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Changes in commuting behaviours in response to the COVID-19 pandemic in the UK

Deirdre M. Harrington^{a,b,*}, Michelle Hadjiconstantinou^b

^a Psychological Sciences and Health, University of Strathclyde, Glasgow, UK

^b Diabetes Research Centre, University of Leicester, Leicester, UK

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ABSTRACT

Background: The UK Government restrictions on non-essential work in response to the coronavirus disease 2019 (COVID-19) pandemic forced millions of working aged-adults into an unplanned lifestyle change. We present data on changes in commuting behaviour in response to COVID-19 and describe the facilitators and barriers to switching commuting behaviours, with a specific focus on cycling and walking.

Methods: An online survey queried individuals' transport mode to/from work before and when becoming aware of COVID-19, when restrictions were in place and the transport mode they may use once restrictions are lifted. Free-form text responses were collected on why they may switch to a sustainable commute mode in the future and what would help/allow them to achieve this. Quantitative and qualitative data on those who commuted by car (single occupant) and public transport (bus/rail/park & ride) were analysed and presented separately.

Results: Overall, 725 car and public transport commuters responded; 72.4% were car commuters and 27.6% were public transport commuters before COVID-19. *Of the car commuters, 81.9% may continue travelling by car once restrictions are lifted while 3.6% and 6.5% might change to walking and cycling, respectively. Of the public transport commuters, 49.0% might switch modes.* From the free-form text responses three themes were identified: (a) perceived behavioural control towards cycling and walking (infrastructure and safety of roads, distance, weather) (b) key motivators to encourage a switch to cycling and walking (provision to support cycling, personal and environmental benefits); (c) the demands of current lifestyle (job requirements, family and lifestyle commitments).

Conclusion: These UK data show how the COVID-19 pandemic has been an "external shock" causing some individuals to reassess their commuting mode. This provides an opportunity for theory-based behaviour change interventions tackling motivations, barriers and beliefs towards changing commute mode.

1. Introduction

The UK government has an ambition for cleaner air in neighbourhoods, streets and roads (Department for Environment Food and Rural Affairs and [Department for Transport, 2017](#)) achieved through reductions in industry, home, farm and transport emissions ([Department for Environment Food and Rural Affairs, 2019](#)). Funding for walking and cycling between 2016 and 2021 and cleaner

* Corresponding author. Leicester Diabetes Centre, Leicester General Hospital, Leicester, LE5 4PW, UK.
E-mail address: deirdre.harrington@strath.ac.uk (D.M. Harrington).

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transport vehicles were at the heart of the sustainable transport investments (Department for Transport, 2017). An unplanned disruption in transport began when, on March 23rd 2020, the UK Government launched their official response to the coronavirus disease 2019 (COVID-19) pandemic (UK Government, 2020). Restrictions on non-essential work meant that millions of working-aged adults were forced into an unplanned lifestyle change. Travel to and from work and to public transport hubs dropped significantly in the first two months (Google, 2020) with evidence to suggest that some of these trends will persist in favour of walking/cycling once travel restrictions are lifted (Transport Focus, 2020). The behaviours and views of car commuters are of particular interest during the pandemic as they are the commuter group targeted in sustainable travel interventions (Hiblin et al., 2016). Public transport users may have personal safety concerns around the wearing of face coverings (Transport Focus, 2020) and getting ill (Sustrans, 2020b) and may move away from this sustainable mode (De Vos, 2020; What Works Centre for Local Economic Growth, 2020). However, contemporary data are needed showing these changes while also exploring commuters' attitudes to, and plans for, any changes in their commuting behaviour.

Behaviour is influenced by factors at a number of different levels. Individual factors (e.g. knowledge, skills, attitudes), the micro- and macro-physical environments (e.g. opportunities or infrastructure available to accommodate a new behaviour) and the social environment (e.g. how a new behaviour perceived by the media or by peers) (Michie et al., 2011) all interact to result in a behaviour change. Understanding the factors associated with commuters who have, or may, change commuting behaviour will be important in planning responses to future pandemics. It will also provide a unique opportunity to inform targeted transport and public health behaviour change messaging and interventions to support those who may plan to change commuting mode in response to the conditions brought about by COVID-19 itself and the associated lockdowns and restrictions.

The first aim of this analysis was to present actual changes as well as the potential future commuting behaviour of those who were public transport and car commuters before the COVID-19 pandemic. The second aim was to describe the facilitators and barriers reported by public transport and car commuters to switching commuting behaviours.

2. Methods

An online survey that queried lifestyle behaviours during the early stages of the COVID-19 pandemic was developed by academics at the University of Leicester in April 2020. Questions were drawn from validated physical activity and lifestyle questionnaires. Questions specific to commuting behaviours were also included. These were adapted from the transport use question included in the

Table 1
Characteristics of the sample stratified by transport mode.

	Public transport (n = 200)	Car (single occupant) (n = 525)
<i>Location in the UK, %</i>		
England	98.0	92.4
Scotland	2.0	7.6
<i>Sex, %</i>		
Female	80.0	73.5
Male	20.0	26.1
Other	0	<0.1
Prefer not to say/missing	0	0.4
<i>Ethnicity, %</i>		
White British	82.0	81.1
Other white	10.5	4.8
Indian	4.0	7.2
Other Asian	1.5	3.9
Black	1.5	1.6
Other	0	0.4
Prefer not to say/missing	0.5	0.2
<i>Age group, %</i>		
18–24	3.5	2.9
25–34	21.5	13.9
35–44	25.5	29.1
45–54	26.0	29.7
55–64	18.5	21.9
65+	4.5	2.3
Missing	0.5	0.2
<i>Lockdown status, %</i>		
Staying at home, only leaving for exercise, food shopping or essential activity permitted	84.0	66.1
Staying at home, only leaving for exercise, food shopping AND work	9.5	27.4
Full isolation, not leaving my home at all	4.5	3.0
Not following the stay-at-home guidance but trying to adhere to social distancing when out	2.0	3.0
Not following the stay-at-home guidance and not adhering to social distancing when out	0	0.4
<i>COVID-19 vulnerable status, %</i>		
No	87.0	81.7
Yes	11.0	16.6
Prefer not to say/missing	2.0	1.7

local City Council Health and Wellbeing survey (Rigby and Wheeler, 2018). Participants were asked about their usual transport mode to/from work before becoming aware of the COVID-19 threat. Separately, they were asked about commute mode at three different time points. They reported on their commute mode when they first became aware of COVID-19 but before any official restrictions were put in place, the commute mode once official Government restrictions were put in place and the commute mode they might use once UK Government restrictions are lifted. The four questions had the same stem:

“We are interested in knowing whether transport modes changed once people became aware of the COVID-19 threat and once the restrictions were put in place. Thinking about your journey to and from work ...

... what was your usual main mode of travel before you were aware of COVID-19?”

...what was your main mode of travel when you became aware of COVID-19 but before official Government restrictions were in place?”

... what is your main mode of travel since the Government restrictions?”

... how might you travel after restrictions are lifted?”

For all four questions participants could choose one from 11 options: walk; cycle; bus; park and ride; rail; car (single occupant); car share (more than one person); motorcycle; taxi/taxi app; scooter; N/A or working from home; and an “other” option which included specifying any mixed modes.

Participants then had the opportunity to include free-form text responses to the following questions which were developed ad hoc for this survey:

- “If you have made any changes, why did you make them?”
- “Think about whether you would like to/plan to use a sustainable mode of transport (e.g. walk, bicycle or bus) to work in the future. Why would you do this and what would help/allow you to achieve this?”

Demographic questions on geographic location, gender, age group and ethnicity used herein were aligned to those used in the local Health and Wellbeing survey. A question on COVID-19 vulnerability status (“Do you have any on-going health conditions that put you into a COVID-19 vulnerable category?” with responses of yes/no/prefer not to say) and lockdown employment situation which included five common isolation and employment situations were also included (see Table 1 for details).

These questions were deployed as part of two online surveys (one specific to transport and one specific to workplace health) hosted on the JISC Online Surveys platform (Jisc, Bristol, UK). This UK General Data Protection Regulation (GDPR) compliant online survey tool is designed for academic research, education and public sector organisations. *Participant information and a consent statement were included in the opening page of the surveys. Ethics approval was gained from the University of Leicester College of Life Sciences Research Ethics Committee (non-NHS).* The online surveys were launched at the beginning in May 2020 and were distributed ad hoc through Twitter, Facebook, and via email to research and local stakeholder networks. No sampling frame or recruitment strategy was employed in the deployment of the survey. The responses cover the period from 2nd May to June 2, 2020.

In the analysis herein we were interested in knowing how two key commuter groups might change their commuting behaviours once COVID-19 restrictions lifted. Therefore, we partitioned out the responses from public transport commuters (bus, rail and park & ride) and single occupant car commuters. Those who responded with bus, rail or park & ride are included in the analysis herein as “group 1, public transport commuters.” Those responding with car (single occupant) are included in the analysis as “group 2, car commuters.”

Quantitative categorical data are presented as frequency and percentages (%) as reported from the online survey platform. No statistical analyses were conducted on quantitative data. The qualitative data from the free-text questions were analysed using a thematic approach in Microsoft Excel. We familiarised ourselves with the responses to get an idea of potential themes, and searched for patterns across the free-form text sections. We used manual coding with a colour-based code assigned to each theme. The patterns were reviewed and themes were generated. Responses were organised under each heading until no new themes were identified.

3. Results

The results from the full survey can be found online (Harrington and O’Connell, 2020). Overall, 1134 adults completed the overall survey. Of these, 525 participants were single occupant car users (46.3%), 12.5% cycled, 10.9% walked, 8.6% were bus users, 8.2% used a car share, 8.1% were rail users and 0.9% used park and ride before the COVID-19 pandemic. We focus on the 525 single occupant car users and 200 public transport users to help answer our research questions.

3.1. Quantitative results

Table 1 presents the characteristics of the included sample ($n = 725$) stratified by commute mode. The majority (96.5%) of the participants lived in England, were female (75.2%) and reported being of white British ethnicity (81.6%). In accordance with UK guidelines at the time of the survey, 71.0% reported that they were staying at home and only leaving home for permitted activities (i.e. they were not leaving home for non-essential work). Of our sample, 15.1% reported being in a COVID-19 vulnerable group.

Of the 725 respondents, 72.4% were car (single occupant) commuters and 27.6% were public transport commuters before COVID-19. Table 2 presents how respondents might travel to/from work at three time points during the COVID-19 pandemic (stratified by commuting mode). As a guide, 6% of public transport user switched to walking when they first became aware of the COVID-19 threat, 26.0% switched to walking once official restrictions came into force and 9.0% may commute on foot once restrictions are lifted.

Of importance to transport planning are the results in the “future intentions” columns. Of the single occupant car commuters, 81.9% may continue travelling by car once restrictions are lifted while 3.6% and 6.5% might change their commuting behaviour to walking and cycling, respectively. Of the public transport commuters, 48.0% may continue with bus, rail or park & ride. The other 52% are spread across modes with 10.0% reporting not applicable or working from home.

3.2. Qualitative results

Overall, three themes with sub-domains were identified from our analysis.

1. Perceived behavioural control towards cycling and walking;
2. Key motivators to encourage a switch to cycling and walking;
3. The demands of current lifestyle.

Respondents were categorised as public transport or car commuters, whether they are male (M) or female (F), their ethnicity group with their age group also listed.

3.2.1. Perceived behavioural control towards switching to cycling and walking

Respondents from both commuter groups (public transport and car) reported various barriers to switching to cycling and walking. These barriers were either currently experienced by the respondents, or were perceived as barriers that they would experience, if they were to choose cycling or walking over public transport or the car.

3.2.1.1. Travel distance. The commute distance was considered as a perceived barrier to switching to any type of sustainable transport. Respondents reported travel distances from six to 60 miles which was a barrier to changing transport mode. Long travel time and no direct routes are also barriers to those respondents who have considered alternatives to using the car:

“Cannot do (switching to sustainable transport) as live 6 miles from work & very limited public transport.”
(F, Indian, 45–54, car)

“This wouldn’t be feasible for me as my office is 60 miles away. So I would continue to drive or take the train if necessary.”
(M, Asian other, 25–34, car)

“I work 8 miles away and where I live we have an hourly bus service and I would need to catch a bus to the city and then another to my destination which is not reasonable as it adds an hour to my journey.”
(F, Indian, 55–64, car)

3.2.1.2. Infrastructure and safety of roads. These barriers mainly captured issues around the safety of the roads for cyclists. Individuals’ fear and perceived danger of cars was enough to deter them from commuting by bicycle:

Table 2

Self-reported commuting modes of public transport users and car commuters at three time points during the COVID-19 pandemic.

	Public transport (n = 200)			Car (single occupant) (n = 525)		
	First became aware	When restrictions were in place	Future intentions	First became aware	When restrictions were in place	Future intentions
Walk	6.0	26.0	9.0	0.5	9.0	3.6
Cycle	3.0	6.0	11.5	0.5	2.5	6.5
Bus	28.0	1.5	21.5	0	0	0.2
Park & ride	3.5	0	4.5	0	0	0.0
Rail	30.5	1.0	23.0	0	0.5	0.4
Car (single occupant)	10.0	7.0	14.5	89.0	49.5	81.9
Car share (>1 person)	2.5	3.5	3.0	0.5	0.5	0.6
Motorcycle	0.5	1.0	1.0	0	0	0.2
Taxi/taxi app	0.5	0.5	0	0	0	0
Scooter	0	0	0	0	0.5	0.2
N/A or work from home	15.5	53.5	10.0	9.5	37.5	5.5
Missing	0	0	2.0	0	0	1.0

Note: Participants reported on the mode they used when they first became aware of COVID-19, when official restriction were put in place and how they might plan to commute once restrictions are lifted in the future. Those reporting “N/A” include those using a van, wheelchair, a mixed method within each journey (i.e. car and walk, cycle and rail or walk and tram), a mixture across the week (i.e. car share and bus), or are retired. The “public transport” column includes bus, rail and park & ride. N/A in the ‘restrictions’ columns includes those who specified they were on furlough (the UK Government’s temporary lay-off scheme).

"I would love to cycle to work but am scared of cars, lorries, other fast cyclists."

(M, White British, 25–34, public transport)

"I would love to cycle to work but the route is straight through the middle of town and at 'rush' hour so is not pleasant at all."

(M, White British, 55–64, car)

Respondents also highlighted the lack of cycle lanes, and the structure of some cycle lanes, which were deemed as hazardous, disjointed, and posed a safety threat to those considering cycling:

"The biggest obstacle is the lack of proper cycle lanes - they are frequently terrifying (sic) narrow on major roads with no barrier to protect you from traffic, some roads don't have them, and they often start and then peter out."

(F, White British, 35–44, public transport)

"Wider cycle lanes that are actually segregated would be a big help. A special lane for beginner commuter cyclists could also be helpful. Less confusing road layouts!"

(F, White British, 25–34, public transport)

3.2.1.3. Weather. The weather was mentioned as a barrier to switching to cycling but was not mentioned in relation to walking. Some commuters considered cycling in good weather. The clement weather during the lockdown facilitated people in trying to cycle to their essential work:

"My work is too far too walk to and the weather will not always allow me to cycle but I plan to when the weather allows."

(F, White other, 55–64, public transport)

"I used a mixture of bike and car. However I have been on my bike more but the weather has been nicer which has helped. In the winter it was tough riding my bike to work."

(F, White British, 35–44, car)

3.2.2. Motivations for cycling and walking

Respondents from both groups (public transport commuters and car commuters) reported various motivations for switching to cycling or walking and facilitators that would help then switch.

3.2.2.1. Intrinsic motivators. During the COVID-19 restrictions, respondents were provided with the unique opportunity to increase their cycling and walking. In particular, respondents expressed that their enjoyment was seen as a key motivator to continue these activities in the future:

"I would hope that in future I will aim to walk to work more often. Especially now that I've found lovely woodland routes to walk through to work within the city limits."

(M, White British, 25–34, car)

For others, the ability and enjoyment to be able to cycle again increased their confidence levels:

"I am going to try and cycle to work at least once a week, I have really enjoyed cycling and have been put off previously but being able to cycle during this time has helped my confidence."

(F, White British, 45–54, car)

"That was always my plan to start cycling but the lockdown has made me "practice" cycling in emptier London streets and I feel more confident."

(F, Other White, 35–44; public transport)

In line with the COVID-19 lockdowns, for some, a decrease in traffic volume allowed them to reassess their approach to their commute. However, a switch to cycling in particular may be dependent on future traffic levels.

"Having empty roads has really highlighted how antisocial cars are and I will definitely cycle more."

(M, White British, 45–54, car)

"I would like to cycle more but it depends on how many cars come back onto the roads."

(F, White British, 35–44, car)

3.2.2.2. Personal and environmental benefits. Both groups of commuters recognised the personal health and financial benefits as well as those for the environment that a change towards cycling or walking would bring. These benefits are motivating people to consider a switch to cycling or walking.

"I've been considering cycling to work over getting the bus for fitness reasons as well as helping the environment."

(F, White British, 25–34, public transport)

“I would like to walk and cycle to work in future rather than relying on the bus, as it’s healthier, more enjoyable, more eco-friendly and less expensive.”

(F, White British, 35–44, public transport)

Although walking or cycling was not feasible for everyone, car commuters contemplated a mixed mode (e.g. driving plus walking) and this would have personal health benefits of getting exercise and avoiding the COVID-19-related risk of crowded public transport:

“I already plan to park a distance away to walk in. I prefer to walk, but driving some of the way allows me to do more of the exercise I want to do rather than waiting or sitting on a crowded bus.”

(Gender/ethnic group not stated, 35–44, car)

Electronic options, such as e-bikes and e-scooters, were perceived by respondents as an alternative mode that would allow them to commute sustainably more regularly. Furthermore, the infrastructure to allow the use of footpaths was also seen as a key motivator to switch to e-scooters which have environmental benefits:

“Getting an electric bike might make me more inclined to cycle all the time.”

(F, White British, 55–64, car)

“If e-scooters were allowed more freely on footpaths then that would be an option, however the government would need to provide subsidies towards this to encourage people to go greener.”

(M, Indian, 35–44, car)

3.2.2.3. Provision to support cycling. Respondents reported their preference for the provision of safe cycle storage and showering facilities at work. Appropriate cycle storage at home, at the workplace and on the streets were perceived as motivators to switch to cycling. This could be particularly important for those living in apartments where there is no safe space to store a bicycle:

“I would like to have a bike, but would have to store it in front of the house and do not think it would be safe.”

(M, White British, 45–54, public transport)

“If there were more places to safely store a bike I might get one - I live in a small flat so keeping it there isn’t really an option and bikes get stolen from the stairwell. If there were more places in the street to lock one up I might get one.”

(F, White other, 25–34, public transport)

“I’d probably look into getting a bike however I have no safe storage where I live.”

(F, White British, 25–34 public transport)

“Secure covered bike storage outside my apartment would be a great help and would avoid me having to carry my bike up and down the stairs and would keep my bike dry and stop it from rusting etc.”

(M, White British, 35–44, public transport)

The desire for “acceptable” and “adequate” showering and changing facilities as well as lockers and places to hang wet cycling kit at work was also mentioned by the car commuter group only.

“I would like to bike, however my work does not have acceptable facilities for showering etc.”

(F, White British, 20–24, car)

“There would need to be adequate shower / locker facilities to enable this. If unavailable I will use the bus but get off a stop earlier.”

(F, White British, 35–44, car)

3.2.3. The demands of current lifestyle

There was a clear sense that cars were still very much needed by many commuters to align with the demands of their lifestyle arrangements, particularly around commuting. These commitments made the switch to cycling or walking very challenging.

3.2.3.1. Job requirements. A need to commute by car was evident throughout the survey due to the nature of work roles and responsibilities. This included having a physical job, carrying equipment to work or the time of day their work was scheduled. Some respondents used their car in their job role:

“I’d like to cycle to work but have a very physical job so try to save energy for that.”

(F, White British, 45–54, car)

“It is nice to cycle to work sometimes but generally isn’t suitable due to the nature of my job and often needing to use the car for work.”

(M, White British, 35–44, car)

Respondents did express potential facilitators towards using sustainable transport instead of the car. These facilitators mainly depend around flexible working hours, and flexible workload:

“I would consider a bicycle if my starting hours were more flexible.”

(M, White British, 55–64, car)

“I would like to reorganise my workload so I can walk to work more often.”

(F, White British, 55–64, car)

3.2.3.2. *Family and lifestyle commitments.* Commuting by car meant that, for some, there was an opportunity to combine family and lifestyle commitments. These included dropping off and collecting children from school or childcare and doing the grocery shop.

“I intend to cycle at least 1 day a week when going back to the office when I am not required to collect children from school.”

(F, White British, 35–44, car)

“Buses take too long - changing in town, plus walking. Also I have to buy lots of groceries so I need the car.”

(F, White British, 45–54, car)

4. Discussion

The COVID-19 pandemic was an “external shock” forcing people into unplanned, temporary changes to their lives. It is seen as an ‘unprecedented opportunity’ for a shift towards cycling and walking in the UK (Brooks et al., 2020). Our data show how the commuting modes of both car and public transport commuters changed when they became aware of the COVID-19 threat and when restrictions came into place. Crucially for intervention planning, commuting modes may change as the country comes out of lockdowns and people return to the office. Some 20.5% of public transport commuters and 10.1% of car commuters may switch to walking or cycling once restrictions lift. The remaining 81.9% may continue to use their car. The pandemic may serve as a “tipping point” (Gladwell, 2006) whereby individuals and societies reassess their approaches to health. Our data from the UK show how the work and travel restrictions have caused some individuals to reassess their mode of transport to work. The results herein provide a snapshot of how this tipping point could affect the use of sustainable transport into the future.

A survey of 1200 adults across the globe (70% from South and South-East Asian countries) was conducted at the same time period (May 2020) as the survey reported herein that reported a shift from public transport to car and bicycle/walking during the COVID-19 pandemic (Abdullah et al., 2020). Results from a representative sample of UK transport users in June 2020 found that 65% of public transport users may switch to a car (presumably those who have access to a car) (Systra, 2020a) when restrictions are lifted. This is much higher than the 14.5% of public transport users in our sample that might switch to the car. While our results provide reasons for optimism they also emphasise the dominance of the private motor vehicle.

The modern lifestyle in the UK is very much car dependent due to distances between the home and the workplace, the convenience of combining more than one destination in one trip and the lack of viable public transport options. Although the majority of car commuters likely will not be in a position to change away from their car, they have recognised the benefits of cycling or walking to work. There is evidence that they have a desire to change and have considered how to make this happen in their own lives through identifying their own opportunity and capability. The demands and commitments in their lives are restricting their ability to adopt a new commuting behaviour. We found indications that travel distance and their lifestyles means that a switch of commute modes away from the car may not be possible for most respondents. The convenience and necessity of the car for occupational, family and lifestyle reasons has appeared in reviews (Redman et al., 2013) and in-depth interviews (Beirão and Cabral, 2007). The commute to and from the workplace serves other lifestyle purposes such as dropping children off to school or grocery shopping - so called ‘trip-chaining’ (Kitamura, 1984).

The devotion to the car is likely to continue while the safety concerns of public transport (Systra, 2020b; Transport Focus, 2020) remain. Contemporary data from Australia identified COVID-19 safety concerns on public transport with authors highlighting a “likely high aversion to public transport at least in the short term” (Beck and Hensher, 2020). These safety concerns may force those with the autonomy to switch from public transport to a car commute once a return to the workplace resumes. This could result in an increase in emissions which could threaten the achievement of UK air quality goals (i.e. reducing emissions via modal shift) (Department for Environment Food and Rural Affairs, 2019). This may be offset by reduced car journeys by those planning to work from home as our data suggests. Conversely, the desire to avoid public transport could be a motivator for those who are primed to cycle or walk to work. Our data showing that 20% of public transport commuters and 10% of car commuters may cycle or walk illustrates the potential for a change in transport behaviour, particular at peak commuting times, if these plans are translated into sustained individual behaviour change.

An evidence gap at the individual, social and micro-physical environment has been identified in how cycling is promoted and supported (Kelly et al., 2020). Our data can help researchers, organisations or local authorities when designing interventions and actions to plug that gap. Our results show indications of plans or desires to switch commute mode once Government COVID-19 restrictions are lifted which are meaningful for longer-term transport behaviour change. The themes identified surrounded the barriers and motivators reported by car and public transport commuters when thinking about switching to a commute by bike or on foot. These can be used to inform and tailor intervention functions within behaviour change programmes. COVID-19 is not the only threat to public health the UK is facing in the 21st century. Interventions responding to the needs of commuters in the pandemic recovery may also help tackle other public health crises such as mental health, obesity, and air quality. Participants in our study recognise the personal health and environmental benefits to making a switch to commuting by bike or on foot.

It is clear from the data herein that there are many contributing factors when people contemplate a switch in commuting behaviour.

Our conclusions chime with recent editorials (Brooks et al., 2020; Musselwhite, 2020) and a review (Kelly et al., 2020) highlighting the importance of psychosocial factors and looking beyond the macro-level physical infrastructure when encouraging more walking and cycling. A theory-based approach to transport behaviour change would be instrumental in identifying, understanding, influencing and acting on individuals' attitudes, beliefs, perceptions and motivations to switching commuting mode. This means that interventions beyond cycling and walking infrastructure are needed (Brooks et al., 2020). A cross-disciplinary critique of modal shift through urban redesign from 2018 illustrates how the approach of urban planners can be supplemented with additional interventions to bring about more effective behaviour change (Kollert, 2018).

One comprehensive behaviour change model which is gaining popularity is the COM-B (capability, opportunity and motivation to behaviour change) model (Michie et al., 2014). COM-B attempts to explain the influences on a given behaviour through the interaction between capability (the physical and psychological ability of an individual to carry out a behaviour), opportunity (the physical and social opportunities afforded to an individual) and motivation (the reflective beliefs and evaluations and automatic needs and responses of an individual). Our data show some participants have an intrinsic motivation for cycling. UK data have shown that life events combined with, or influencing, a change in the external physical, social or policy environment were found to be the trigger for a change in levels of cycling (both more and less) supported through increases in intrinsic motivation, facilitating provision and personal history (Chatterjee et al., 2013). Car use is a habit which is difficult to change unless a setting or condition is changed (e.g. change job, move house) (Daramy-Williams et al., 2019). We postulate that the COVID-19 global pandemic has brought about a setting and condition change for some car users. The provision of bicycle storage at individuals' homes emerged as a barrier to switching to cycling. This relates to the socio-economic position of the individual and cramped living conditions meaning that people living in inner cities have very little storage or safe communal spaces for their bicycle (Lucas et al., 2019). These individuals are likely reliant on public transport and will be unable to avoid it even with COVID-19 related concerns. Interventions need to be cognisant of this barrier or work towards intervention functions that help overcome this issue. Such interventions could include, as was suggested, secure on-street bicycle storage.

Uncovering and addressing barriers to cycling and walking to work during the COVID-19 pandemic provides a unique opportunity for an ingrained habit such as commuting mode to be disrupted. This could be mapped on a psychological theory, known as the habit discontinuity hypothesis, described by Verplanken et al. (2008). This theory suggests "context change makes behaviour-relevant information more salient and individuals more attentive and deliberate." Interventions may be more effective when delivered during, or shortly after context change (i.e. COVID-19 restrictions) as people have enhanced sensitivity to consider a behaviour change (Verplanken et al., 2008).

Verplanken et al. also state that when the *self-activation hypothesis* is looked at in tandem with the habit discontinuity hypothesis, *then* values, attitudes and beliefs are more noticed during times of context change. As a result, individuals may be more attentive to their attitudes and belief and be more deliberate in how they respond to them (Verplanken et al., 2008). The beliefs in the health, economic and environmental benefits of cycling were mentioned herein as motivators to change mode. The COVID-19-related context change may provide a window of opportunity for behaviour change to occur in individuals concerned about their health by activating their beliefs and attitudes. The emphasis of the beneficial effects of cycling and walking on mental and physical health (Flint et al., 2014; Martin et al., 2014) and mortality levels (Celis-Morales et al., 2017) alongside the emerging link between COVID-19 and obesity-driven conditions (Docherty et al., 2020) could be a particularly salient message.

A number of implication and areas for future research have emerged from our findings. Our findings highlight the various factors at the individual, environmental and the physical infrastructure level that may influence whether commuting behaviour reverts back to pre-pandemic levels. It is important that researchers, policy makers and local authorities consider these multi-level factors that influence behaviour change. Intrinsic motivation plays a significant role in behaviour change. However, initiatives should also provide the opportunity and resources for people of all socio-economic backgrounds and capabilities to ensure that people feel safe and able to change behaviour. The reduction in nationwide traffic (Department for Transport, 2020) due to COVID-19 restrictions and the time saved on commuting (Finder.com, 2020) has given people an unexpected opportunity to reassess their attitudes and beliefs to other commuting modes. A combination of these opportunities and motivators could lead to the intention to change modes of commuting, and more so, could lead to a wider social change shaping the direction of future commuting behaviours post pandemic period. The responses from those who might change behaviour and from those who do not, can inform transport behaviour change interventions. All scenarios provide unique opportunities for targeted behaviour change messaging and multi-disciplinary intervention by transportation, planning and public health teams within local authorities and national government. Local and national interventions (or sets of connected interventions) supported by necessary policy actions would be designed to ensure longer-term behaviour change.

4.1. Limitations

Our work is limited by a number of factors. Distance from home to the workplace has been highlighted as a main correlate of active commute mode (Falconer et al., 2017). Therefore, knowledge of respondents commute distance would have allowed us to ascertain who is within a potentially cycleable or walkable distance to work and who is constrained by distance from the workplace. The small and non-representative sample should be kept in mind when interpreting the findings. The survey was also not distributed to allow it to be demographically representative of the UK population. The largest proportion of respondents came from England due to the networks the survey was distributed through (in particular via Twitter tweets and retweets). The wording of the question "how might you travel?" meant responses likely included participants intentions, plans and preferences to change commuting mode. We cannot definitively say that respondents who replied that they might travel by bike or walk will indeed make that change in commuting mode. We included free-form text sections to allow respondents to give more details of their intentions, plans and preference. However, it is

possible that respondents who were more inclined to be thinking of a change in mode were more motivated to complete the survey and add more details in the free-form text responses. Finally, participants responded in May 2020 meaning they had lived through at least five weeks of the first UK lockdown. We may have received different responses as the restrictions continued into 2020.

5. Conclusion

Since March 2020, public transport and car commuters in the UK have faced changes to their lives that may persist once restrictions are lifted. The COVID-19 pandemic is allowing people re-focus their lifestyle but the themes that emerged from our analysis show that a myriad of barriers and motivators exist in car and public transport commuters who are thinking about switching to an active commute mode. Some 20.5% of those who commuted by public transport and 10.1% of those who commuted by car pre-pandemic may switch to walking or cycling once restrictions lift. However, the predisposition towards the car still remains. COVID-19 will exist in tandem with other public health crises such as mental health, obesity, and poor air quality. There is a unique and time-limited to put active and sustainable commuting modes at the forefront of this refocus.

Author statement

Harrington – conceptualisation, methodology, formal analysis, writing – original draft, project administration. Hadjiconstantinou – methodology, formal analysis, writing – review and editing. The Authors did not receive any specific funding for this work.

CRedit author statement

Deirdre Harrington: Conceptualisation, methodology, formal analysis, writing - original draft preparation. Michelle Hadjiconstantinou: Methodology, writing – review and editing.

Declaration of competing interest

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References

- Abdullah, M., Dias, C., Muley, D., Shahin, M., 2020. Exploring the impacts of COVID-19 on travel behavior and mode preferences. *Transport. Res. Interdiscip. Perspect.* 8, 100255.
- Beck, M.J., Hensher, D.A., 2020. Insights into the impact of Covid-19 on household travel, working, activities and shopping in Australia—the early days under restrictions. *Transport Pol.* 96, 76–93.
- Beirão, G., Cabral, J.S., 2007. Understanding attitudes towards public transport and private car: a qualitative study. *Transport Pol.* 14, 478–489.
- Brooks, J.H.M., Tingay, R., Varney, J., 2020. Social distancing and COVID-19: an unprecedented active transport public health opportunity. *Br. J. Sports Med. bjsports-2020-102856*.
- Celis-Morales, C.A., Lyall, D.M., Welsh, P., Anderson, J., Steell, L., Guo, Y., et al., 2017. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. *Br. Med. J.* 357, j1456.
- Chatterjee, K., Sherwin, H., Jain, J., 2013. Triggers for changes in cycling: the role of life events and modifications to the external environment. *J. Transport Geogr.* 30, 183–193.
- Daramy-Williams, E., Anable, J., Grant-Muller, S., 2019. Car use: intentional, habitual, or both? Insights from Anscombe and the mobility biography literature. *Sustainability* 11, 7122.
- De Vos, J., 2020. The Effect of COVID-19 and Subsequent Social Distancing on Travel Behavior. *Transportation Research Interdisciplinary Perspectives*, p. 100121, 5.
- Department for Environment Food and Rural Affairs, 2019. Clean Air Strategy 2019 [Internet]. Available from: cited July 14 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf.
- Department for Transport Department for Environment Food and Rural Affairs, 2017a. UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations [Internet]. Available from: [cited March 01 2021]. <https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017>.
- Department for Transport, 2017b. Cycling and walking investment strategy [Internet]. Available from: <https://www.gov.uk/government/publications/cycling-and-walking-investment-strategy>. cited March 1 2021.
- Department for Transport, 2020. Transport Use during the Coronavirus (COVID-19) Pandemic [Internet]. Available from: <https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic>. (Accessed 14 July 2020).
- Docherty, A.B., Harrison, E.M., Green, C.A., Hardwick, H.E., Pius, R., Norman, L., et al., 2020. Features of 16,749 Hospitalised UK Patients with COVID-19 Using the ISARIC WHO Clinical Characterisation Protocol. medRxiv.
- Falconer, C.L., Cooper, A.R., Flint, E., 2017. Patterns and correlates of active commuting in adults with type 2 diabetes: cross-sectional evidence from UK Biobank. *BMJ open* 7 (10), e017132.
- [Internet]. Available from: Finder.com, 2020. Working from Home Statistics, cited July 14 2020. <https://www.finder.com/uk/working-from-home-statistics>.

- Flint, E., Cummins, S., Sacker, A., 2014. Associations between active commuting, body fat, and body mass index: population based, cross sectional study in the United Kingdom. *Br. Med. J.* 349, g4887.
- Gladwell, M., 2006. *The Tipping Point: How Little Things Can Make a Big Difference*. Little, Brown.
- Google, 2020. COVID-19 Community Mobility Report United Kingdom [Internet]. Available from: cited July 14 2020. https://www.gstatic.com/covid19/mobility/2020-05-25_GB_Mobility_Report_en.pdf.
- Harrington, D., O'Connell, S., 2020. Work-related Transport Mode and the COVID-19 Pandemic in the UK [Internet]. Available from: [cited March 1 2021]. <https://www.leicesterchangingdiabetes.com/news-blog/2020/8/3/travel-behaviours-during-covid-19-survey-results-are-in>.
- Hiblin, B., Taylor, I., Sloman, L., 2016. What Works? Learning from the Local Sustainable Transport Fund 2011-2015 Report to the Department for Transport [Internet]. Available from: cited July 15 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584463/lstf-what-works-report.pdf.
- Kelly, P., Williamson, C., Baker, G., Davis, A., Broadfield, S., Coles, A., et al., 2020. Beyond cycle lanes and large-scale infrastructure: a scoping review of initiatives that groups and organisations can implement to promote cycling for the Cycle Nation Project. *Br. J. Sports Med.* 54, 1405–1415.
- Kitamura, R., 1984. Incorporating trip chaining into analysis of destination choice. *Transp. Res. Part B Methodol.* 18 (1), 67–81.
- Kollert, C., 2018. Changing cycling behaviour: synthesis of a theoretical framework and a cross-disciplinary critique of urban design'. GAIA – ecological Perspectives for Science and Society. Available from: https://www.researchgate.net/publication/331558103_Changing_Cycling_Behaviour_Synthesis_of_a_theoretical_framework_and_a_cross-disciplinary_critique_of_urban_design_Revised_Edition_Shortlisted_for_the_GAIA_Master_Student_Paper_Award_2018.
- Lucas, K., Stokes, G., Bastiaansen, J., Burkinshaw, J., 2019. Inequalities in Mobility and Access in the UK Transport System [Internet]. Available from: cited July 14 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784685/future_of_mobility_access.pdf.
- Martin, A., Goryakin, Y., Suhrcke, M., 2014. Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. *Prev. Med.* 69, 296–303.
- Michie, S., Van Stralen, M.M., West, R., 2011. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement. Sci.* 6, 1–12.
- Michie, S., Atkins, L., West, R., 2014. *The Behaviour Change Wheel-A Guide to Designing Interventions*. Silverback Publishing, Great Britain.
- Musselwhite, C.B., 2020. JTH editorial v17–The importance of psychosocial factors in transport and health. *Journal of Transport & Health*.
- PM address to the nation on coronavirus: 23 March 2020 [press release]. 2020.
- Redman, L., Friman, M., Gärling, T., Hartig, T., 2013. Quality attributes of public transport that attract car users: a research review. *Transport Pol.* 25, 119–127.
- Rigby, C., Wheeler, J., 2018. Leicester health and wellbeing survey 2018 [Internet]. Available from: [cited March 1 2021]. <https://www.leicester.gov.uk/media/185575/leicester-health-and-wellbeing-survey-2018.pdf>.
- Systra, 2020a. Passenger confidence in public transport post-Covid continues to decline, with journeys expected to be replaced by the car [Internet]. Available from: [cited March 1 2021]. <https://www.systra.co.uk/en/newsroom-37/latest-news/article/passenger-confidence-in-public-transport-post-covid-continues-to-decline-with>.
- Systra, 2020b. Public Transport Passengers Say They Could Make Fewer Trips after Pandemic [Internet]. Available from: [cited March 1 2021]. <https://www.systra.co.uk/en/newsroom-37/latest-news/article/public-transport-passengers-say-they-could-make-fewer-trips-after-pandemic>.
- Transport Focus, 2020. Travel during COVID-19 Tracking Research (Week 10). Internet]. Available from: <https://www.transportfocus.org.uk/research-publications/publications/travel-during-covid-19-survey-week-10/>. cited July 15 2020.
- Verplanken, B., Walker, I., Davis, A., Jurasek, M., 2008. Context change and travel mode choice: combining the habit discontinuity and self-activation hypotheses. *J. Environ. Psychol.* 28, 121–127.
- What Works Centre for Local Economic Growth, 2020. COVID–19: Public Transport Disruptions and Behaviour Change [Internet]. Available from: [cited March 1 2021]. https://whatworksgrowth.org/public/files/COVID-19_Public_transport_disruptions_and_behaviour_change.pdf.