Public Health Research Programme – Rapid Funding Scheme

Project title	Low Traffic Neighbourhoods in London: baseline for a controlled before-and-after study
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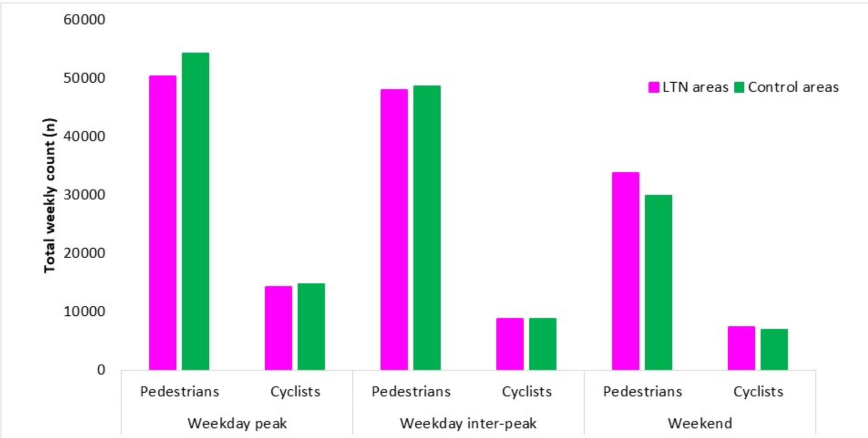
Background	Low Traffic Neighbourhoods or LTNs are transport interventions that remove or substantially reduce through motor traffic from residential streets. This aims to make active travel safer and more attractive (the ‘carrot’), while making driving less convenient, especially short trips (the ‘stick’). LTNs may improve health through increasing active travel and hence physical activity; through reducing car use and hence reducing sedentary behaviour, road injury risks, air pollution and greenhouse gas emissions; and other pathways, such as an increase in children’s play. In the UK this approach has been termed ‘filtered permeability’, i.e., neighbourhoods that are permeable to walking and cycling, but which ‘filter out’ through motor traffic. The approach has formed part of standard post-war town planning in the Netherlands and China. In some smaller European cities, such measures have been retrofitted city-wide, as in Groningen in 1977 and Ghent in 2017. UK cities attempting to retrofit filtered permeability are instead thus far choosing to implement it on a neighbourhood-by-neighbourhood basis, as is Barcelona (‘Superblocks’) and Berlin (‘Kiezblocks’). **Design**: LTNs block through motor traffic using ‘modal filters’, which may be physical barriers (e.g., planters) or camera-enforced no entry points (e.g., to facilitate bus routes). All destinations can be reached by car but driving through the area from one main road to another is harder or impossible. **Providers**: Transport authorities.

	Scalability: Highly scalable, e.g., 91% of Londoners live on primarily residential roads, most likely to be suitable for LTNs. Possible to deliver at pace, e.g., 4% of London's population lives in an LTN implemented in March-September 2020. Highly translatable, being rolled out in and beyond the UK. **Cost**: Cheap (London built 72 LTNs for <£5million in 2020), and so potentially high value for money. **Key potential harms**: First, the displacement of some motor traffic to boundary roads, which may increase congestion, air pollution and injury risk on those roads. Second, impacts on people who are dependent on cars or taxis to access destinations (e.g., some disabled people). Our research will directly examine both these key potential harms.
Plain English Summary	In recent years, levels of motor traffic started increasing again after a period of decline. This is worrying for many reasons. Every year in the UK two thousand people die in road crashes, and tens of thousands are seriously injured. Tens of thousands die early each year because of air pollution or noise pollution, much of it from motor vehicles. If people walk or cycle more, and drive less, they are also much more likely to get the exercise they need to stay healthy. The way we travel is not just a matter of personal choice. Our streets are often busy with cars, even smaller side streets. Streets are difficult to cross on foot, particularly for older people. They are scary to cycle on, particularly for children. This can mean that the easiest and most comfortable way to travel is by car. The pandemic has often made walking even more difficult, especially for vulnerable groups, as it is hard to socially distance on narrow sidewalks. For these reasons, local authorities have been implementing schemes that restrict motor traffic and make more space for walking or cycling. 'Low Traffic Neighbourhoods' are a type of traffic scheme that stop people in motor vehicles cutting through residential streets. This approach is widely used in the Netherlands but less common here. The aim is to make walking and cycling safer and more comfortable (as there are fewer cars), and make driving less convenient, encouraging people to walk or cycle instead. Because around 90% of people live on residential streets, if these schemes work, they could become widely used. Low Traffic Neighbourhoods built in London between March-September 2020 covered areas where 4% of Londoners live. However, these schemes are controversial and many people object, although there is also strong support. It is important to know whether the goals – to get more people walking and cycling and reduce driving – are being met. And we need to know about any negative impacts on roads at the boundaries of these schemes, where there might be increases in motor traffic. But measuring these effects is difficult because travel patterns keep changing during the pandemic, so we need a scientific study. Our project has collected baseline data to compare how volumes of walking, cycling, and driving change after new Low Traffic Neighbourhoods are built in 6 London boroughs. It allows us to examine impacts both inside and on boundary roads. We have collected data using Vivacity sensors, which are mounted on lampposts and film the street, automatically counting the number of pedestrians, cyclists and motor vehicles that pass. This is anonymous, 24/7 data, so we can look at shorter-term disruption and

	longer-term effects. We can also look at changes in speeds and where people walk or cycle (sidewalk or road). We have fitted these sensors both in areas due to become Low Traffic Neighbourhoods and in similar, nearby areas that are not getting a Low Traffic Neighbourhood (control sites). This will mean that, for example, we can separate out increases in walking due to Low Traffic Neighbourhoods from increases in walking because lockdown was lifted, or because of a sunnier than usual Spring. This will allow us reliably to measure the effects of Low Traffic Neighbourhoods on how people travel, and any negative effects on scheme boundary roads. We have used Google API to collect baseline data on congestion on boundary roads at Low Traffic Neighbourhood and control sites, and video cameras to gather data on some aspects of pedestrian and cyclist diversity.
Scientific Summary	RESEARCH QUESTIONS: Do new Low Traffic Neighbourhoods (LTNs) lead to more, and more diverse, walking and cycling (active travel), compared to control areas? Does traffic displacement of motor vehicles lead to unintended consequences on boundary roads? BACKGROUND: LTNs are transport interventions that remove or substantially reduce through motor traffic in residential streets. They involve street furniture such as planters, bollards, and gates; or camera-enforced closures. From a low baseline, LTNs were implemented at scale in 2020, as part of the UK's Covid-19 response. This was particularly the case in London, where 4% of the population (300,000 people) live in an LTN built March to September 2020. However, monitoring of LTN impacts has been patchy, often lacking 'before' data and typically lacking control sites – a key limitation given dramatic ongoing changes in travel behaviour. AIM: To collect baseline data for 6 new London LTNs being introduced from Autumn 2021. This will allow future analysis of how active travel and motor vehicle volumes change inside the LTNs and on boundary roads. OBJECTIVES: 1. To recruit 6 London local authorities that are planning 2021 LTNs. 2. To define 12 intervention and 12 matched control sites. 3. To collect 4 months baseline data for intervention and control sites. 4. To apply for follow-on funding for a full evaluation. BASELINE METHODS: We identified and recruited six local authorities in London that were planning LTNs in 2021. We decided to include seven rather than six LTNs as one local authority was willing to fund additional sensors in their borough, and this gave us an additional South London site and helps mitigate against any problems with another site. We successfully installed 28 sensors across these six boroughs: representing 14 sensors across the LTNs (two in each) and 14 sensors across seven matched control sites (two in each). Control and intervention sites and sensor locations were matched on factors such as demographics, baseline travel patterns, street and street network characteristics, and important destinations (e.g., presence of a school). We successfully gathered baseline data from all 28 sensors from June 2021, apart from two sites (=8 sensors) where baseline data was successfully collected from September 2021. We successfully

	collected Google API data representing congestion on boundary roads and time taken for short car trips, at baseline at our intervention and control sites. In addition, we successfully collected video data and coded for cyclist and pedestrian diversity (e.g., number and % of cyclists who appeared to be male or female; number and % of child and adult pedestrians). We calibrated and validated metrics as needed (e.g., we determined that coders could not accurately distinguish people aged over or under 65, but that our other metrics had sufficient agreement). Our quantitatively measured outcome measures relate to active travel volumes, motor traffic volumes, active travel diversity, congestion, and car journey times. Change in active travel uptake is of key interest, particularly walking, which is rarely measured in scheme monitoring and for which no routine street level datasets exist. We plan in the follow-up study (if funded) to use measured change in active travel uptake to help estimate health impacts of these schemes. FULL EVALUATION: As planned, we have applied for follow-on funding for: (a) follow-up data collection, which would take the total data collection period up to 3 years (36 months), covering intervention implementation and a substantial follow-up period; (b) complementary qualitative research; (c) secondary analysis of routine datasets to explore other health-related impacts (e.g., road traffic injury); and (d) modelling health and health economic impacts.
Methods	This is a controlled before-and-after study of health and health related impacts of LTNs introduced in six different London boroughs. In partnership with six local authorities, we have used this NIHR Rapid Funding grant to carry out baseline data collection. Local authorities find it challenging to plan and implement schemes and initial lists of planned schemes do not always materialise. We therefore did not randomly sample proposed LTNs but purposively selected schemes that local officers were confident will happen during Autumn 2021-Spring 2022. We initially contacted all London boroughs where websites or funding awards suggested schemes might be planned. Of these, 10 boroughs were shortlisted based on the borough's past performance, current resources, and personal communication from borough officers and/or local politicians who responded to our contact. This reduced to 6 as some boroughs cancelled or delayed schemes. The chosen schemes are in Camden, Hackney, Haringey, Islington, Lambeth, and Newham. In Lambeth we are monitoring 2 schemes, with the borough funding the collection of sensor data collection for the second scheme (hence there are now 7 LTNs in this study as opposed to the 6 we planned in our original application). For each scheme, we identified a suitable control area in the same borough based on a range of criteria. These were: size and demographic similarity, suitability for an LTN intervention in principle (but without one planned), not adjacent to the study scheme, and likely to contain sites with roughly similar travel patterns to sites selected from the study area. Where possible, we matched by trip generating destinations including schools, parks, and local high streets, i.e. seeking a control site with similar destination types. In demographic terms, we found high similarity between intervention and control sites, with similar profiles for all characteristics. This enhances the internal validity of the comparisons we will make. A weakness is that, compared to London as a whole, these areas are less car-dependent and more deprived. In our study areas walking

	to work levels are similar to the London average, but people are more likely to commute by bicycle or public transport and less likely to commute by car. In terms of car ownership and commute mode the selected study areas are representative of Inner London (3.2 million people) but differ somewhat from Outer London. This limitation reflects the fact that only 2 of our 6 boroughs are in Outer London (Newham and Haringey). Hence findings from our 7 LTN study sites may be most generalisable to denser metropolitan areas of England. Within each LTN and control area, we identified road segments that were travel desire lines. We chose to focus on travel desire lines (rather than e.g. already quiet cul-de-sacs) because we wanted to study streets where a) motor traffic should decrease considerably if/when an LTN was introduced and b) any subsequent area-wide increase in walking and cycling would likely be captured. We then purposively identified two observation points in each area that a) were >200m crow-fly distance from each other, b) covered different desire lines (e.g. North-South and East-West, or two different East-West lines), to minimise double counting, and c) were on lampposts suitable for installing sensors. Advice from local stakeholders on choosing segments in control areas helped us identify segments that they felt had comparable walking, cycling, and motor traffic flows to segments in the intervention area (generally there was no existing data on such flows for these streets, so this had to be based on their local knowledge). Where intervention sites had key destinations likely to affect traffic flows (e.g. a park) we either matched a nearby segment to a similar location in a control area or, if this was not possible, chose a segment away from that destination. We mapped boundary roads for each LTN and control area, defining these as the closest surrounding road links that might experience traffic displacement from the LTN.
Results	*1. Vivacity sensor data on active travel volumes and mode share* To measure active travel, we installed a Vivacity sensor on each observation point inside LTNs and control areas. These sensors film the streets and use artificial intelligence to classify street users into detailed modes (e.g. pedestrian, bicycle, car, van etc). Footage is classified in the sensor and deleted after classification. These sensors record 24/7, providing rich data. In Figure 1, the total counts of pedestrians and cyclists in the week of 28 June are compared between LTN and control areas. These show a good match, with only a 0.6% difference between the LTN and control sites in the total weekly number of pedestrians, and a 0.9% difference in the total weekly number of cyclists. LTN and control areas also had broadly similar modal share profiles (e.g. 47% active travel in LTNs and 44% in control areas).  *Figure 1: Comparison of weekly flows at observation sites in LTN and control areas, for the week 28/06/2021*

	2. Active travel diversity and independent mobility We have collected baseline data on apparent age group, gender and whether a child is accompanied by an adult for pedestrians and cyclists on an annual basis. We did this using pixelated footage from video cameras located on the same lampposts as the Vivacity sensors, which were then manually coded by a human. As part of our baseline data collection, in June 2021 we recorded four days-worth of footage (7am Weds to 7pm Sat) at the 20 observation sites in the 5 LTN-control pairs with sensor data from continuous June 2020. We have collected comparable data in September 2021 for the remaining 2 LTNs. The four observation points in each LTNs-control pair were filmed simultaneously. We have developed a classification protocol with a specialist subcontractor, to code age group (1-10, 11-16, 17+), gender (male, female, unknown), and independent mobility for those aged 4-16 (alone, only with other children, with an adult). We are in the process of checking and refining their coding using pilot data from Lambeth. Thus far, our work indicates high inter-rater reliability for classification from video. Two members of our study team jointly rated a random 306 observations made during pilot data collection and compared this rating to that made by the subcontractor. This generated a percent agreement of 90% for age group (Kappa 0.74, N=306), 92% for gender (Kappa 0.84, N=306), and 99% for whether a child is accompanied by an adult (Kappa 0.98, n=71). In the 58/677 comparisons where the study team and the subcontractor disagreed, we judged for 44 cases that the subcontractor's coding was plausible given ambiguous footage. This left 14 (2%) cases where we were reasonably confident of error by the subcontractor. We then additionally made comparisons between video raters and in-person raters standing at the roadside. At four pilot sites in June 2021, in-person roadside observations of pedestrians (N=825) and/or cyclists (N=698) were made on weekdays for three 2-hour periods: 08.00-10.00, 11.00-13.00, and 15.00-17.00. The roadway was simultaneously filmed by the subcontractor, who subsequently independently rated the footage. For pedestrians we found very good agreement for the three age categories 1-10/11-16/17+ years (95% agreement, Kappa 0.85) and for gender (93% agreement, Kappa 0.86). For cyclists, we found adequate agreement for age (93% agreement, Kappa 0.69) and gender (85% agreement, kappa 0.66). This included very good agreement for young child cyclists (99% agreement, Kappa 0.94, for the binary age division 1-10/11+). The only problematic characteristic was older age. We had initially hoped to include a distinction between 17-64 vs 65+ but this showed poor agreement (Kappa <0.4 for both pedestrians and cyclists). In addition, both roadside and video raters reported finding older age hard to code. We have now concluded that we will not be able to examine diversity with respect to older age using video data. *3. Congestion on boundary roads and car journey times* We are measuring two possible adverse impacts through primary quantitative data collection. First, changes in congestion on boundary roads. Increases would represent a negative outcome, with residents and users of those roads facing reduced amenity and increased pollution. Second, car journey times to a set of key local and less local destinations. Modest increases in journey time can be a pathway for positive scheme impacts, through discouraging car use. Very large increases and/or high journey time variability could be a cause of concern, however, for example through their impact on some disabled people who rely on cars to access destinations.

Congestion

We will use Google API real-time journey data to measure changes to journey time or journey time variability by car on segments of LTN and control site boundary roads. For each journey, Google estimates the duration in seconds given live traffic conditions. In combination with the distance in metres, this gives average speed along a road segment. This 'live traffic' data can only be purchased to query in real-time – i.e. it requires prospective primary collection.

Speed changes will be used as a proxy for congestion on LTN boundary roads. The measurements will be used to assess changes in congestion including providing timeframes for changes in travel behaviour stabilising. Timeframes are important because any initial acute congestion is expected to reduce as schemes 'bed in', but we lack evidence on how fast this happens and whether boundary road congestion typically ends up higher, lower, or unchanged from pre-LTN levels.

To collect this data, we have divided boundary roads (for both LTN and control sites) into segments between junctions/nodes, aiming for lengths of around 250m to 500m. Each segment is treated as a separate short journey, with a separate journey in each direction on two-way roads. In total, the LTN and control boundary roads are described by 149 of these short journeys. We then use Google API to route each of these journeys by car 30 times each week on Tuesdays (N=24 measurements across the day) and Saturdays (N=6 measurements from 10:00-15:00, this being the weekend period with the most car driving trips in London in the National Travel Survey 2017-19).

Figure 2 plots median journey time (minutes per km) across the day for the first 8 Tuesdays of data from 12 LTNs and 12 controls (data from the second Lambeth LTN not available until August). The journey time profile across the day is similar for LTN and control boundary roads, and the LTN and control were also very similar in the distribution of average speeds seen across the various road segments. Figure 5 shows that Google API is sensitive to differences in journey time by time of day. Our pilot testing has additionally showed sensitivity to differences between different road segments and to holiday periods versus term time on roads near schools.

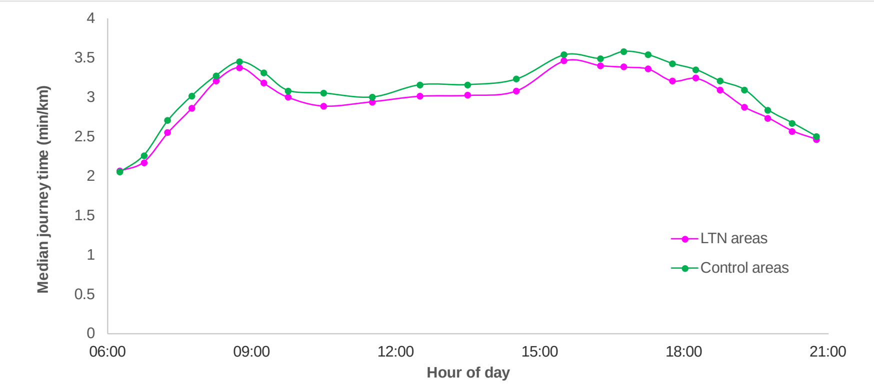


Figure 2: Median journey time (minutes per km) across boundary road segments by time of day on Tuesdays, from 08/06/2021 to 20/07/2021

Delays to car users

We are using Google API to quantify the increased journey times faced by local car drivers. To collect this data, we have taken a random selection of 10 census output area centroids inside each LTN/control area plus 10 centroids outside the areas but <500m from the boundary. For each centroid, we selected the nearest destination (by straight line distance) of the following types:

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- Very local destinations: Doctors surgeries, Primary schools, Convenience stores and independent supermarkets, Post offices.
- Additional destinations: Supermarket chains, Accident & Emergency hospitals, Shopping centres and retail parks, Vets and animal hospitals, Recycling centres, Hospices.

These destinations were identified from Ordnance Survey's Points of Interest database, except the schools which were identified from Edubase. The four very local destinations correspond to those used in the Index of Multiple Deprivation 'Geographical Barriers' sub-domain. The additional destinations were chosen as a) frequently involving somewhat longer distances and b) involving trip purposes that may be harder to shift to non-car modes. The result is 14 LTN/control areas * 20 origins * 10 destinations * 2 directions = 5600 journeys. We used Google API to route each of these journeys by car every Tuesday (at 08:30, 13:00, 17:30) and Saturday (at 13:00). For each journey, Google estimates duration in seconds given live traffic conditions.

In June 2021 our 10 destination types showed a range of median car journey times, from under 2 minutes to the nearest local food shop to over 15 minutes to the nearest recycling centre (Figure 6: NB data from the second Lambeth LTN not available until September). These medians were similar between 12 LTN and 12 control areas for the local destinations, but somewhat shorter for the control areas for the three most distant destination types. We will therefore look at relative as well as absolute changes in journey time for these more distant destinations.

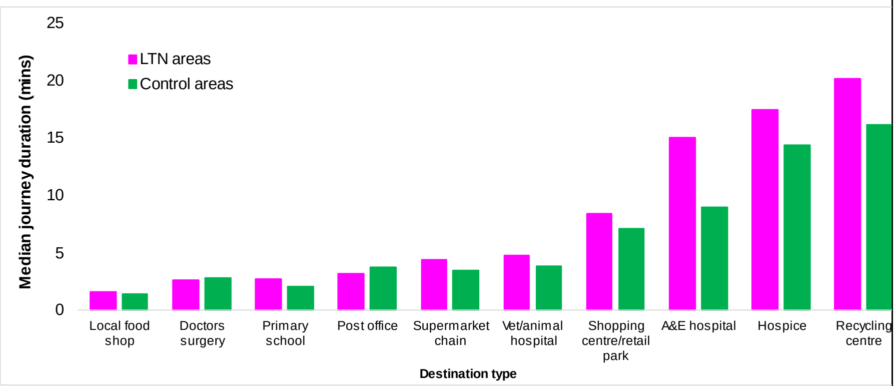

Figure 3: Median journey duration by car to different destinations, 08.30 on Tuesdays from 01/06/2021 to 20/07/2021

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<tr><td>Conclusions and Recommendations</td><td>Our baseline data collection has given us a firm basis to proceed with the study, showing for instance that we have well matched intervention and control areas, and that our methods can accurately capture measures of age and gender diversity. We have applied for follow-on funding to continue the baseline data collection work begun here, and see this as a unique opportunity to evaluate LTNs using a range of data sources and metrics.</td></tr>
<tr><td>Appendices</td><td>N/A</td></tr>
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