Summary

Exposure to air pollution related to transport mode in Norway

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Air pollution is a global health problem and road traffic is one of the largest sources in urban areas. Mode of transport will hence influence level of exposure. This literature review has focused on levels of travel exposure in Norway, by assembling international literature. It is found that the Metro likely have high concentration levels of particulate matter while busses have important levels of self-pollution. Particle concentrations inside vehicles are dependent on efficient filtering of air whereas bikers and pedestrians are experiencing large rapid variations in their exposure with high peaks due to exhaust plumes. No literature was found on studies in Norway. International results on travel related exposure were not found relevant enough to give quantitative estimates. However, knowledge about important factors for the observed pollution levels in different transport modes is useful to facilitate for reduced exposure during travel.

Importance of transport mode

Air pollution levels are too high in Norwegian cities, both compared to Norwegian limit values and the World Health Organization's guidelines. As a result municipalities need to implement several measures to improve the air quality. Some of the measures are intended to reduce traffic amount and public transport, biking and walking are promoted. But how do travel mode affect the exposure to air pollution? That has been the key focus in this literature review.

Challenging to use international results for Norway

Relevant compounds in Norway are particles (PM) in different fractions, including Black carbon (BC) and Particle number concentration (PNC) as well as nitrogen dioxide (NO_2). Most studies on travel exposure with different transport mode are performed in big cities, like Paris and London, with much higher concentration levels than Norwegian cities. It was therefore concluded that the results could not be used to give a quantitative answer to travel related exposure in Norway. A couple of studies we have looked at were performed under similar settings, but study restrictions like too short time frame (only summer) or very special test conditions (very high tunnel concentrations) made it not directly relevant for a quantitative estimate. However, the reported main factors for the differences and variability of the exposure levels are universally valid. For example is the local dispersion conditions a major factor determining the temporal variation (e.g. from day to day) and were the highest pollution levels occur, even if the emissions are the cause of the pollution.

Clear differences between transport modes.

For travels in the Oslo Metro it is expected that the levels of PM will be elevated because this is consistently reported from metro systems around the world. The PM in the metro will have a different chemical composition as well as size distribution compared to ambient air. This is due to different sources and exhaust do not contribute in the metro. The PM in the metro comes from wear of rails, wheels and break and contain therefore lots of metal dust. The general layout and technicalities like braking system will be the factors influencing the metro dust production and pollution levels. The total exposure for a traveler will likely be determined by time spent in the Metro underground as it is here the levels are expected to be elevated.

Road transport is one of the largest source to local air pollution in Norway. For in-vehicle pollution levels the ventilation rate and filtering will determine the particle amount entering the cabin. For the gases, like NO_2, concentrations are more similar to the outdoor concentrations, as long as recirculation of the cabin air is not turned on. Traffic amount and distance to other vehicle's exhaust pipes will also be important.

It has been shown for busses that route is one important factor for the observed pollution levels inside the buss. From that it can be deduced that dispersion conditions, urban background levels and other traffic sources are important. This will also be true for trams and light rails, while busses have an important extra source in self-pollution. Concentration levels at bus or tram stops are only reported in two studies and only for ultrafine particles (UFP). Experience and results reported about pedestrians and bikers, and knowledge about general dispersion, suggest that distance form traffic will be crucial for at-stop exposure.

For pedestrians and bikers it is reported exposure to short and high pollution peaks. Distance to traffic and single exhaust pipes, including limiting number of road crossings, have been found to be beneficial. Separate walking and biking paths along a higher traffic density road might therefore be overall better than biking in mixed traffic on a smaller road. Because the dispersion conditions are so important an open road route could also be better than a route in an urban street with buildings on each side (street canyon) even if the street canyon might have lower traffic density. However, a large uncertainty for this group is the road dust exposure. High density roads with higher speed are a large source of road dust in Norway, especially in areas with high studded tyre fractions. A biking path adjacent to such a road might therefor give more road dust exposure. The best solution for the active travellers is anyway a complete separate route with a distance as large as possible away from sources preferably with protective vegetation.

Importance of location and time of travel

Time of day of a travel might be important for some components and the travel modes especially sensitive to single exhaust pipes, like biking and walking. Pollution levels are higher during daytime and in general higher in winter compared to summer. For some components one do not always observe the highest pollution level at rush hour, even at road side measurement station. How the pollution will vary from hour to hour will depend on the place and localization of emission sources, but the weather conditions will influence the concentrations in such a way that they will smooth out the variation when looking at the pollution average over a long period of time. The difference in pollution level might be larger from one place to another or time of day when looking at the averages. This difference of space vs time could also be important when comparing two transport modes, for instance biking and using the car. For a biker, it might be possible to choose a low concentration route which will compensate for the extra time needed compared to a car traveling faster, but along a higher polluted road.

Health benefits of active transport

Active transport leads to increase in respiration levels and hence increased dose of air pollution pr. unit time. Taking this into account most studies found that the active traveller received the largest overall dose. The health benefits of activity is large and most studies conclude that these health benefits anyway outweigh the health risk from air pollution. Even if these studies have several limitations the conclusions hold even in areas with way higher pollution levels than Norway. It should hence be fair to conclude that active transport can be recommended everywhere in Norway on a general basis. People do however have very individual responses to air pollution. For groups at special risk or during a pollution episode it is not possible to conclude from the literature what should be the recommended transport mode. This is a theme that should be explored in further studies.

Outlook

Electric vehicles are a rapidly increasing part of the Norwegian fleet leading to decreasing exhaust pollution. Pollution from road dust will none the less keep on being a large source as exhaust is not the main contributor. Road dust should hence get attention in future studies on travel related exposure in Norway.