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Transport and health on the path to a net zero carbon world

James Woodcock and colleagues argue that achieving a healthy and net zero carbon transport system requires a transition from the private car, whether electric or fossil fuelled

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Key messages

- Transport is a major source of greenhouse gas emissions and an important determinant of population health
- A rapid transition to electric vehicles is needed but will not on its own solve transport related health problems or achieve zero greenhouse gas emissions fast enough
- A holistic approach to reducing greenhouse gas emissions caused by transportation is required
- Cycling and the "15 minute city" are part of the solution but require attention to reducing housing inequalities
- There is an urgent need to imagine a future beyond the car as a privately owned, one-size-fits-all mobility solution

The dissonance between the palpable climate emergency and political inaction to meaningfully reduce carbon emissions around the world can be paralysing. Transport is a leading contributor to greenhouse gas emissions, comprising approximately 21% of total annual CO2 emissions, with emissions largely flat since 1990 in the UK.[1] Transport mode, associated infrastructures, technologies, and land use also affect health through multiple pathways.[2] Physical activity—such as walking or cycling, including from and to public transport—reduces the risk of premature all cause mortality by around 30%.[3] By contrast, road traffic injuries are the eighth leading cause of death in the world, with 1.35 million deaths and 50 million injuries a year.[4] Air pollution is an established risk factor for non-communicable disease, with nearly 400 000 deaths a year from small particulate matter (PM2.5) and ozone attributed to exhaust emissions.[5]

The rationale for changing how people travel is thus two pronged: harms to the climate of inaction on transportation will continue to accrue if we do not act, while driving less and walking and cycling more would also substantially benefit population health.[6] Focusing on the health benefits of climate action should be highly motivating. Despite this, greenhouse gas emissions from transport remain stubbornly high, with increased vehicle ownership, larger vehicles, and greater distances travelled across the world cancelling out improvements in vehicle efficiency and technology.[7] Technological fixes that do not fundamentally change power, behaviour, and culture around transportation will not achieve sufficient reductions quickly enough nor realise the potential population health gains. Instead, we argue that a more holistic approach is needed.

Transportation is an important determinant of health

Because they can be incorporated into everyday schedules, walking and cycling are the best opportunities to be physically active throughout life. Walking is the most common type of physical activity. All physical activity matters for health: the greatest population health benefits would result from increased physical activity in the least active populations, but there is no clear upper limit. More exercise is better, both in terms of volume and intensity (brisk walking or cycling).[8] Consistent findings from cohort studies of self-reported physical activity support an association between physical activity and reduction in multiple disease endpoints, including ischaemic heart disease, stroke, dementia, depression, and several cancers.[3] For example, a dose-response meta-analysis with 165 million person years evaluating different volumes of physical activity found that nearly 19% of premature deaths could have been prevented if the cohort population had achieved five hours a week of moderate to vigorous physical activity.[9 10] The association between physical activity and health outcomes is increasingly supported by evidence from objectively measured exposures.[11] A cohort study of 96 000 UK Biobank participants evaluating physical activity using a device worn on the wrist found that the risk of cardiovascular disease incidence was 49% (23-66%) lower for people expending 30 kJ/kg/d with 40% from moderate to vigorous activity compared with those expending 15 kJ/kg/d with 10% moderate to vigorous activity.[8]

By contrast, there is no known "safe" limit for exposure to air pollution, which increases the risk of premature death and disease across the cardiovascular, circulatory, endocrine, immune, reproductive, respiratory, musculoskeletal, and nervous systems.[10 12] In a pooled analysis of eight cohorts with 325 367 adults followed up for an average of 19.5 years across six European countries, a 5 $\mu g/m^3$ increase in PM2.5 was associated with a 13% increase in natural deaths (95% confidence interval 10.6% to 15.5%).[13] Associations tended to be steeper at lower concentrations and remained significantly positive at pollution levels well below current regulatory standards.

There is also a growing evidence base of the harms of transport related noise (after controlling for air pollution) on multiple aspects of human health. Often seen as just a source of annoyance, noise not only disturbs sleep and learning but also increases risks of cardiovascular disease and mortality, diabetes, hypertension, obesity, and adverse nervous system

effects.[14] For example, in a population based cohort study of nearly 2 million adults living in Denmark evaluating the relationship between residential noise (> 65dB vs <45dB) and risk of dementia found a relative risk of 1.16 (95% CI 1.11 to 1.22).[15] The burden of noise caused by transportation is substantial, with one health impact study finding it larger than that of air pollution in Warsaw.[16] Another health impact study, in Lausanne, showed that traffic speed reduction would benefit health more through noise reduction than traffic crashes.[17]

Traffic injuries result in 1.35 million deaths each year and are the leading cause of death among people aged between 5 and 29 years.[18] This is a preventable public health catastrophe; there is no acceptable level of death and disability due to road traffic injuries.[19] Pedestrians and cyclists pose the least amount of danger to others because of lower speed and mass but, along with motorcyclists, they remain the most at risk. Road death burden is the highest among low and middle income countries.[18] Among the richest countries, the United States performs badly (with more than twice as many deaths due to road traffic injuries per capita as Canada, France, Australia, and Italy, and more than three times as many as Germany, the UK, Spain, and Japan) with poor infrastructure for walking and cycling, larger vehicles, higher traffic speeds, and pervasive car dependency outside of some urban centres.[20]

Finally, traffic and its infrastructure exacerbate our warming cities through urban heat islands generated by heat absorbing concretes and asphalts and by anthropogenic heat and reducing space for green areas and vegetation, which not only directly influence mental health and physical activity, but also mitigate harmful exposures, including air pollution and noise.[21]

Electric vehicles alone are not the answer

One reason for stagnating action on transportation is that governments and corporations have focused on purported solutions that maintain business as usual and thereby reinforce car dependency rather than more fundamental changes to transportation or urban infrastructure. This is exemplified by the incentivisation of and push for electric cars to directly replace existing cars, rather than taking the opportunity to rethink accessibility. As Grant Shapps (former UK secretary of state for transport) argues in the foreword to *Decarbonising Transport: A Better, Greener Britain*, "It's not about stopping people doing things: it's about doing the same things differently. We will still fly on holiday, but in more efficient aircraft, using sustainable fuel. We will still drive on improved roads, but increasingly in zero emission cars. We will still have new development, but it won't force us into high carbon lifestyles."[22]

Previous attempts to lower greenhouse gases through narrow fixes have failed. Most notably, a policy evaluation estimated that between 1990 and 2010 Europe increased the diesel fleet by around 47 million, without implementing wider infrastructural change.[23] This did not reduce global warming after accounting for black carbon emissions, exacerbated local pollution, and slowed progress towards sustainable alternatives.[23]

Unlike the dash for diesel, electrification is a necessary part of carbonisation and will benefit population health. But electrification on its own will not solve transport's health problems or enable us to reach net zero carbon quickly enough. Electric vehicles reduce exhaust related greenhouse gas emissions, but net reductions vary according to what powers the electricity grid and is small for countries reliant on coal (such as India and Australia).[24]

Nor do electric vehicles solve problems of low density development with high greenhouse gas emissions from construction and operation.[25] Motor vehicles are already getting larger and heavier, and electric vehicles exacerbate this. The more they try to replicate fossil fuel cars in terms of range, the greater the battery weight.[24] Greater weight increases non-exhaust emissions (tyre, surface and brake wear, and resuspension of dust) and road traffic danger.[24] Life cycle assessment of electric vehicles in China found no reduction in PM2.5 or SO2 emissions. They reduce noise at lower speeds (from the engine); at higher speeds, noise (from the road surface) can be worse owing to the greater weight.[26]

Electric vehicle production is also linked to other environmental and social harms, notably in mining cobalt for batteries.[27] Finally, as an inactive mode of travel, they tend to crowd out active alternatives, potentially more than combustion engine cars, caused by the lower running costs.[28] Thus, although electric vehicles are necessary, the fewer and the smaller the better, and other complementary solutions will be required.

Cycling and walking in 15-20 minute cities are important alternatives

Cycling, including electric bicycles (e-bikes), has huge potential to reduce the dependency on automobiles for daily movement. The proportion of all trips taken by bicycle reaches around 30% in Amsterdam and Osaka.[29] No single mode of transportation will be accessible, available, and acceptable for everyone, but cycling can be highly inclusive with the right infrastructure and array of cycles. Electric-assist bikes require pedalling to achieve maximum speeds of 15-25 mph and can extend the distance people are willing to travel by bicycle (for a work commute, for example), making hilly areas more accessible to cyclists, while helping to maintain an active lifestyle.[30] E-bikes can be prohibitively expensive, and governments should subsidise and incentivise them, unlike the current regressive UK Cycle to Work scheme. The manufacture of e-bikes has a greater environmental cost than for conventional bikes but is far less resource intensive than for electric cars.

Efforts to promote and incentivise cycling need to include supporting infrastructure: pleasant, safe, and direct routes to all destinations. These routes require a combination of protected bike lanes, as recognised in the latest Department for Transport guidance,[31] and separation at the network level, such as bicycle boulevards and low traffic neighbourhoods.[32] All space reallocation policies provide a simultaneous push and pull: incentivising active travel while discouraging motor vehicle use, but the push element is greater for low traffic neighbourhoods that deliberately aim to reduce traffic volumes and speeds, compared with cycle tracks.

Many cyclists and pedestrians experience a conflict between the physical activity benefits of walking and cycling and the exposure harms of air pollution and road injuries.[33] At a population level, however, fewer cars reduce pollution and road traffic danger if speeds do not increase. The countries with the lowest per capita burden from road traffic injuries are Singapore, where car use is highly constrained and public transport dominates, Norway, and Switzerland, which both have relatively high proportions of walking and cycling. If the US had the same fatality rate as Norway it would have 35 000 fewer deaths a year (a more than 80% reduction). Reducing traffic danger and all sources of air pollution increases the benefits from walking and cycling, while benefiting everyone else too.

However, investing in cycling alone is not sufficient to tackle the climate emergency. Cycling can be combined with high rates of

intercity driving, as in the Netherlands, and if trips are replaced like-for-like, cycling can only directly replace a relatively small vehicle distance (in England around 10% with conventional bikes and 15% with e-bikes).[34]

In practice, people who walk or cycle will often choose nearer destinations, reducing total travel distance. But this would mean that workplaces, shops, and entertainment need to be available within short distance of where people live. Thus, a complementary idea to improving infrastructure for cycling and walk is the 15 or 20 minute city, in which most activities should be accessible within a 15-20 minute walk or cycle ride.[35] This idea is being supported by the C40 network of cities. These cities require medium to high population density, diversity in land use (such as intermingled housing, retail, and employment spaces), proximity of services, and well designed attractive walkable neighbourhoods.[36] There may be elements of 15-20 minute "cities" outside of cities themselves, where an accessible combination of housing and services co-exist. Still, in the context of high inequalities in wealth and income, creating attractive neighbourhoods or improving transport connectivity can have negative social implications; for example, by increasing house prices they might out-price current renters. Similarly, public transport oriented development might disproportionately benefit high income populations (who already have the most choice about working remotely), leaving lower income population tied to costly car dependent commutes from poorly serviced neighbourhoods.[37]

In the UK, the housing crisis does not result from too few houses (the housing stock per capita is higher than ever), and house building will increase greenhouse gas emissions. Hence, achieving a healthy, equitable, and net zero carbon transport system requires a holistic approach incorporating more equitable system of housing provision.

Challenging the idea of the car

Investment in cycling, alongside urban planning can provide strong complementarity with the transition to electric vehicles, reducing emissions and benefiting population health. But can we go beyond that and challenge the idea of the car? By the idea of the car, we mean the privately owned vehicle that is suitable for all trip purposes.

While cars have been getting larger, the basic design of the multipurpose, five passenger vehicle has not changed. The industry achieves economies of scale through product differentiation based on largely superficial characteristics,[38] and one consequence is that cars are not efficient at the speeds suitable for urban roads (less than 30 kmph). One place where alternatives are visible is Japan, where smaller and lighter Kei cars benefit from lower taxes if they meet criteria on power, engine size and physical dimensions.

The potential for wider innovation can be seen in the proliferation of micromobility vehicles (such as electric scooters). Currently many of these vehicles are marketed (for example, by Google Maps) as an alternative to walking, and existing rental business models risk high turnover and waste. But the right regulatory framework could support small, light, low power, speed limited electric vehicles, potentially with some incorporating personal energy expenditure during their use. These vehicles could complement a walkable neighbourhood and cyclable city, by providing for the combination of trip and person for which a motor vehicle is necessary. The low speeds and weights would mean a fraction of the harms of the conventional or electric car. Shared, more powerful electric vehicles or public transport could be used for longer journeys. Such innovation could empower cities to enact ambitious car-free policies.

Conclusions

The principles of net zero carbon and healthier transport are known to achieve sufficient population density; reduce travel distances with mixed land use and truly affordable housing; design attractive, safe, and climate resilient environments for walking and cycling; replace fossil fuel vehicles with electric smaller vehicles, and progressively restrict car ownership and use. To achieve net zero carbon transport, these actions must be rolled out rapidly and at scale, providing widespread and just benefits.

Cities should extend car-free and low emission zones, ahead of national phasing out of fossil fuel powered vehicles. Space reallocation to pedestrians and cyclists, through infrastructure and low cost, low traffic neighbourhoods,[32] provides a simultaneous push and pull: incentivising active travel while discouraging motor vehicle use. Subsidies and scrappage schemes should support moving away from private vehicle ownership and incentivise and facilitate e-bikes, season tickets, and carsharing, not just to buy a large electric vehicle.

Importantly, most housing and transport infrastructure that will be in use in 2050 has already been built, and new construction comes with considerable embedded emissions. Thus we need to develop contextual medium term visions to reduce transport emissions and mitigate harms to health. Such visions will consist of a differing mix of walking, cycling, e-bikes, public transport, new forms of mobility, and electric vehicles, without a narrow focus on any of these options on their own.

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