CHILDREN AGED 0-14 YEARS LIVING IN PROXIMITY TO HEAVILY TRAFFICKED ROADS	
GENERAL CONSIDERATIONS	
Issues	Respiratory diseases Physical injuries
Type of indicator	Exposure (proximal)
Rationale	Road traffic represents an important source of risk for children, both as a result of physical injuries and respiratory illness due to exposures to vehicle emissions. Risks are growing in many areas not only because of increased traffic volumes, but in some cases also because of population growth in areas close to busy roads. In all cases, children are especially vulnerable. They tend to receive higher doses from vehicle emissions, for example, because they spend much of their time at home and, when in the street, have a breathing height that is often close to the emission source. They are also more prone to physical injury because they are likely to be less aware of the dangers to which they are exposed, are less easily seen and avoided by vehicle drivers, are bodily more fragile, and in many cases spend more time as pedestrians (e.g. playing on the streets) than do adults.
Issues in indicator design	This is a relatively non-specific exposure indicator in that it takes no direct account either of the vehicle emissions that are most important for children's respiratory health, or the road and vehicle characteristics (e.g. speed) that most directly pose risks of injury. On the other hand, it is useful as a general indicator because it provides a way of representing the collective risks from road traffic. Several approaches can be taken to designing this indicator. For example, it can be defined in terms of the levels of traffic on residential roads, the numbers of children living close to busy roads, or the population-weighted distance to the nearest road. Each poses some problems, for they all require the ability to identify where children live in relation to roads, and in some cases the level of vehicle usage on these roads. This implies the availability of geographically disaggregated data (i.e. at a scale below generalized administrative regions). GIS techniques may be useful in this context to analyse spatial relationships between road traffic networks and residential areas. An age range of 0-14 years is used in this indicator because risks from road traffic persist throughout the child's life – and in many cases increase in school-age children.
SPECIFICATION	
Definition	Percentage (or number) of children aged 0-14 years living in proximity to heavily trafficked roads.
Terms and concepts	***Living in proximity to heavily trafficked roads***: living in a house that directly adjoins or lies within ca. 50 metres of a heavily trafficked road. ***Heavily trafficked roads***: a road carrying a more-or-less constant flow of traffic – at a rate of at least one vehicle per minute (60 vehicles per hour). ***Children aged 0-14 years****:* resident children aged 0-14 years at the survey date.
Data needs	Road network

	Traffic volumes Place of residence Numbers of children aged 0-14 years
Data sources, availability and quality	Data on the road network can usually be obtained from the relevant highways authorities or local authorities; road network data can also be derived from road or topographic maps and aerial photographs. Especially when in digital form, these data are likely to be reliable, though generalized data may omit smaller, often residential streets. Data on traffic volumes can usually be provided by the highways or local authorities. Counts are commonly based on short (e.g. 1-2 day or week) surveys, and may not be wholly representative of traffic flows, but should be sufficient to permit classification of roads according to their traffic volume. Small roads are often not covered by these data. Where count data are not available, estimates may be made using traffic models (e.g. trip generation or vehicle assignment models). More crudely, estimates can also be made by extrapolation of data from elsewhere: for example, by classifying roads on the basis of counts or modelled data for similar types of road. High resolution data on residential locations can often be obtained from local authorities (e.g. planning maps), from postal sources (e.g. postcode data) or from household surveys. Where none of these are available, broader scale data (e.g. census information) may be disaggregated to a more local level using GIS techniques. Land cover data – e.g. from satellites or aerial photography – can also be used to identify residential areas, and to disaggregate population data to a finer spatial scale.
Level of spatial aggregation	Community or municipality
Averaging period	Annual or longer term
Computation	The indicator is best computed using a GIS to intersect data on the residential distribution of children aged 0-14 years with data on road networks and traffic volumes. Roads classified as having a traffic volume greater than 60 vehicles per hour are then buffered to a distance of 50 metres, and overlaid with the population map. The percentage of children living within the 50 metre buffer zone along these roads is then computed, either using point-in-polygon techniques (where the population is available on a point basis) or by proportional area (where the population is available for areal units). The indicator is then given by: *100 * Cnear / Ctot* where: *Cnear* is the number of children aged 0-14 years living within the 50 metre buffer zone; *Ctot* is the total number of children aged 0-14 years in the area as a whole.
Units of measurement	Percentage or number

Worked example	Assume that in one city 47 500 children, out of a total of 195 000 children are found to be living within 50 metres of heavily trafficked streets. In this case, the value of the indicator is: 100 * (47 500 / 195 000) = 24.4%
Interpretation	This indicator provides a useful general measure of the level of exposure of children to road traffic, since it measures the percentage of children living close to busy roads. An increase in this indicator thus implies that more children are at risk of traffic accidents or respiratory illness due to exposure from vehicle emissions, while a decrease in the indicator implies a reduction in risk. For various reasons, however, these interpretations need to be made with care. The first problem is the quality of the available data: often the indicator will require some degree of approximation, so small changes in the indicator value may not be significant. Secondly, it needs to be appreciated that traffic volumes – and residential proximity to heavily trafficked roads – are not direct measures of accident risk or exposure; many other factors, such as road layout, building configuration, driver behaviour, traffic speed, behaviour of children, are also important.
Variations and alternatives	This indicator can be constructed using different definitions both of 'heavily trafficked roads' and of 'proximity' (both the criteria used here are essentially arbitrary). For example, higher traffic and distances of less than 50 metres might be more appropriate where the aim is to assess variations in risk within large, densely populated cities. The indicator may also be varied to focus on a narrower age range (e.g. 0-4 years). As an alternative, the indicator may also be expressed as the traffic volume on residential roads. In this case, a baseline definition is required of residential areas (e.g. based on land use data or population statistics). Average traffic volumes on roads passing through these residential areas may then be computed. Ideally they should then be expressed as vehicle kilometres per 1000 children (or per 1 km^2) in order to give a measure of the *intensity* of road traffic in these areas. In this form the indicator is more sensitive to changes in traffic volume (especially over time); however, it does not necessarily reflect the degree of proximity of roads to the place of residence. A further alternative is to estimate the population weighted average distance to the nearest busy road. This can readily be done using GIS techniques – for example by averaging the distance of each place of residence to the nearest busy road. Again, this requires a definition of a busy road.
Examples	None known (though the indicator is widely used as a measure of exposure in epidemiological studies).
Useful references	Banos, A. and Huguenin-Richard, F. 1999 Spatial distribution of road accidents in the vicinity of point sources: application to child pedestrian accidents. In: *Geography and Medicine. Proceedings of the Second International Workshop on Geomedical Systems.* (A. Flahaut, L. Toubiana, and A.J. Valleron, eds.), pp. 54-64. Brunekreef, B., Janssen, N.A., de Hartog, J., Harssema, H., Knape, M. and van Vliet, P. 1997 Air pollution from truck traffic and lung function in children living near motorways. *Epidemiology* 8, 298-303. Oosterlee, A., Drijver, M., Lebret, E. and Brunekreef, B. 1996 Chronic respiratory symptoms in children and adults living along streets with high traffic density. *Occupational and Environmental Medicine* 53, 241-7.

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