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### *Restrictions on mobility due to the coronavirus Covid19*

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*Published in:*

Journal of Transport & Health

*DOI:*

[10.1016/j.jth.2021.101042](https://doi.org/10.1016/j.jth.2021.101042)

*Publication date:*

2021

*Citation for published version (APA):*

Musselwhite, C., Avineri, E., & Susilo, Y. (2021). Restrictions on mobility due to the coronavirus Covid19: Threats and opportunities for transport and health. *Journal of Transport & Health*, 20, [101042].  
<https://doi.org/10.1016/j.jth.2021.101042>

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# Journal of Transport & Health

journal homepage: <http://www.elsevier.com/locate/jth>

## Restrictions on mobility due to the coronavirus Covid19: Threats and opportunities for transport and health

### 1. Introduction

Almost one year ago, in this editorial we discussed the outbreak of the SARS COV 2 virus that causes Covid19 and its relationship with transport (Musselwhite et al., 2020). We highlighted how our hypermobile society, especially international transport contributed to its spread from person to person quickly across the globe, and then how national transport networks spread it into the heart of communities. The response from the government in many countries, among other measures such as social distancing, hand washing and the wearing of masks, was to place restrictions on movement, reducing all those but essential workers (for example, healthcare, social care, police, fire, postal and delivery workers, food production and food shops) to working at home or in some places being placed on furlough (being paid for their work, but not actually working) as their work could not be carried out. The more successful countries who have so far managed to get virus numbers down and keep transmission down to very low numbers, such as Vietnam, Taiwan, Thailand, China and New Zealand, implemented a set of very strict reductions on mobility including tight controls on entry and exit from the country at the early stage of the pandemic. Gargoum and Garguom (2021) state countries that locked down early were able to keep mobility at around 40% levels throughout the pandemic, whereas those that locked down too late had to restrict mobility further.

Restrictions on movement have been in place for large parts of the last year in many countries, resulting in significant changes in mobility patterns. Reductions in mobility are needed to help bring down the rate of transmissibility of Covid19. As Noland (2021) points out, reductions in mobility between 20 and 40% bring the reproductive rate of Covid19 down below 1, especially where that mobility is in workplaces, transit and retail. According to Google data, in the UK for example, for the month of January 2021, people are travelling 71% less for retail and recreation, 31% less for supermarkets and 34% less for work (Google, 2021), compared to the equivalent time in January 2020 pre-lockdown. In the UK, use of the car is down 30% for the whole of 2020, compared to a February baseline, and was down 50% during the first lockdown (March-July 2020). Bus use is down 68% and rail passengers have fallen by 76% from March-December 2020 compared to previous year's data (DfT, 2021b). During the UK's first lockdown railways ran at 8% of the levels of the previous year, and public buses 15% (DfT, 2021b). Cycling is up 18% during the UK's first lockdown (March-July 2020) compared to previous year (DfT, 2021b). It was also noted that people who did cycle also cycled longer distances than previously (DfT, 2021a). This has reduced somewhat latterly as the country entered winter, though levels remain slightly higher than normal (DfT, 2021b). The replacement of motorised vehicles with more active modes and people working at home can be associated with positive changes to pollution levels. Similar trends of reductions are also reported in Germany (Anke et al., 2021), Sweden (Bin et al., 2021; Almlöf et al., 2021), Switzerland (Molloy et al., 2021), the Netherlands (de Haas et al., 2021), Indonesia (Irawan et al., 2021), Colombia (Arellana et al., 2020), China (Gibbs et al., 2020; Huang et al., 2021), Australia (Hensher et al., 2021), and Japan (Parady et al., 2021), among others.

On average across the UK during the first month of lockdown, the concentrations of emissions of air pollutants from transport, and in specific NO<sub>2</sub> and PM<sub>2.5</sub>, fell respectively by 38.3% (8.8 µg/m<sup>3</sup>) and 16.5% (2.2 µg/m<sup>3</sup>) (Jephcote et al., in press). Baldasano (2020) reports that NO<sub>2</sub> concentrations at measurement sites fell by 50% in Barcelona and 62% in Madrid in March in Spain's lockdown compared to previous month's data. In Brazil, Dantas et al. (2020) notes that there was a 24% reduction in PM10 and 43% reduction in NO<sub>2</sub> in Rio de Janeiro, for the first week of their lockdown in March 2020 compared to the previous month. Le Quere et al. (2020) reported that, in total, daily global CO<sub>2</sub> emissions decreased by -17% (-11 to -25% for ±1σ) by early April 2020 compared with the

<https://doi.org/10.1016/j.jth.2021.101042>

mean 2019 levels, just under half from changes in surface transport. At their peak, emissions in individual countries decreased by –26% on average.

Behavioural change work has previously noted how disruption to people's travel behaviour can result in permanent changes to that behaviour (Clarke et al., 2014). For example, moving home and changing job can alter behaviour, along with changes over the life course for example having children, children leaving home, becoming ill, retiring from work, losing a driving licence, losing a partner or spouse all change travel behaviour (Clark et al., 2016; Lanzendorf 2010). These significant life events have often been seen as naturally occurring places for interventions in travel behaviour change and a chance to lock-in new behaviours, potentially new more sustainable travel choices (Clarke et al., 2014). For example, moving home or changing job being coupled with personalised travel planning can be a trigger to change behaviour and an opportunity to encourage people not to use their car to travel to work in their new location. In addition, transport planning and travel training or bus buddying schemes can help people retiring their driving licence maintain mobility without the car (Brown, 2010; Musselwhite, 2010; Stevens, 2013). It can be suggested that government set restrictions on movement is a significant disruption to norms that have potential to lock-in more sustainable travel behaviour. However, there is some evidence that as restrictions eased there was a significant return to using the car in many countries. Perhaps norms and habits are harder to change than has been thought or perhaps governments did not do enough to help sustain travel behaviour change. Many infrastructure changes giving space to active travel and away from vehicles were temporary for example.

Here we reflect on two temporary changes to travel behaviour due to restrictions during lockdown that have positive potential to move to more sustainable and healthy mobility, namely the reduction in travelling for work, and the increase in leisure walking and cycling and reflect on the potential for their permanency. However, we also identify that there is a threat to more healthy and sustainable travel behaviour as a result of the reduction in use of public transport.

## 2. Working from home

In the UK at the start of lockdown in April 2020, 44% of people in employment did some work at home and 86% of these did so as a direct result of the coronavirus (COVID-19) pandemic (see Reuschke and Felstead, 2020 for example). Back in 2002, the US government (Office of Governmentwide Policy General Services Administration, 2002) identified three threats to its own agencies working from home, threats to cybersecurity and therefore the security of data, issues with bandwidth of dial-up communications and connectivity issues. It could be said while the latter two are now significantly improved from 2002, issues for some people remain, especially those in Low to Middle Income Countries where provision of Wi-Fi, 4G or 5G might be more patchy, but also in rural areas in High Income Countries too. The issue of security is still a problem, though again advances in technology continue to improve this.

What seems to be a more significant barrier moving forwards is more human in nature. While people have generally welcomed extra time at home, issues of working from home long-term cannot be ignored, including cost of electricity and heating, psychological issues of not being able to create a demarcation of home and work space and even the lack of a commute as a space to travel from home to work and vice versa all creating an unhealthy overloaded situation. The blurring of home and work is made worse for those who lack room; some people have much more room to be working at home than others, can afford the technology and the internet, when their employer isn't paying. People also cite that they miss social interaction, for example passing the time of day with others, "water cooler" moments with colleagues and that the narratives within the workplace and sub-text of meetings become formalised when everything is online, reducing people's ability to communicate, be creative and be productive. Continued barriers of trust of employees to actually work is also an issue for some, with employers believing employees will shirk work responsibilities. Yet this is likely to be misplaced, in a UK survey 41% of employees working at home due to the pandemic said they got as much done at home as they did at work, while 29% said that they got more done at home (Felstead and Reuschke, 2020). Those getting more done are more likely to be the people wanting to continue homeworking after lockdown, and as such this 'selection effect' is key for employers keen to bounce back strongly from the impact of Covid-19 (Felstead and Reuschke, 2020).

Evidence of the effects of working at home on physical and mental health are mixed. There is research to suggest that working at home can cause musculoskeletal issues, increase stress and exhaustion, but it can also improve wellbeing (see Oakman et al., 2020). The context to working at home is crucial in determining positive outcomes for individuals, including other demands around the home environment, the level of support from the employer and external social connections (Oakman et al., 2020).

With new ways of working come increasing inequalities that must be balanced. Obviously, those with poorer or no internet connection are unable to work at home. In addition, those in jobs which cannot be done from home are more likely to be lowly paid. It is rather ironic that many of the jobs that required essential travel during lockdown were among the lowest paid. Women are 1.8 times more likely to lose their job during Coronavirus, and in addition, they do three quarters of the unpaid tasks around the home, which some studies suggest has increased in lockdown, for example taking on the majority of homeschooling or additional tidying up that has occurred (BBC, 2020a). Those struggling to be productive working at home often cited the need to provide care for family members or homeschooling children as a key barrier to productivity (Felstead and Reuschke, 2020).

Overall, we will almost certainly see an increase in people working at home, but a total move to homeworking is probably less likely. The results of the UK survey suggest that 88% of employees who worked at home during lockdown would like to continue working at home in some capacity, with almost half (47%) of employees wanting to work at home often or all of the time, yet the majority who can work at home still favour at least some time in an office each week (Felstead and Reuschke, 2020). How this hybrid model might work and impact on transport is not necessarily clear. De Vos et al. (2018) suggested that more working at home means people can live further away from the workplace and gains from reducing a daily commute are substituted by travelling to work less often but from further away. In the UK, there has been interest in moving from cities to countryside since the start of the pandemic, as remote working becomes more attractive (Marsh, 2020). In addition, people working at home travel more often for other reasons

(Budnitz et al., 2020). Based on data in Sweden, Italy and India, Bin et al. (2021) found that the acceptance and long-term adoption of using technology alternatives supporting working at home are tied to the personality and socio-demographic group of the person, which highlights the importance of promoting alternatives as a part of longer-term behavioural and lifestyle changes.

### 3. Walking and cycling

Many countries across the world have seen increases in both walking and cycling during lockdowns. In the UK, both walking and cycling increased to double its usual numbers early on in lockdown, spurred on by good weather in Spring and Summer, and on average 38% say they have walked more, and 34% of people saying they cycle more often than before coronavirus occurred, with cycling up 18% across the year (DfT, 2021a,b). Similarly in the US, riding in cities and especially for leisure, on trails and other designated areas, has tended increased during lockdown. Bikeshare schemes have seen an increase in use. For example, Mobike in Wuhan bike hire saw a 10% increase in hire, along with an increase of 22% on length of ride during lockdown, and was a key source of transport for key medical workers in the city (Inres, 2020). CitiBike in New York saw an increase in the length of time people hired the cycle, and even though total numbers of users fell due to tourism and commuting being down, it has been found that people shifted from using the subway to hiring a bike (Teixeira and Lopes, 2020). In Berlin, London and Paris data suggests around a 15% increase in the number of electric bike and scooter trips, between February and June. Although some of this is weather related, it still shows people see shared micromobility as a way of maintaining mobility during some Covid-19 restrictions (BBC, 2020b).

It might be hypothesized that the changes in the observed amount of time allocated for individual travel by different modes of travel might be associated with the concept of “travel time budgets”: a number of studies have observed the constancy and stability of travel time at the aggregated level (Zahavi and Talvitie, 1980; Newman and Kenworthy, 1999; Schafer and Victor, 2000). Once a certain travel activity has been restricted due to lockdown, its time allocation might be traded-off with the time allocated to alternative modes of travel, less affected by Covid-19 restrictions, such as walking and cycling. Susilo and Avineri (2014) argued that the individual’s and household’s out-of-home time expenditure may perform better than “travel time budget” in drawing the constraints of individual space–time prisms. The Covid-19 restrictions on out-of-home activities introduced in many countries might be an opportunity to further explore this paradigm in explaining the changes in mobility at the time of the pandemic.

The increase in walking and cycling means more room is needed, especially in places where “social distancing” or “minimum proximity” is in place – a measure to curb airborne virus spreading between people by keeping people 1–2 m apart at all times. Across the world this has highlighted where there are issues such as narrow walkways, sidewalks or pavements and in some places a lack of accessible and usable outdoor space in general. Moves have been made to reallocate space for pedestrians, for example in support of walking, enhancing the capacity to cross the road, making pavements larger, perhaps taking away parking outside shops and changing loading bays and introducing street closures. The width of pavements is especially an issue outside areas where queuing might be taking place, such as outside shops, to navigate around the queue.

With fewer cars using roads, some places have introduced road closures, albeit often only temporarily, to aid walking and cycling. In terms of cycling, Bogotá, Colombia, has opened up its Ciclovía (cycleway), normally only held on Sundays to the rest of the week, adding an additional almost 50 miles to an existing network of around 300 miles of walking and cycling network. Philadelphia closed a 4.4 mile road to cars and gave it to cyclists and pedestrians. Temporary bike lanes were installed on many major roads in cities across Europe and in North America including Oakland, Denver, Vancouver and New York City. In Israel, the city of Tel-Aviv responded to COVID-19 by introducing several tactical urban design initiatives to encourage walking and cycling, and transform parking areas into public space. In London, funding was provided to introduce Low Traffic Neighbourhoods (LTNs), which tried to reduce all or most vehicle use creating filtered residential streets through the use of gates, bollards, planters and other street furniture to block through roads. Aldred and Goodman (2020) found lower car use and higher levels of active travel in LTNs, as is similar in wider mini-Holland style schemes (see Aldred et al., 2021). In Cardiff, Wales, UK, a boulevard outside Cardiff Castle was open to the public to allow walking and cycling, as well as giving space to bars, cafes and restaurants to open out of doors while being able to maintain social distancing measures in place. Crossing the road was changed to give priority to pedestrians without having to press the button in Perth and Kinross in Scotland and Sydney, Perth and Adelaide in Australia. In Manchester, UK, the length of time having to wait to cross the road was reduced at around 1000 crossings in order to lower the number of people congregating together.

It would be hoped such measures could become permanent. There is a worrying trend of schemes being disbanded as lockdowns are eased across the World and streets once again returning to vehicles at the expense of walking and cycling.

### 4. Public transport

During 2020, there has been a significant reduction in public use of taxis (75% reduction), trams (78% reduction), buses (79% reduction) and trains (84% reduction) in the UK (DfT, 2021a,b). Although this is in part due to changes in working practice, with more people working at home, it is also in part due to concerns over use of public transport and inability to social distance and fears over catching the virus. In Musselwhite et al. (2020) we highlighted that there is a risk of airborne viruses spreading on public transport, including surface transmission of droplets, but this is no greater than in other indoor spaces and with good ventilation, cleaning, mask wearing and allowing social distancing measures to be introduced issues with viral spreading can be reduced. Attitudes towards transport modes in the UK, suggest there is a general lack of confidence in the use of public transport during the lockdown restrictions. As many as 90% of people would be concerned for their health using the underground, 82% using a train, 78% using a bus and 72% using a taxi or minicab, compared to 9% cycling, 17% walking and 11% using a car (DfT, 2021a). These anxieties around use is set to continue. Almost two thirds of people in the UK who usually used public transport suggested it was very likely (38%) or fairly likely

(27%) that they would avoid using public transport if it is crowded when travel restrictions are relaxed (Dft, 2021a). Some cities in China have reported a shift from public transport to car of between 30 and 40% when lockdowns have been eased.

If commuting to offices and for work is reduced after lockdown ends as is hinted at, some public transport services may have to do some reorientation of their services into different markets, for example moving from providing services for commuters and workers to more leisure travel to stem loss in income. In any case, public transport providers will have to ensure public confidence in public transport is restored. There are a series of steps that could be implemented to help increase confidence among users. First, changes to services may be appropriate to allow services to run less crowded. Reducing the capacity on services while blocking off seats so people are sitting apart from one another would help. This is what has happened across the UK bus and rail network. Extra services would have to be provided if demand outstripped supply as lockdown eases. Spreading out the demand for services by working with organisations and companies to create staggered start and finish times for employees would also help. Next, reducing waiting times and crowding at interchanges is needed. Again, such issues can be reduced with increasing the frequency and reliability of public transport modes and this should become a major priority. In addition, changes to the infrastructure could happen, such as markers on platforms have been introduced in some countries across the world, keeping passengers 1–2m apart as they wait for the transport to arrive. Real-time public transport information would also help allowing people to stay away from the boarding place and from other passengers until the transport is actually due. Hand sanitisers or washing facilities at train stations or bus stops should be encouraged, as is found in many large cities, notably across the bus and metro network in Paris.

Changes to the vehicle itself include extra cleansing of the vehicle, adding screens between workers and passengers or even between passengers can help. Many UK bus companies have introduced screens between the bus driver and the passengers, while encouraging contactless or outside the vehicle payments. Where possible good air circulation is suggested as being important, for example running with windows open and turning off air conditioning if it is recirculating air. Having hand sanitiser on vehicles is also suggested, as is found in Cape Town. Enforcing mask use for users ensures passenger safety, now found in the majority of cities across the world. In addition, changes in the infrastructure and the operations may make services more attractive and reduce time passengers spend on buses, for example introducing temporary bus lanes, as has occurred in Barcelona. All of this would require careful marketing and planning. Finally, as public transport been unjustifiably stigmatised by media, authorities and citizens, there is an urgent need to correct misperceptions related to the risks associated with travel. The fear of the Coronavirus might still linger on even after COVID-19 effects have declined and government authorities will need to put effort and introduce measures in order to restore the public's trust and to encourage the use of public transport as a safe, healthy and efficient mobility.

## 5. Mental health

One of the most obvious health problems due to the pandemic is its impact on people's well-being (e.g. anxieties due to insecurity, confusion, emotional isolation, and stigma) which can lead to insomnia, self-harming, and suicidal behaviours. Pfefferbaum and North (2020) explain that particular groups of society are likely to be more vulnerable than others to the psychosocial effects of pandemics. In particular, people who contract the disease, those at heightened risk for it (including older people, people with compromised immune function, and those living or receiving care in congregate settings), and people with pre-existing medical, psychiatric, or substance use problems are at increased risk for adverse psychosocial outcomes. What is absolutely crucial is that we cannot allow mobility to be a barrier to such groups going out, to going to work and connecting with community and family and friends, as the World eases out of lockdown. People who do not have access to mobility are more likely to be isolated and lonely and some evidence suggests immobility is linked to poorer physical and mental health and even mortality. Mobility must continue post-pandemic, but there must be a hope that such mobility can consist of active travel and public transport. We must therefore reduce transport anxiety and create more space to walk and cycle, and we must instil confidence to get back to using public transport. Support for working at home needs to be forthcoming from organisations to help balance competing demands, provide comfortable and safe space to work, and allow interactions with colleagues.

## 6. Conclusion

Overall, as we move towards vaccination programmes across the world, some may suggest that we will have an opportunity to make the world a better place, to have something positive to come out of this international disaster. If our insatiable desire for hypermobility has fuelled the rapid spread of the virus, maybe we need to reconsider our mobility practice. People have adapted well to local mobility, and for some lucky people they have had been able to enjoy spending more time locally, in their community, getting to know their local place better. There has never been a better time to encourage a more sustainable and healthy transport system across the world. There is no need to go completely backwards to the unhealthy high polluting hypermobility we had in the past. Enabling appropriate working at home, coupled with more space for walking and cycling, while using policy measures and techniques to encourage people back to public transport is needed.

## References

- Aldred, R., Goodman, A., 2020. Low traffic Neighbourhoods, car use, and active travel: evidence from the people and places survey of outer London active travel interventions. SocArXiv. <https://doi.org/10.31235/osf.io/ebj89>. September 1.
- Aldred, R., Woodcot, J., Goodman, A., 2021. Major investment in active travel in Outer London: impacts on travel behaviour, physical activity, and health. *J. Transport Health* 20, 100958.
- Almlöf, Erik, Rubensson, Isak, Cebecauer, Matej, Jenelius, Erik, January 20, 2021. Who continued traveling by public transport during COVID-19? Socioeconomic factors explaining travel behaviour in stockholm 2020 based on smart card data. <https://ssrn.com/abstract=3689091>. <https://doi.org/10.2139/ssrn.3689091>.
- Anke, J., Francke, A., Schaefer, L.M., et al., 2021. Impact of SARS-CoV-2 on the mobility behaviour in Germany. *Eur. Transp. Res. Rev.* 13, 10. <https://doi.org/10.1186/s12544-021-00469-3>.
- Arellana, J., Márquez, L., Cantillo, V., 2020. COVID-19 outbreak in Colombia: an analysis of its impacts on transport systems. *J. Adv. Transport.* 2020, 16. <https://doi.org/10.1155/2020/8867316>. Article ID 8867316.
- Baldasano, J., 2020. COVID-19 lockdown effects on air quality by NO<sub>2</sub> in the cities of Barcelona and Madrid (Spain). *Sci. Total Environ.* 741, 140353.
- BBC, 2020a. Coronavirus: how the world of work may change forever. <https://www.bbc.com/worklife/article/20201023-coronavirus-how-will-the-pandemic-change-the-way-we-work> (last accessed 28<sup>th</sup> January 2021).
- BBC, 2020b. How green and profitable are e-scooters? <https://www.bbc.co.uk/news/business-55107754> (last accessed 29<sup>th</sup> January 2021).
- Bin, E., Andruetto, C., Susilo, Y., et al., 2021. The trade-off behaviours between virtual and physical activities during the first wave of the COVID-19 pandemic period. *Eur. Transp. Res. Rev.* 13, 14. <https://doi.org/10.1186/s12544-021-00473-7>.
- Brown, R., 2010. Maintaining Community Mobility in Portsmouth after Retirement from Driving: How Do People Find Out about and Gain Confidence in Using Alternative Forms of Transport? MSc Thesis in Accessibility and Inclusive Design University of Salford.
- Budnitz, H., Tranos, E., Chapman, L., 2020. Telecommuting and other trips: an English case study. *J. Transport Geogr.* ISSN: 0966-6923 85, 102713. <https://doi.org/10.1016/j.jtrangeo.2020.102713>.
- Clark, B., Chatterjee, K., Melia, S., 2016. Changes in level of household car ownership: the role of life events and spatial context. *Transportation* 43 (4), 565–599.
- Clark, B., Chatterjee, K., Melia, S., Knies, G., Laurie, H., 2014. Life events and travel behavior: exploring the interrelationship using UK household longitudinal study data. *Transport. Res. Rec.* 2413 (1), 54–64. <https://doi.org/10.3141/2413-06>.
- Dantas, G., Siciliano, B., França, B., da Silva, C.M., Arbilla, G., 2020. The impact of COVID-19 partial lockdown on the air quality of the city of Rio de Janeiro, Brazil. *Sci. Total Environ.* 729, 139085.
- De Haas, M., Faber, R., Hamersma, M., 2021. How COVID-19 and the Dutch 'intelligent lockdown' change activities, workand travel behaviour: evidence from longitudinal data in The Netherlands. *Transport. Res. Interdis. Perspect* 6, 100150. July 2020.
- De Vos, D., Meijers, E., van Ham, M., 2018. Working from home and the willingness to accept a longer commute. *Ann. Reg. Sci.* 61, 375–398.
- Department for Transport, 2021a. National Travel Attitudes Study: Wave 4 (Final) Public Attitudes on Travel and Transport during the Coronavirus (COVID-19) Pandemic. London, UK. <https://www.gov.uk/government/statistics/national-travel-attitudes-study-wave-4-final> (last accessed 28<sup>th</sup> January 2021).
- Department for Transport, 2021b. Transport Use by Mode: Great Britain, since 16 March 2020. London, UK. <https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic> (last accessed 4<sup>th</sup> March 2021).
- Felstead, A., Reuschke, D., 2020. Homeworking in the UK: before and during the 2020 Lockdown. Wales Institute of Social and Economic Research. <https://wiserd.ac.uk/publications/homeworking-uk-and-during-2020-lockdown>.
- Gargoum, S.A., Gargoum, A.S., 2021. Limiting mobility during COVID-19, when and to what level? An international comparative study using change point analysis. *J. Transport Health.* ISSN: 2214-1405 20, 101019. <https://doi.org/10.1016/j.jth.2021.101019>.
- Gibbs, H., Liu, Y., Pearson, C.A.B., et al., 2020. Changing travel patterns in China during the early stages of the COVID-19 pandemic. *Nat. Commun.* 11 <https://doi.org/10.1038/s41467-020-18783-0>, 5012 (2020).
- Google, 2021. Community Mobility Reports. <https://www.google.com/covid19/mobility/> (last accessed 28<sup>th</sup> January 2021).
- Hensher, D.A., Wei, E., Beck, M.J., Balbontin, C., 2021. The impact of COVID-19 on cost outlays for car and public transport commuting - the case of the Greater Sydney Metropolitan Area after three months of restrictions. *Transport Pol.* 101, 71–80. February 2021.
- Huang, J., Wang, H., Fan, M., Zhuo, A., Sun, Y., Li, Y., 2021. Understanding the impact of the COVID-19 pandemic on transportation-related behaviors with human mobility data KDD '20. In: Proceedings of the 26th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, pp. 3443–3450. <https://doi.org/10.1145/3394486.3412856>. August 2020.
- INRES, 2020. Wuhan bike ridership report. <https://info.inrosoft.com/blog/wuhan-bikeshare-quarantine-data-report> (last accessed 29<sup>th</sup> January 2021).
- Irawan, M.Z., Belgiawan, P.F., Joewono, T.B., Bastarianto, F.F., Rizki, M., Ilahi, A. (forthcoming) Exploring activity-travel behavior changes during the beginning of COVID-19 pandemic in Indonesia Transportation.
- Jephcote, C., Hansell, A.L., Adams, K. and Guillver, J. (in press), Changes in air quality during COVID-19 'lockdown' in the United Kingdom, *Environ. Pollut.*, <https://doi.org/10.1016/j.envpol.2020.116011>.
- Lanzendorf, M., 2010. Key events and their effect on mobility biographies: the case of childbirth. *Int. J. Sustain. Transport* 4 (5), 272–292.
- Le Quéré, C., Jackson, R.B., Jones, M.W., et al., 2020. Temporary reduction in daily global CO<sub>2</sub> emissions during the COVID-19 forced confinement. *Nat. Clim. Change* 10, 647–653. <https://doi.org/10.1038/s41558-020-0797-x>.
- Marsh, S., 2020. Escape to the Country: How Covid Is Driving an Exodus from Britain's Cities. *The Guardian*, 26<sup>th</sup> September 2020. <https://www.theguardian.com/world/2020/sep/26/escape-country-covid-exodus-britain-cities-pandemic-urban-green-space> (last accessed 4<sup>th</sup> March 2021).
- Molloya, J., Schatzmann, T., Schoemanb, B.m, Tchervenkova, C.m, Hintermannb, B., Axhausen, K.W., 2021. Observed impacts of the Covid-19 first wave on travel behaviour in Switzerland based on a large GPS panel. *Transport Pol.* 104, 43–51, 2021.
- Musselwhite, C.B.A., 2010. The role of education and training in helping older people to travel after the cessation of driving. *Int. J. Educ. Age.* 1 (2), 197–212.
- Musselwhite, C., Avineri, E., Susilo, Y., 2020. The Coronavirus Disease COVID-19 and implications for transport and health. *J. Transport Health* 16, 100853.
- Newman, P., Kenworthy, J., 1999. Costs of automobile dependence: global survey of cities. *Transport. Res. Rec.* 1670, 17–26.
- Noland, R.B., 2021. Mobility and the effective reproduction rate of COVID-19. *J. Transport Health.* ISSN: 2214-1405 20, 101016. <https://doi.org/10.1016/j.jth.2021.101016>.
- Oakman, J., Kinsman, N., Stuckey, R., et al., 2020. A rapid review of mental and physical health effects of working at home: how do we optimise health? *BMC Publ. Health* 20, 1825. <https://doi.org/10.1186/s12889-020-09875-z>.
- Office of Governmentwide Policy General Services Administration, 2002. Final report on technology barriers to home-based telework. <https://www.telework.gov/reports-studies/agency-reports/final-report-on-technology-barriers-to-home-based-telework/> (last accessed 28<sup>th</sup> January 2021).
- Parady, G., Taniguchi, A., Takamia, K., 2021. Travel behavior changes during the COVID-19 pandemic in Japan: analyzing the effects of risk perception and social influence on going-out self-restriction. *Transport. Res. Interdis. Perspect* 7 (September 2020), 100181.
- Pfefferbaum, B., North, C.S., 2020. Mental health and the covid-19 pandemic. *N. Engl. J. Med.* 383, 510–512. <https://doi.org/10.1056/NEJMp2008017>.
- Reuschke, D., Felstead, A., 2020. The Effect of the Great Lockdown on Homeworking in the United Kingdom. Wales Institute of Social & Economic Research, Data & Methods. <https://wiserd.ac.uk/publications/effect-great-lockdown-homeworking-united-kingdom>.
- Schafer, A., Victor, D.G., 2000. The future mobility of the world population. *Transport. Res.* 34, 171–205.
- Stevens, N., Battellino, H., Pedler, K., 2013. Evaluating travel training in Northern Sydney: methodological and practical issues. In: Australasian Transport Research Forum (ATRF), 36th, 2013, Brisbane, Queensland, Australia.
- Susilo, Y., Avineri, E., 2014. The impacts of household structure to the individual's stochastic travel and out-of-home activity time budget. *J. Adv. Transport.* 48 (5), 454–470.
- Teixeira, J.F., Lopes, M., 2020. The link between bike sharing and subway use during the COVID-19 pandemic: the case-study of New York's Citi Bike. *Transport. Res. Interdis. Perspect* 6, 100166.

Zahavi, Y., Talvitie, A., 1980. Regularities in travel time and money expenditures. *Transport. Res. Rec.* 750, 13–19.

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