1:1:1 allocation ratio, stratified by baseline car access and travel patterns. The randomisation sequence was computer generated by the statistician and programmed into the database by the data manager. The sequence was unknown to research staff and participants upon randomisation. Blinding research staff to group allocation during data collection was not possible.

2.7. Measurements and data collection

2.7.1. Study procedures

Participants completed online informed consent and baseline questionnaires and received a £10 voucher for Amazon or the local food store. Following randomisation, we shared participants’ group allocation with the local authority who delivered the financial incentives to intervention and intervention plus groups.

2.7.2. Questionnaires

At all time points participants reported basic demographic (sex, age, highest education level), household (number of people in the household, housing tenure and length of time living in Northstowe) and travel data (number of cars and bikes available, driving license provision, usual travel to work and journeys made yesterday). At three and six months, participants self-reported incentive use (used

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Financial incentives received per household by group allocation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Intervention</td>
</tr>
<tr>
<td><strong>Overall Description</strong></td>
<td>Incentives offered but residents have to complete online form</td>
</tr>
<tr>
<td>£50 sports goods voucher</td>
<td>1 offered per household</td>
</tr>
<tr>
<td>7 day bus ticket</td>
<td>4 offered per household</td>
</tr>
<tr>
<td>Electric Bike hire scheme</td>
<td>Subsidised electric bike hire accessible via app</td>
</tr>
<tr>
<td>Cycle maintenance (1 per household)</td>
<td>1 free bike service</td>
</tr>
<tr>
<td>Annual Management Charge</td>
<td>Payable by all participants</td>
</tr>
<tr>
<td><strong>Intervention target</strong></td>
<td>[Standard practice]</td>
</tr>
</tbody>
</table>

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**Box 1**

**Incentive description**

**£50 sports goods retailer voucher:**

Monetary voucher redeemable online or in-store at an affordable nationwide sports goods retailer. The nearest store is located 8 miles from Northstowe. Participants were informed that this is a walking and cycling equipment voucher but it was possible to redeem for any available item.

**4 × 7 day bus tickets:**

Tickets were valid for 7 days upon activation and useable across the bus network in Cambridgeshire.

**Subsidised access to Northstowe Electric Bike hire scheme.**

Northstowe residents could hire electric bikes from two electric bike hubs situated in the town, bookable via an app. Residents received a subsidised rate upon registration with a Northstowe postal code.

**Cycle maintenance:**

Northstowe residents received a free bicycle service, including checks on bike wheels, brakes, gears, tyre pressures, lights, racks, pedals and saddles. Participants pre-booked a timeslot with the travel plan co-ordinator.

**Annual Management Charge (AMC):**

Each household pays an Annual Management Charge to contribute to the maintenance cost of communal greenspaces in the town.
by me/within household/outside household/not used) to assess incentive use and contamination.

2.7.3. Incentive provider data
Incentive providers agreed to provide individual incentive data on use.

2.7.4. Qualitative data collection
As part of the questionnaire, we invited participants to indicate their willingness to participate in longitudinal semi-structured interviews at baseline, three and six-month follow-up. We purposively selected willing participants to generate a diverse sample across intervention groups, ages and car ownership status. Interviews were conducted by KG via telephone or video call and followed a flexibly applied topic guide (Appendix A) covering travel patterns, impressions of incentives and incentive use. Interviews were audio recorded, transcribed verbatim by a third party and detailed field notes were written. Transcripts were checked against the audio recording.

2.8. Data analysis
We used a mixed-methods analysis approach, iteratively conducting quantitative and qualitative analysis and interpretation. Each analysis stage informed the next, pursuing key findings between each dataset, described as ‘following a thread’ (O’Cathain et al., 2010). Quantitative analysis used descriptive statistics, given that the study was not adequately powered to detect intervention effect on travel behaviour. From this, we generated a formative matrix of key findings that directed the qualitative content analysis and used this as a coding scheme to explore the use of incentives and potential impact on travel behaviour.

2.9. The implication of the COVID-19 pandemic and changes to protocol
We planned to start the study in April 2020 while strict COVID-19 restrictions were in place (limiting travel and social contact), and it was not feasible to begin the study. The UK underwent a phased exit from lockdown from April 2021 with the removal of all

Fig. 2. Consort flow chart showing the progress of participants through the trial.
restrictions in June 2021. Data collection commenced in October 2021 while there were no restrictions in place. We reduced the final follow up from twelve months to six months post baseline due to the resource required to pause and restart the study. Between baseline and three-month follow up, the UK government implemented further restrictions (from 08 December 2021 until 27 January 2022) encouraging employees to work from home if they could.

3. Results

3.1. Objective 1: Feasibility, recruitment, response and retention

At the time of recruitment 908 households in Northstowe were occupied, of which 475 (52%) were eligible to participate. 99 participants from 88 households (household response rate = 19%) completed the baseline questionnaire and were randomised at the household level (Control n = 30 participants: Intervention, n = 37: Intervention plus, n = 32) (Fig. 2). Participants were not required to give a reason for non-participation. Table 2 displays baseline participant characteristics. Anecdotal evidence from door knocking suggested not receiving the invite, forgetting to complete survey and the irrelevance of incentives were reasons for non-participation.

Despite pandemic-related delays in the study, we maintained relationships with the local authority and private partners to restart the study. The local authority reported sending incentives to all registered email addresses for households in the intervention and intervention plus groups. Despite initial agreement it was not feasible to collate individual-level incentive use data from the local authority or service providers due to operational limitations. We received group level data for the electric bike hire service, bus vouchers and partial data for the cycle maintenance sessions. No data was available for the sports goods vouchers as it was not possible to isolate data related to incentives issued for this study.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Baseline demographic data.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>16-24</td>
<td>5 (5)</td>
</tr>
<tr>
<td>25-34</td>
<td>38 (38)</td>
</tr>
<tr>
<td>35-44</td>
<td>34 (34)</td>
</tr>
<tr>
<td>45-54</td>
<td>15 (15)</td>
</tr>
<tr>
<td>55+</td>
<td>6 (6)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>41 (41)</td>
</tr>
<tr>
<td>Female</td>
<td>53 (54)</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>5 (5)</td>
</tr>
<tr>
<td>Length of time lived in Northstowe</td>
<td></td>
</tr>
<tr>
<td>&lt;1 month</td>
<td>5 (5)</td>
</tr>
<tr>
<td>2-5 months</td>
<td>12 (12)</td>
</tr>
<tr>
<td>6-12 months</td>
<td>24 (24)</td>
</tr>
<tr>
<td>&gt;12 months</td>
<td>58 (59)</td>
</tr>
<tr>
<td>Highest level of education</td>
<td></td>
</tr>
<tr>
<td>Degree or equivalent and higher</td>
<td>71 (72)</td>
</tr>
<tr>
<td>A level or equivalent</td>
<td>13 (13)</td>
</tr>
<tr>
<td>GCSE or equivalent</td>
<td>8 (8)</td>
</tr>
<tr>
<td>Other</td>
<td>7 (7)</td>
</tr>
<tr>
<td>Housing tenure</td>
<td></td>
</tr>
<tr>
<td>Rent property</td>
<td>9 (9)</td>
</tr>
<tr>
<td>Shared ownership</td>
<td>10 (10)</td>
</tr>
<tr>
<td>Privately owned</td>
<td>80 (81)</td>
</tr>
<tr>
<td>Household car ownership</td>
<td></td>
</tr>
<tr>
<td>0-1 cars</td>
<td>55 (56)</td>
</tr>
<tr>
<td>&gt;2 cars</td>
<td>44 (44)</td>
</tr>
<tr>
<td>Travel to work using car in last four weeks</td>
<td></td>
</tr>
<tr>
<td>Never or rarely</td>
<td>40 (40)</td>
</tr>
<tr>
<td>Occasionally</td>
<td>15 (15)</td>
</tr>
<tr>
<td>Usually</td>
<td>12 (12)</td>
</tr>
<tr>
<td>Always</td>
<td>32 (32)</td>
</tr>
</tbody>
</table>
3.2. Objective 2: Incentive acceptability and use, and feasibility to bring about behaviour change

3.2.1. Acceptability of incentives

Qualitative data suggests that the incentives were deemed as acceptable to residents in Northstowe, even among those who chose not to use them ‘They’re good incentives for getting people to move to Northstowe and for getting people set up’ (P10, male). The only negative view expressed by participants was in relation to the week-long nature of the bus ticket, expressing it ‘would seem a bit wasteful’ (P04, male), and changing its structure from a weekly ticket to a daily ticket would increase its acceptability.

3.2.2. Use of incentives

Table 3 presents participants’ self-reported data on incentive use at three and six month follow up. Participants in the control group had lower self-reported use of any incentives (three month - 3/19, 16%; six month – 2/13, 15%) compared to the intervention (three month - 17/22, 77%; six month – 13/18, 72%) and intervention plus (three month - 16/26, 62%; six month – 13/20, 65%) at three and six month follow ups. Data reported from the local authority shows only four participants in the control group claimed the incentives at six months (4/30, 13%), but no further information on their use is available. Qualitative analysis suggests the reasons that the control group did not claim incentives included deeming them as irrelevant to current travel patterns, ‘And the bus thing, I’d had no need for it (P02, female)’ or ‘it seems to me a bit of a cheek when I’m not actually doing either of the things that are incentivising me to do (P03, male).’ Others stated that they already travelled via alternative modes and therefore did not think the incentives applied to them.

Self-reported data suggests little difference in voucher use between the intervention and intervention plus groups indicating that increasing incentive value did not impact their use. Within the qualitative data, participants commonly suggested an increased value bus voucher, yet only one intervention group participant noted that a higher value sports good incentive would be beneficial ‘I will probably do that [buy a helmet] when I’ve been paid from work to be able to do it. So £50 is useful, but it certainly wouldn’t cover what I’d need’ (P04, male). Other participants reported using personal money to purchase additional/better quality items or purchased items less than the value of the incentive.

Four participants reported that the incentives were used by someone outside of the household and qualitative interviews suggest that these were mainly shared between other family members who lived locally or were visiting ‘both my wife and I have a bus pass, so it was basically for guests, (P01, male)’.

3.2.3. Feasibility to bring about behaviour change

Due to limited sample size, our quantitative data is unable to assess the effect of financial incentives on behaviour, yet it is possible to identify potential behavioural pathways from the qualitative analysis. The most common use of the incentives was to supplement existing travel behaviour or leisure physical activity. This was particularly relevant for existing bus commuters using the bus voucher, although others stated that they already travelled via alternative modes and therefore did not think the incentives applied to them.

Other examples include purchasing bicycle lights or walking boots to supplement existing walking and cycling. We identified some instances where the incentives initiated new leisure travel behaviour, particularly new leisure travel to Cambridge city centre and the nearest major airport due to their convenience. When trialling new modes, participants used their experience to inform future travel behaviour ‘it’s very much a case of it’s interesting, I’ll see what it’s like and if that informs what I might use them for in the future’ (P06, male). We did not identify any participants that changed mode of travel for commuting.

Table 3

Self-reported use of financial incentives.

<table>
<thead>
<tr>
<th>Incentive used</th>
<th>Three month follow up, n (%)</th>
<th>Six month follow up, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Int</td>
</tr>
<tr>
<td>Incentive used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3 (16)</td>
<td>17 (77)</td>
</tr>
<tr>
<td>No</td>
<td>16 (84)</td>
<td>5 (23)</td>
</tr>
<tr>
<td>Number of incentives used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>16 (84)</td>
<td>5 (23)</td>
</tr>
<tr>
<td>1</td>
<td>1 (5)</td>
<td>11 (50)</td>
</tr>
<tr>
<td>2</td>
<td>1 (5)</td>
<td>3 (14)</td>
</tr>
<tr>
<td>3</td>
<td>1 (5)</td>
<td>3 (14)</td>
</tr>
<tr>
<td>4</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Type of incentive used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>£50 sports goods voucher</td>
<td>2 (11)</td>
<td>12 (55)</td>
</tr>
<tr>
<td>7 day bus ticket</td>
<td>2 (11)</td>
<td>10 (45)</td>
</tr>
<tr>
<td>Cycle maintenance</td>
<td>0 (0)</td>
<td>4 (18)</td>
</tr>
<tr>
<td>Electric Bike Hire Scheme</td>
<td>2 (11)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

* Yes - Incentive used by participant, someone within the household or outside of the household; No – incentive not used.
3.3. Objective 3: Understand the potential explanations and mechanisms for (lack of) behaviour change associated with the intervention

Fig. 3 displays the hypothesised behavioural and cognitive pathways for behaviour change from the incentives and assumes that participants need to be aware of incentives, (control group) make some effort to access them, have intentions to use them and use them on travel to potentially bring about changes in behaviour. Participants must complete each step in sequence for behaviour change to occur and any break will disrupt the pathway.

Among individuals already considering using alternative travel modes, the automatic delivery of incentives appeared to strengthen existing intentions, either to use the incentives or to engage in alternative modes ‘referring to existing intention to purchase bicycle lights] ‘it was an incentive to go and do it basically’ (P01, male), noting that they ‘gave me an extra push’ (P10, male). For two participants the incentives arrived when they were considering how to travel to work, and receipt of the incentives tipped them to using the alternative travel mode. For other participants receiving the financial incentives raised awareness of alternative travel modes ‘it’s a bit of an eye opener to … looking at different ways of transport and using them. That it’s kind of encouraging you to do it’ (P14, female); encouraging them to seek further information about these modes ‘I think if I hadn’t had the vouchers, I probably wouldn’t have investigated it, ’ (P11, female).

This evidence suggests that the value of incentives was sufficient. The target of this intervention was to reduce the cost of alternative travel modes (Fig. 3), and in some cases, the bus voucher reduced the cost of leisure travel ‘I use it to go out during weekends and if I’m not off to work as well, if I go to the city centre and stuff like that just to get the value,’ (P13, female). However, long term effects after the voucher has ended are uncertain due to the price sensitivity of the bus ‘whilst it’s an incentive to use the bus for that initial period it may not continue … the bus is fine but I’m having to pay for it now and it’s expensive, I’ll just go back to using the car’ (P10, male). This may be reflective of views held by participants that the current bus fares are expensive and many suggested permanent reductions as a long term cost solution. There was no qualitative evidence to suggest that the other incentives operated by reducing the cost of alternative travel behaviour.

The hypothesised behavioural and cognitive pathway identifies break points in the sequence that may provide an explanation for the lack of effect. Firstly, the pathway demonstrates why participants had not claimed the incentives upon moving, citing a lack of awareness ‘I didn’t even know about the [sports goods retailer] one, (P05, female), and the effort required ‘There was a form that you had to complete … yet another form … with all the other forms that you needed to complete’ (P16, female) as key barriers to claiming incentives. Particularly within the context of a busy relocation period ‘Honestly, it was mostly just in the chaos of having moved house and trying to settle, taking up the incentives hadn’t been a priority (P06, male). Therefore, sending the incentives directly to intervention group participants shortens the sequence of action.

Secondly, we identified receiving the incentives to forming intentions as a key breaking point in the sequence, mainly explained by views on the relevance of the incentive to existing behaviours or preferences ‘I don’t use it [the bus] enough to make it make a difference’ (P03, male) or ‘I haven’t actually had a journey when I’ve used the bus lately’ (P08, female). Particularly we found the accessibility of workplace destinations for the alternative travel modes as a key barrier. Specific barriers to use of each incentive type are included in

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**Individual and environmental context**

Control group only

- Be aware of available financial incentives
- Visit website to claim financial incentives
- Receive financial incentives
- Reduce effort required to receive financial incentives
- Reduce cost of using alternative travel modes
- Form Intention to use financial incentive
- Increase awareness of alternative travel modes
- Prompt existing intentions
- Use financial incentive
- Initiate new travel behaviour
- Supplement existing travel or leisure behaviour
- Share incentive outside of household

**Hypothesised cognitive and behavioural pathway**

- Breaking points in sequence

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Fig. 3. Potential explanations for incentive mechanisms of action for travel behaviour change.
Appendix B.

Thirdly, we noted a break point representing an intention-behaviour gap ‘We spoke a little about the electric bikes and trialling those, that’s something that I intend to do ... now that the weather has improved’ (P06, male). Another explanation was saving the incentives for a time when they were needed ‘they [sports goods vouchers] expire in 2023 so we’ve just left them to see when they are required’ (P09, male). For the cycle maintenance and sports goods vouchers, where the travel behaviour is distal to incentive use, we identified an additional intention-behaviour gap, ‘one incentive I did use was to repair my bicycle and that was really good ... but the weather being bad, I haven’t had the time to use it yet’ (P09, male). These breaking points are likely contributing factors leading to 28% and 35% of participants in intervention and intervention plus groups respectively not claiming any incentives.

3.3.1. Impact of context

Despite a clear vision for developing a town with urban infrastructure that supports alternative travel modes, the environmental context in Northstowe at the time of the study did not facilitate this vision. Examples displayed in Fig. 4 demonstrate ongoing building work, unfinished and blocked cycle paths, uneven surfaces as well as an existing bus service unable to cope with the additional demand. Many participants cited that environmental barriers had a greater influence on behaviour than the incentives ‘I’m not particularly encouraged to cycle anywhere around Northstowe because the roads are not very wide ... I could cycle to the shop but I’m not tempted to because the roads are in a bit of a poor state’ (P03) or ‘The last interview was at the point at which I just stopped using the bus altogether because I couldn’t rely on it ... often I’d turn up in the morning, stand in a queue and not be allowed on [due to crowding]’ (P10). One participant detailed the environmental barriers to travel and subsequently said ‘I think the incentives on their own are not enough’ (P03).

Differences in individual contexts also appeared to influence incentive use. For example, those who are more proficient cyclists may be more willing to cycle on the existing infrastructure and those whose workplaces are accessible via the bus service have a higher propensity to use the bus. Changes to individual circumstances (e.g., work locations/childcare) and attitudes throughout the follow up period prompted travel change, at which time participants considered the incentives relevant to informing their choice. Completion of the hypothesised behavioural pathway is influenced by the individual and environmental context, which we found to be dynamic in nature. Some contexts act to enable the sequence of action to be completed, whereas others present barriers resulting in a break in the sequence of events.

4. Discussion

4.1. Summary of findings

This study demonstrated that it is feasible to deliver a RCT exploring the intersection between individual-level and environmental interventions in collaboration with a local authority. We developed insights in relation to recruitment, retention and collaborative working to inform a future trial. Our results show that reducing the effort required from individuals to receive incentives may lead to increased use, but that increasing their value may not lead to any further increase in use. We found evidence for a sequential behavioural and cognitive pathway illustrating how incentives affect travel and identified key stages where the sequence breaks. The intended supportive environmental context did not materialise in Northstowe and environmental barriers were partly responsible for preventing incentive use. Participants used incentives to initiate new leisure travel or to subsidise existing travel, with little evidence to suggest they initiated commuting behaviours.

4.2. Feasibility of recruitment, randomisation and intervention delivery

We demonstrated the feasibility of collaborating with the local authority and achieved all fundamental aspects of the study including recruiting households, collecting self-reported data and delivering incentives by involving partners early, clear communication and clear outcomes, as recommended for effective collaboration (Kothari et al., 2011; Reback et al., 2002). Despite employing these principles, we encountered challenges receiving individual-level data which would have strengthened our understanding of how participants used the incentives.

While the recruitment rate in the current study was lower than our target (99 vs 134), reviews of publicly funded trials in the UK suggest this is a widespread difficulty, with only half of trials achieving 100% of their sample within the pre-agreed timescale (Walters et al., 2017; Sully et al., 2013). We employed additional recruitment strategies for example careful staff selection, incentives and
collaboration, which are supported in the literature as appropriate methods to target the disengaged population reflected in our sample (Gebler et al., 2012; Smit et al., 2021). Achieving a higher recruitment rate in a future trial will require additional resource to scale up door knocking, provide completion incentives at all data collection points and increase the time allowance for recruitment and should be costed for in future work. The build and occupation rate of homes in Northstowe was, and continues to be slower than anticipated, despite its status as the largest new development in the UK since the 1960’s (Homes England, 2022) which limits the pool of eligible participants. The environmental context described in the current study was not supportive of alternative travel modes, despite a promising policy context and design code (South Cambridgeshire District Council, 2014) limiting our proposed objective to explore the intersection between supportive environmental contexts and individual-level interventions. The aforementioned conditions would be required in order to progress to a future trial to ensure the results are meaningful to practice. It may be possible to conduct a trial after all residents have moved to the development, however this approach would not capitalise on the relocation period as an opportunity to change travel behaviour (Bamberg, 2006). Thus, achieving an adequately powered trial within the relocation period presents significant challenges.

4.3. Use, acceptability and potential to bring about change in travel behaviour

A key finding of this study was that reducing the effort required by participants to obtain incentives increased their use, which has important implications for implementing future financial incentives and individual-level interventions. This is consistent with other literature which finds that immediate and complete registration opportunities heavily influenced rates of organ donation registration (Siegel and Alvaro, 2009). The increase in use can be partially attributed to addressing any deficit in participants’ awareness of the incentives, a key antecedent to behaviour change (Sutherland et al., 2008). Existing practice, as replicated in the control group requires residents to claim financial incentives and the cost to providers only occurs once the incentive is provided. Increasing the number of incentives provided by replicating the package in the intervention and intervention plus groups increases the intervention cost, which may be prohibitive. However, some literature suggests that the cost of financial incentive interventions are lower compared to other individual-level interventions, due to the high cost associated with delivering individual-level interventions (Sutherland et al., 2008). Upon accessing the incentives, participants were still required to complete a sequence of actions to engage in the target behaviour. For example, to use the bus voucher participants have to activate the voucher, be aware of the bus timetable and travel to the bus stop and change leisure-time physical activity and travel but not work-related travel. Maintaining existing levels of travel and leisure-time activity (Sutherland et al., 2008) as well as transitional life events, such as childbirth, work relocation, retirement and marital changes that affect physical activity participation (Engberg et al., 2012). Drawing on the Capability, Opportunity, Motivation, Behaviour (COM-B) model of behaviour, an individual must have sufficient capability (psychological and physical), opportunity (physical and social) and motivation (automatic and reflective) to engage in a specified behaviour (Michie et al., 2011). Financial incentives may address deficiencies in psychological capability (awareness), physical environment (cost) or reflective motivation (prompt), however it is feasible that deficiencies remain within other parts of the COM-B model that prevent behaviour change. These differences in environmental and individual contexts in which financial incentive studies are implemented may affect their acceptability and effectiveness (Martin et al., 2012; Marteau et al., 2009) and should be described to identify contextual factors that explain intervention effectiveness (Marteau et al., 2009).

This study suggests that financial incentives were predominantly used to subsidise existing behaviour. They may have potential to change leisure-time physical activity and travel but not work-related travel. Maintaining existing levels of travel and leisure-time physical activity may be viewed positively from a health perspective by avoiding a decline in physical activity, and in order to
capture all health effects, a future study should use adequate assessments and length of follow up to capture this. However, the potential environmental benefits are lower due to the lack of a modal shift in work-related travel. This research suggests financial incentives delivered within an unsupportive environmental context are unlikely to produce the desired modal shift, and efforts should perhaps primarily focus on building supportive environments ahead of implementing individual-level interventions. Future research opportunities to implement financial incentives within supportive environments will enable researchers to study the impact of variations in delivery method, incentive type and value in greater detail – these have been identified as potentially important elsewhere (Mortimer et al., 2021).

4.4. Implication for policy and practice

Our findings present clear implications for policymakers and practitioners implementing financial incentive interventions. We illustrate the importance of considering the environmental context in which financial incentives are implemented to ensure that both the environment and incentives work in synergy to support the target behaviour. If the environmental context is considered conducive, our findings suggest that reducing the effort required by individuals to obtain financial incentives shortens the sequence of action and potentially increases uptake. We achieved this by emailing participants, but other approaches are suitable that can replicate the function of this intervention. We also demonstrated that the dynamic nature of individual contexts reflects as a changing relevance of financial incentives for individuals, therefore ensuring financial incentives are available at multiple opportunities is likely to enhance their use.

4.5. Strengths and limitations

A key strength of this study is the collaboration with a local authority to evaluate an existing intervention exploring the intersection between individual-level and environmental interventions. In the UK, local authorities are responsible for changes that might affect transport and health, including the implementation of both environmental and individual-level interventions. While natural experiments evaluation methods have been previously used to evaluate policy interventions (Ogilvie et al., 2016), we demonstrate the feasibility of working within existing policy environments to deliver an RCT. However, the environmental context that this study operated within was not as supportive as planned, therefore limiting our ability to fully explore the intersection between individual-level interventions and supportive environmental contexts. The lower than planned recruitment and retention rates limits our ability to draw accurate estimates for progressing to a full trial. Northstowe is located in an area categorised as in the least deprived in the UK (Ministry of Housing, Communities Local Government, 2019) and our participants themselves had predominantly high levels of education and the majority resided in privately owned homes and therefore there may be limited generalisability of the study results to other individuals and areas, both in the UK and outside of Western, well developed regions.

While our study aimed to recruit participants shortly after a period of residential relocation, the majority of our sample had resided in Northstowe for longer than twelve months limiting our ability to speculate about the incentives effect upon residential relocation.

5. Conclusion

This study demonstrated reducing the effort required to obtain financial incentives increased their use, but increasing their value had no additional impact on incentive use. Delivering a trial in collaboration with a local authority and private partners was operationally feasible, yet the resulting unsupportive environment did not allow scientific aims of exploring the intersection between individual-level and environmental interventions to be met. Based on the findings of this study, a future trial would require substantial resource for participant recruitment and retention, an established environment supportive of the aims of the financial incentives, and an existing pool of participants. Any future trial should consider collecting data that explores leisure physical activity as a secondary outcome, and consider whether assessing change in travel mode is an appropriate primary outcome. In addition the equity effects of such an intervention on participant subgroups should be considered. The identification of context-dependent mechanisms requires further research to understand pre-requisite contextual factors that influence effectiveness.

Author statement

KG, LF, SC, JA and JP designed the study and prepared study materials, KG conducted data collection, KG and LF conducted quantitative analysis, KG conducted qualitative analysis. KG and JP drafted paper and all authors contributed to editing.

Ethics approval

Ethics approval was provided by University of Cambridge Humanities and Social Sciences Research Ethics Committee [HVS/2019/2778]

Funding sources

This study is funded by the National Institute for Health Research (NIHR) School for Public Health Research (Grant Reference Number:SPHR-PROG-WSBT-CS2). The NIHR School for Public Health Research is a partnership between the Universities of Sheffield;
Bristol; Cambridge; Imperial; and University College London; the London School for Hygiene and Tropical Medicine (LSHTM); LiLaC—a collaboration between the Universities of Liverpool and Lancaster; and Fuse—The Centre for Translational Research in Public Health, a collaboration between Newcastle, Durham, Northumbria, Sunderland and Teesside Universities. KG, LF, JA and JP are supported by the Medical Research Council (MRC; Unit Programme number MC_UU_12015/6 & MC_UU_00006/7). LF was funded by the National Institute for Health Research (NIHR) (16/137/64) using UK aid from the UK Government to support global health research. The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care.

Data access statement

The data cannot be made openly available because of ethical and legal considerations. Non-identifiable data can be made available to bona-fide researchers on submission of a reasonable request to datasharing@mrc-epid.cam.ac.uk. The principles and processes for accessing and sharing data are outlined in the MRC Epidemiology Unit Data Access and Data sharing Policy.

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Acknowledgements:

The authors would like to thank policy partners for contributing to the development of the study, recruitment strategies and participant materials. Specifically we would like to thank Clare Gibbons, Jon London and Mihaela Stan (South Cambridgeshire District Council), and Christine Sprowell (Living Sport). In addition to contributing to the above, we would like to thank Prajina Baisyet (SmartJourneys) for identifying eligible households and delivering the financial incentives. The authors would like to thank Stephen Sharp for generating the randomisation lists, the MRC Epidemiology Unit Data Management Team for developing the online surveys and study database and the MRC Epidemiology Unit Field Team for conducting door knocking to assist with recruitment.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jth.2023.101673.

References
