CHILDREN AGED 0-14 YEARS LIVING IN POVERTY	
GENERAL CONSIDERATIONS	
Issues	Perinatal diseases Respiratory diseases Diarrhoeal diseases Physical injuries
Type of indicator	Exposure (distal/driving force) Can also be used as a measure of action in relation to social policy.
Rationale	Poverty is a major risk factor for children's environmental health. It operates in three main ways. First, because of what has been termed environmental injustice, there is a marked tendency for the poorest in society to be more exposed to environmental hazards. This occurs both because the poor are more likely to live in inadequate housing, and in more hazardous areas, and because there is a tendency for polluting industries and other activities to congregate in poorer areas (e.g. because of lower land prices, less strict regulations and less effective opposition from the communities involved). Secondly, poverty tends to be associated with more harmful (or less self-protective) lifestyles and behaviours, for example in terms of diet, smoking, exercise and drug usage, both because of lack of awareness of the risks concerned and the lack of resources to avoid them. Thirdly, poverty makes it harder for those at risk to obtain treatment or help, often because of their remoteness from the necessary services, their lack of resources to access them and – in some cases – inherent biases and inadequacies within the services themselves. As a result, almost all environmental health effects show strong associations with poverty. Poverty thus represents an important, complex and inter-related set of social and environmental risks that cannot easily be separately specified. It also acts as an important confounder and modifier to relationships between many other risk factors and human health.
Issues in indicator design	Defining and measuring poverty is extremely difficult. Poverty is neither a unitary nor absolute condition. It is multi-facetted and contextual. No single, simple threshold or measure for poverty therefore exists that can be used as a basis for the indicator. Instead proxies of various types tend to be used. These are variously described in terms of poverty, deprivation, disadvantage or inequality. Some of these rely on single measures – such as disposable income, or family assets. Others use compound indices, often including a range of social, economic and, in some cases, health variables. The main example internationally is the UNDP Human Poverty Index (HPI), of which two forms have been devised, one for developed and one for developing countries. Various national indicators are also in use (e.g. the Carstairs Index which is widely used in the UK). Each of these indicators – and each of these approaches to devising indicators of poverty – has limitations. Indicators based on income alone, for example, take a very narrow view of poverty, and ignore the many other factors that influence social well-being – for example, customs that may limit the ability of some groups (e.g. women) to access, or benefit from, the available wealth. For the most part, compound indicators tend to be more powerful, but these are often highly contextual, and include variables that are not always widely relevant. Those (such as the UNDP HPI) that include variables relating directly to health (life expectancy, disability etc.) are not

	appropriate as *independent* measures of poverty, that can readily be used in combination with health indicators. Defining thresholds with any of these measures, below which people may be said to be living in poverty, is also difficult. On the other hand, merely taking an average measure across a population (e.g. average household income, or the average HPI) is misleading, because it fails to reflect the disparities in affluence and poverty that may exist within that population. Against this background, it is impossible to define a single indicator that will satisfy all circumstances and applications. The indicator proposed here attempts to define poverty in terms of both sustainable and disposable income, and its ability to meet basic needs. The concepts of income and need are defined generically, as a basis for indicator development, but in many cases would need to be further specified to take account of local circumstances (e.g. social structure, economic conditions, expectations). The age range of 0-14 years is taken because poverty affects children of all ages more or less equally.
SPECIFICATION	
Definition	Percentage (or number) of children aged 0-14 years living in households with a sustainable income inadequate to meet their basic needs.
Terms and concepts	***Sustainable and disposable income:*** the level of household income (in money or in kind) that is available to spend after primary commitments (e.g. taxation, tithes, travel and other costs involved in acquiring the income) have been paid, and that can realistically be expected to be maintained in the long term (i.e. over a period of one or more years). This income can be measured in different ways, depending on local circumstances, but should be converted to a common 'currency' (based on relative purchasing power) where international comparisons need to be made. ***Basic needs:*** the costs of essential life-support materials and services required to provide a healthy existence for a child within the local context. These should include all requirements for nutrition (to an acceptable, basic level), shelter (of a safe and adequate condition), education (to acquire essential literacy, numeracy and vocational skills) and health care (access to basic primary and secondary health care services). Costs of materials and services provided either via taxation or through direct deduction from income should not be included.
Data needs	Number of children aged 0-14 years by sustainable, disposable household income Costs of basic needs
Data sources	Data on household income can usually be obtained from national censuses or other routine surveys or registers (e.g. declarations to taxation offices). Where these sources are not available, sample data may be obtained from household surveys. In some cases, sample data are also collected by commercial companies (e.g. for marketing purposes). To estimate the disposable income it may be necessary to subtract from the reported income figures the levels of taxation and other routine deductions. To identify households with a sustainable income, it may be necessary to adjust the data according to employment rates (e.g. the percentage of people in long-term employment). Costs of basic needs should be calculated on the basis of an average 'basket' of goods, comprising essential food, shelter, education and health care. In some cases, national measures will be available (e.g. from national

	statistical offices or social service departments); otherwise, data to compute these costs may need to be obtained from household surveys.
Level of spatial aggregation	Administrative district (e.g. census tract)
Averaging period	Annual or longer
Computation	The indicator is computed as a simple percentage, as follows: *100* (Cpov / Ctot)* where : *Cpov* is the number of children aged 0-14 years living in households with a sustainable income inadequate to meet their basic needs; *Ctot* is the total number of children aged 0-14 years
Units of measurement	Percentage (or number)
Worked example	Assume that an area contains 15 000 households, with a total population of 62 000 children. Of these households, 6 400 (containing 31 400 children) are deemed to have a disposable and sustainable income below that needed to satisfy their basic needs. In this case, the indicator would be calculated as: *100 * 31 400 / 62 000 = 50.6%*
Interpretation	In general terms, an increase in the index value may be taken as an indication of increased poverty and an associated increase in the vulnerability of children to health problems, and reduced quality of life. Care is nevertheless necessary, especially in comparing countries or regions that differ markedly in terms of their culture, economy and way of life. Marked rural/urban differences may also occur, which may be masked where data are aggregated to large areas. The data needed to construct the indicator may also suffer from inaccuracies, inconsistencies and gaps, which might not be apparent in the reported statistics. Data on income, for example, are often subject to major uncertainties because of incorrect or incomplete reporting, and because of difficulties in assessing non-monetary or occasional income. Estimates of the cost of basic needs are also inherently uncertain, and likely to vary substantially from one country or population group to another. Minor differences in the indicator value are therefore unlikely to be meaningful and the indicator should only be seen to present a broad measure of poverty.
Variations and alternatives	Many alternatives to this indicator are possible. Examples include: ***Average household income per child:*** the mean household income (total or disposable) per child. ***Income disparity:*** the difference or range of incomes across the population. The UNCHS Household Income Distribution Indicator (UNCHS 1993), for example, is calculated as the ratio of the average income of the highest income quintile to the average income of the lowest income quintile. ***The poverty gap***: a measure of the difference between the poverty line and the level of consumption of all individuals in the population – e.g. the Poverty Gap Index (DAC 1999, UN 1996). ***Poverty or deprivation indices***: these typically assign an arithmetic score to individuals or areas based on a number of poverty or deprivation indicators (e.g. income, employment status, family situation, access to basic resources). Examples include the UNDP Human Poverty Index (UNDP

	1999), the Jarman score (Jarman 1983), the Townsend Index (Townsend *et al*. 1988), and the Carstairs score (Carstairs and Morris 1989).
Examples	WHO *Environmental health indicators: framework and methodologies* • **Poverty** UNDP *Human development report* • **Human poverty index for developing countries (HPI-1)** • **Human poverty index for developed countries (HPI-2)** *UN Indicators of sustainable development* • **Head count index of poverty** • **Poverty gap index** • **Squared poverty gap index** • **Gini index of income inequality** UNCHS and World Bank *Housing indicators programme* • **Household income distribution** • **Households below poverty line** • **DAC Indicators of poverty reduction** • **Incidence of extreme poverty** • **Poverty gap ratio** • **Inequality** Many indicators have also been developed at national level, often as a basis for allocating health resources e.g.: • **the Carstairs score** • **the Jarman score** • **the Townsend index**
Useful references	Carstairs, V. and Morris, R. 1989 Deprivation: explaining difference in mortality between Scotland and England and Wales. *British Medical Journal* 299, 886-889. DAC 1999: http://www.oecd.org/dac/indicators/htm/list.htm Gwatkin, D.R. and Guillot, M. 2000 *The burden of disease among the global poor. Current situation, future trends and implications for strategy.* Washington: World Bank. Jarman, B. 1983 Identification of underprivileged areas. *British Medical Journal* 286, 1705-1709. Townsend, P., Phillimore, P. and Beattie, A. 1988 *Health and deprivation: inequality and the north.* London: Croom Helm Ltd. UN *1996 Indicators of sustainable development. Framework and methodologies.* New York: United Nations. UNCHS (Habitat) and the World Bank 1993 *The Housing Indicators Programme*. Report and the Executive Director (Volume I). Nairobi: United Nations Centre for Human Settlements. UNCHS (Habitat) 1997 M*onitoring human settlements with urban indicators*.

	Nairobi: United Nations Centre for Human Settlements. UNDP 2000 *Human development report*. New York: United Nations. Wagstaff, A. 2002 Poverty and health sector inequalities. *Bulletin of the World Health Organization* 80, 97-105.

PEOPLE LIVING IN INFORMAL SETTLEMENTS	
GENERAL CONSIDERATIONS	
Issues	Perinatal diseases Diarrhoeal diseases Physical injuries
Type of indicator	Exposure (distal/state) Can also be used as a measure of action in relation to housing quality.
Rationale	Rapid urbanization and inadequate capability to cope with the housing needs of people in urban areas have contributed to the development of informal settlements. Living in these settlements often poses significant health risks. Sanitation, food storage facilities and drinking water quality are often poor, with the result that inhabitants are exposed to a wide range of pathogens and houses may act as breeding grounds for insect vectors. Cooking and heating facilities are often basic, with the consequence that levels of excessive exposures to indoor pollution may occur. Access to health and other services may be limited; overcrowding can contribute to stress, violence and increased problems of drugs and other social problems. Together, these pose special risks to children both during the prenatal period and after birth. This indicator provides a general measure of these risks.
Issues in indicator design	Severe problems exist both in defining 'informal settlements' and in obtaining reliable data on the number of people who live within them. The definition of informal settlements is context-specific. Various definitions have thus been proposed, but that suggested by the UN Habitat Programme is probably the most widely applicable. This defines informal settlements as: i) residential areas where a group of housing units has been constructed on land to which the occupants have no legal claim, or which they occupy illegally; ii) unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing). Many other terms and definitions have also been devised for informal human settlements, for example: unplanned settlements, squatter settlements, marginal settlements, unconventional dwellings, non-permanent structures, inadequate housing, slums, housing in compliance etc. *Unconventional dwellings* are commonly defined by the number of housing units occupied by households, but considered inappropriate to human habitation. *Housing in compliance* is used as a Human Settlements Indicator by the UN Habitat Programme and is defined as the percentage of the total housing stock in urban areas which is in compliance with current regulations (authorized housing). Housing may also be categorized by its type or permanence (e.g. permanent, semi-permanent, non-permanent), although definitions of these categories vary widely from country to country. Problems occur in measuring the extent or defining the boundaries of such settlements. By definition, officially recognized boundaries to these settlements rarely exist, and the settlements themselves often merge almost imperceptibly into formal areas of housing, industrial or rural areas. Use of remotely sensed data (e.g. aerial photography or high resolution satellite data) may be useful in this context. Similar difficulties occur in obtaining data on the numbers of people who live within these settlements. They are often not covered by formal censuses,

	and many of the people living in the settlements may not be registered or officially recognized. Most population data are therefore estimates, and as such are subject to considerable uncertainties.
SPECIFICATION	
Definition	Percentage of the population (or number of people) living in informal settlements.
Terms and concepts	***Informal settlements:*** based on the UN Habitat Programme definition, these are defined as: i) residential areas where a group of housing units has been constructed on land to which the occupants have no legal claim, or which they occupy illegally; ii) unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing). ***Unauthorized housing:*** excludes units where land titles, leases or occupancy permits have been granted (UN 1996). It should be noted that informal settlements do NOT cover the ***homeless***.
Data needs	Number of people living in informal settlements. Total population.
Data sources, availability and quality	Information on the number of people living in informal settlements is often limited, since inhabitants are often only inadequately covered by formal censuses: census data may therefore not provide a clear separation of those living in informal settlements. Where suitable census data do not exist, special surveys may be necessary. Data on the total population should be available from national censuses and should be broadly reliable.
Level of spatial aggregation	Municipality, district etc
Averaging period	Annual to decadal
Computation	The indicator is computed as: *100 * Pinf / Ptot)* where *Pinf* is the number of people living in informal settlements and *Ptot* is the total number population.
Units of measurement	Percentage (or number)
Worked example	Assume that a total of 3 600 people are counted in informal settlements, from a total city population of 26 900. In this case, the value of the indicator will be: 100 * (3 600 / 26 900) = 13.4%
Interpretation	This indicator provides a relatively straightforward measure of the quality of housing, and thus of the risks to children's health. A large percentage of people living in informal settlements can be taken to imply an increased risk to children's health; a low percentage implies a reduced risk. Nevertheless, the relationship between the number of people living in informal settlements and environmental health is not always simple. In particular, those living in formal settlements are not necessarily better provided for (e.g. the homeless or people living in crowded or unsafe

	housing). Problems of data accuracy also mean that the indicator should be interpreted with care, especially where comparisons are being made between different surveys.
Variations and alternatives	The indicator proposed above is non-specific, in that it relates to the total population. In practice, variations on this indicator are likely to be useful, aimed at more specific age groups. For perinatal diseases, the target group should be women of childbearing age (15-49 years); for respiratory illness the 0-5 year age group is likely to be the most relevant; for physical injuries all children (0-14 years) should be included. This indicator can also be defined on the basis of different classifications of informal settlements (or other, similar concepts). Where suitable data on population are not available, the indicator might alternatively be measured as the area (e.g. km^2) of informal settlements. This may be estimated from aerial photographs. It is liable to understate the scale of the problem, however, since it makes no allowance for population density, which is often higher in informal settlements than in formal settlements.
Examples	WHO *Environmental health indicators: framework and methodologies* • **Population in informal settlements** UN *Indicators of sustainable development* • **Area and population of urban formal and informal settlements**
Useful references	UN 1996 *Indicators of sustainable development. Framework and methodologies*. New York: United Nations. UNCHS (Habitat) and the World Bank 1993 *The housing indicators programme*. Report and the Executive Director (Volume I). Nairobi: United Nations Centre for Human Settlements. UNCHS (Habitat) 1995 *Monitoring the shelter sector. Housing Indicators review*. Nairobi: United Nations Centre for Human Settlements. UNCHS (Habitat) 1995 *Monitoring human settlements, abridged survey*. Indicators Programme. Nairobi: United Nations Centre for Human Settlements. UNCHS Urban Indicators Programme website: http://www.urbanobservatory.org/indicators/database/ WHO 1999 *Environmental health indicators: framework and methodologies*. Geneva: WHO. (Available at http://www.who.int/docstore/peh/archives/EHIndicators.pdf)

CHILDREN AGED 0-14 YEARS LIVING IN DISASTER-AFFECTED AREAS	
GENERAL CONSIDERATIONS	
Issues	Diarrhoeal diseases Physical injuries
Type of indicator	Exposure (distal/state)
Rationale	Natural disasters, such as floods, drought, earthquakes or landslides are a major cause of disease and death for children, not only directly – as a result of physical injury – but also because of their longer-term legacy. Indeed, diarrhoeal diseases, as a result of contamination of water supplies, breakdown of sanitation facilities and the need to scavenge for food, often take a larger toll of life than the original disaster. Nor are disasters restricted to natural events: war and social conflict can be equally devastating and prove even more intractable to resolve. The number of children living in disaster-affected areas is, therefore, an important indicator of risks to health and the need for international action.
Issues in indicator design	The main problem in designing this indicator is the definition of disaster-affected areas and their associated populations. Not all disasters are sudden and acute events; most are chronic or endemic processes, that wax and wane according to the state of politics, climatic cycles or the level of international aid, but which persist in the background for years or decades. Disaster-affected areas thus have no clear boundaries in either time or space. Because one of the only available responses for those affected is to flee the area in search of safety, sustenance or help, the affected population is also fluid – and not confined to the immediate vicinity of the disaster. In defining this indicator, account thus needs to be taken of the displaced populations, as well as those who remain. A related difficulty is the availability of reliable data. Many of the most disaster-prone areas are also those in which basic statistical systems, such as population counts, are poorly developed; during prolonged periods of strife or natural emergencies they are likely to deteriorate further. Data are therefore scarce, and the data that do exist often of poor quality. An age range of 0-14 years is used for this indicator because risks remain more-or-less uniform (i.e. are not age-dependent) throughout the child's life.
SPECIFICATION	
Definition	Numbers of children aged 0-14 years living in, or refugees from, areas affected by natural or human-made disasters
Terms and concepts	***Disaster:*** a non-routine event or process of either natural or human origin that causes severe social disruption and physical harm to a large number of people.
Data needs	Extent of disaster-affected area Numbers of resident children, aged 0-14 years (including refugees)
Data sources, availability and quality	Data on the extent of disaster-affected areas are likely to come in most cases from the emergency and humanitarian aid agencies, especially international organizations. These may also be able to provide estimates of the numbers affected, either within the area or as refugees. In both cases, data are liable to be uncertain, due to problems of definition and the inevitable difficulties of acquiring reliable information in severely disrupted (and often remote) societies. Estimates thus provide only a general indication of the numbers of

	children at risk. Routine procedures need to be established to acquire, process and validate these data in order to support this indicator. Use of satellite data can also be helpful in attempting to define more accurately disaster-affected areas, especially in relation to disasters that leave a clear signal on the landscape (e.g. due to vegetation deterioration or collapse of buildings).
Level of spatial aggregation	Region
Averaging period	Annual (or shorter term in the case of acute events)
Computation	The indicator can be computed by summing the numbers of children aged 0-14 years both within, and displaced from, the disaster-affected areas. Often this can be done only approximately (e.g. based on assessments by workers in the field). In some cases, however, more reliable estimates can be made by intersecting maps of the extent of the disaster-affected area with data on population distribution (e.g. using GIS techniques).
Units of measurement	Number
Worked example	Assume that the disaster is affecting three areas as follows. In A (which has a population of 320 000 children aged 0-14 years) it covers the whole area; in B (472 000 children), it covers 60% of the area; in C (198 000 children), it covers 85% of the area. The total number of children affected is thus: (1.0 * 320 000) + (0.6 * 472 000) + (0.85 * 198 000) = 771 500
Interpretation	This indicator provides a broad approximation of the numbers of children at risk from natural or human-made disasters. An increase in the indicator thus represents an increased risk, a decrease represents a reduced risk. Because of the inherently approximate nature of the data used to construct the indicator, only broad patterns and trends can be regarded as significant, and care is needed especially in the early stages of any disaster because of the potential for major errors in assessment.
Variations and alternatives	Various alternatives are possible for this indicator. It could, for example, be expressed in terms of the area affected rather than the numbers of children. Alternatively, separate estimates could be made for children still living in the disaster-affected area, and those displaced: this would enable different aspects of the disaster, and different needs for action, to be better specified. Separate indicators could also be developed, if appropriate, for different types of disaster (e.g. floods, drought, seismic events, war). A further alternative – as a measure of effect – is to define the indicator in terms of the numbers of deaths or injuries.
Examples	None known
Useful references	PAHO 2000 *Natural disasters. Protecting the public's health.* Washington: Pan American Health Organization. ReliefWeb: (http://www.reliefweb.int/) WHO 1990 *Emergency preparedness and response: introduction to rapid health assessment.* Geneva: World Health Organization. WHO-Afro 2000 *Environmental health hazard mapping for Africa.* Harare: World Health Organization Regional Office for Africa.

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.

	Van Vliet, Knape, M., de Hartog, J., Janssen, N., Harssema, H. and Brunekreef, B. 1997 Motor vehicle exhaust and chronic respiratory symptoms in children living near freeways. *Environmental Research* 74, 122-32. Venn, A.J., Lewis, S.A., Cooper, M., Hubbard, R. and Britton, J. 2001 Living near a main road and the risk of wheezing illness in children. *American Journal of Respiratory Critical Care Medicine* 164, 2177-80.

CHILDREN AGED 0-14 YEARS INVOLVED IN ROUTINE EMPLOYMENT

GENERAL CONSIDERATIONS	
Issues	Physical injuries
Type of indicator	Exposure (proximal) Can also be used as a measure of action targeted at child labour.
Rationale	Despite international initiatives to deter the employment of children in routine work, in many countries the practice of child labour continues. Though often seen as an economic necessity, use of child labour undoubtedly has many important adverse consequences for children's health. It restricts education and social contact, and thus limits the intellectual development of the child, and their long-term social and economic possibilities. Child labour is often itself physically demanding and repetitive, so that it can cause both acute and long-term injuries and developmental abnormalities. Work places involving children are also often poorly supervised and managed, so that risks of injury through accidents at work are relatively high. In addition, child labour often takes place in dusty, noisy or otherwise polluted environments, so that children are exposed to high levels of pollutants, often including toxic or hazardous chemicals. This indicator is thus intended to provide a measure of the extent of child labour, and its implications for children's health.
Issues in indicator design	A major difficulty in designing and applying this indicator is the availability of reliable and consistent data. Because it is often informal and/or illegal, the practice of child labour is often not officially reported. Child labour may also take many different forms, ranging from organized and full-time employment in large factories or on large estates to part-time involvement in a family or casual business. Attitudes to, and laws on, different forms of child labour also vary from one country to another, and over time, so problems can occur in making spatial or temporal comparisons. In most cases, therefore, the indicator needs to rely on purposely collected data, for example through special surveys. An age range of 0-14 years is used for this indicator since it is mainly children of school-age who are at risk.
SPECIFICATION	
Definition	Percentage of children aged 0-14 years involved in routine employment
Terms and concepts	***Routine employment*****:** involvement in paid or unpaid work, other than as part of education, for an average of more than 2 hours per day, on a regular or repeated basis. ***Total number of children aged 0-14 years***: resident children aged 0-14 years at the time of survey.
Data needs	Number of children aged 0-14 years in routine employment. Total number of children aged 0-14 years.
Data sources, availability and quality	Data on child labour are unlikely to be available through routine sources. Generally, therefore, they need to be collected through special surveys, usually targeted at the workplace. Considerable problems may be encountered in these surveys, due to the illicit nature of much child labour, and the fear of prosecution amongst both employers and employees. Much labour also takes place in informal workplaces, that cannot easily be

	surveyed. Major uncertainties thus tend to occur in the available data. Data on the total number of children aged 0-14 years should usually be available from national censuses and should then be reliable. Estimates for inter-censual years (or where census data are not available) may be made using population models or from births and deaths data. However, because employment data are usually collected through workplace-based surveys, problems may be encountered in defining a relevant denominator population.
Level of spatial aggregation	Community, administrative district
Averaging period	Annual or longer term
Computation	Where data are available from an area-wide (e.g. household) survey, or where all workplaces employing children in an area have been included, the indicator can be computed as: *100 * (Clab / Ctot)* where: *Clab* is the number of children aged 0-14 years involved in routine employment in the survey; *Ctot* is the total number of children aged 0-14 years in the study area. Where data on child labour is available from a sample workplace survey, then the indicator can be computed as: *100 * (Clab * Wptot / WPsurv) / Ctot* where: *Clab* is the number of children aged 0-14 years working in the sample workplaces; *WPsurv* is the number of workplaces surveyed; *WPtot* is the total number of workplaces in the study area; *Ctot* is the total population of children aged 0-14 years in the study area. This formula assumes that the sample of workplaces is representative in terms of size, and level of child labour, of all workplaces in the area. Where this is not the case, further adjustments may be needed to ensure that the indicator provides a representative measure.
Units of measurement	Percentage
Worked example	Using method 1 above, assume that a survey shows that there are 2 475 children employed in an area, from a total of 26 950 children aged 0-14 years. In this case the value of the indicator is: 100 * (2 475 / 26 950) = 9.2% Using the second method, assume that a survey of 30 workplaces, out of a total of 160 workplaces, shows that 267 children are employed; assume also that there are 14 680 children in the whole study area. In this case the value of the indicator is: 100 * (267 * 160 / 30) / 14 680 = 9.7%
Interpretation	Because of the difficulties in acquiring reliable data, this indicator needs to be interpreted with extreme care. Large cultural differences exist in the nature of employment, and the role in it of children: often, child labour will only become manifest in societies with organized, paid employment systems but

	will remain hidden in societies characterized by informal labour or subsistence economies. Possible inaccuracies in surveys of child labour also need to be recognized.
Variations and alternatives	This indicator may, alternatively, be computed for different age ranges of children, or for more specific forms of employment. In some cases, it may be more appropriate to report the indicator in terms of absolute numbers or children, rather than percentage, since this helps to highlight the extent of the practice.
Examples	None known
Useful references	International Programme on the Elimination of Child Labour 2001 *Eliminating the worst forms of child labour: an integrated and time-bound approach. A guide for governments, employers, workers, donors and other stakeholders. (*Available at: http://www.ilo.org/public/english/standards/ipec/timebound/manual.pdf) Manciaux, M. and Romer, C.J. 1991 *Accidents in childhood and adolescence*. The role of research. Geneva: World Health Organization.

CHILDREN AGED 0-14 YEARS LIVING IN UNSAFE, UNHEALTHY OR HAZARDOUS HOUSING	
GENERAL CONSIDERATIONS	
Issues	Respiratory diseases Physical injuries
Type of indicator	Exposure (proximal) Can also be used as a measure of action in relation to housing quality.
Rationale	The adequacy of housing is an important determinant of the health status of children. *Inter alia*, housing quality affects levels of exposure to indoor pollutants, food and water hygiene, levels of sanitation, exposures to physical hazards and injury, and general quality of life. Housing may be unsafe, therefore, for a variety of reasons, including: dangerous construction, inadequate ventilation, inadequate heating, dangerous or inadequately maintained services, inadequate size for the number of residents (i.e. overcrowding), location in a hazardous area (e.g. areas prone to flooding or earthquakes, or on contaminated land) or the presence of dangerous contaminants (e.g. lead or radon) in the building materials. Living in inadequate housing is therefore likely to result in increased risks of a variety of health effects, including respiratory illness and physical injury.
Issues in indicator design	Although potentially valuable, this indicator is difficult to define and measure in a clear and systematic manner. In many cases, the most appropriate measure may be the percentage (or number) of children living in unsafe, unhealthy or hazardous housing. Defining the terms 'unsafe', 'unhealthy' and 'hazardous', however, poses severe difficulties for these are all to a large extent both environmentally and culturally dependent, and thus are liable to vary from one area (or one time) to another. Possible definitions of unsafe, unhealthy or hazardous housing include housing which is: • **physically unsound and likely to be dangerous to its occupants, because of its poor construction, or inadequately maintained services (e.g. electricity); or** • **is located in a physically hazardous area (e.g. an area of flood or earthquake risk) or is sited on contaminated land (e.g. by chemical wastes, radioactivity); or** • **provides serious risks of exposures to indoor pollution (e.g. air pollutants) or pathogens (e.g. moulds, ticks, fleas); or** • **provides inadequate shelter (e.g. due to poor insulation, inadequate roofing) and basic amenities (e.g. cooking facilities, heating).** Problems may also exist in devising a single indicator that combines all these different conditions in a single measure, since in terms of health they may not be equivalent. As an alternative, therefore, separate indicators can be developed, relating to specific aspects of housing condition and quality. Thus, indicators might be compiled of overcrowding, access to basic amenities, indoor air pollution, flood risk, avalanche risk, earthquake risk etc. The disadvantages of this approach are the large number of indicators that might need to be compiled, and the difficulties of comparing between them or of using them to provide a general overview of housing conditions. An age range of 0-14 years is applied in the case of this indicator because the various risks from hazardous housing conditions affect children of all

	ages.
SPECIFICATION	
Definition	Percentage (or number) of children aged 0-14 years living in unsafe, unhealthy or hazardous housing.
Terms and concepts	This indicator requires the ability to identify, and measure the extent of, unsafe, unhealthy or hazardous housing. This may be generally defined as housing which is: • **physically unsound and likely to be dangerous to its occupants, because of its poor construction, or inadequately maintained services (e.g. electricity); or** • **is located in a physically hazardous area (e.g. an area of flood or earthquake risk) or is sited on contaminated land (e.g. by chemical wastes, radioactivity); or** • **provides serious risks of exposures to indoor pollution (e.g. air pollutants) or pathogens (e.g. moulds, ticks, fleas); or** • **provides inadequate shelter (e.g. due to poor insulation, inadequate roofing) and basic amenities (e.g. cooking facilities, heating).** These definitions may need to be adjusted locally to meet specific circumstances. In addition, a definition is required of the total number of children: i.e. the total resident population of children aged 0-14 years, at the time of census or survey.
Data needs	Number of children aged 0-14 years living in unsafe, unhealthy or hazardous housing. Total resident population of children aged 0-14 years.
Data sources, availability and quality	Data on the quality of the housing stock, and the number of children living in unsafe, unhealthy or hazardous housing is rarely available from routine sources. In some countries, an approximation to this may be available from census statistics (e.g. housing lacking basic amenities). Generally, however, data will need to be obtained by special surveys. In all cases, these data are liable to considerable margins of error and inconsistency due to difficulties of definition, inconsistent reporting and difficulties of ensuring representative sampling. Data on the total resident population of children should be available from national censuses and should be reliable.
Level of spatial aggregation	Community, administrative district or region
Averaging period	Annual or longer term
Computation	The indicator can be computed as: *100 * Cunsafe / Ctot* where: *Cunsafe* is the number of children aged 0-14 years living in unsafe, unhealthy or hazardous housing; *Ctot* is the total population of children aged 0-14 years
Units of measurement	Percentage or number
Worked example	Assume that a survey of housing conditions shows that 1 440 children, from a total sample of 11 070 children, are found to be living in homes classified

	as unsafe, unhealthy or hazardous. In this case the value of the indicator is: 100 * 1 440 / 11 070) = 13.0%
Interpretation	This is an important indicator, which has wide-ranging significance for policy. In providing a measure of the adequacy of the housing stock, it also acts as an indicator of health risks associated with poor sanitation, exposures to indoor air pollution, and access to safe water. It can, therefore, help to interpret a range of other issues and indicators. Like all general-purpose indicators, however, it needs to be interpreted carefully. The characteristics which render housing unsafe, unhealthy or hazardous may clearly vary; without information on these specific characteristics it can be misleading to infer either the existence of particular health risks or effects or the need for specific actions. Definitional issues are also likely to pose major difficulties for comparisons between different areas, or between different surveys, unless standard protocols have been used. A clear understanding of the data is therefore essential before interpretations are made.
Variations and alternatives	This indicator can be based upon a wide range of locally defined classifications of housing quality – for example, temporary or non-permanent housing, housing without adequate amenities, housing built on unsafe or unstable land, or houses at risk of flooding. It can also be applied to different age ranges (e.g. children 0-5 years in age), as appropriate.
Examples	WHO *Environmental health indicators: framework and methodologies* • **Population living in unsafe housing** UNCHS (Habitat) *Urban Indicators Programme* • **Permanent structures (percentage of housing units located in structures expected to maintain their stability for 20 years or longer under local conditions with normal maintenance);** • **Housing in compliance (percentage of the total housing stock in compliance with current regulations);** • **Housing destroyed (percentage of the housing stock destroyed by natural or man-made disasters over the past ten years).**
Useful references	UNCHS Urban Indicators Programme: http://www.urbanobservatory.org/indicators/database/ WHO 1999 *Environmental health indicators: framework and methodologies.* Geneva: World Health Organization. (Available at http://www.who.int/docstore/peh/archives/EHIndicators.pdf)

CHILDREN AGED 0-14 YEARS LIVING IN HOMES LACKING ACCESS TO A PIPED WATER SUPPLY	
GENERAL CONSIDERATIONS	
Issues	Physical injuries
Type of indicator	Exposure (distal/state) Can also be used as an indicator of action targeted at improving water services to the home.
Rationale	Drowning represents a major cause of death and injury to children, worldwide. In developing countries, especially, many cases of drowning are associated with the lack of piped water to the home or neighbourhood. As a result, water has to be collected either from wells or streams, and washing and bathing often has to be carried out in open water bodies. Risks of drowning are increased as a result. Water collection from remote areas also adds to other risks, including injuries by traffic, snake bites, falls and chronic physical injury (e.g. back problems) and deformities. The need for mothers to spend time collecting water may also mean that children are left unsupervised for longer than would otherwise be the case, raising the risks of accidents. This indicator thus provides a general measure of the risks of physical injuries due to lack of adequate water supplies in the neighbourhood or home, and the consequent need for water gathering and use of open water sources.
Issues in indicator design	The major difficulty in developing this indicator is the definition of access to a piped water supply. Two problems arise in this respect: how close the supply tap should be to provide adequate access; and how to take account of the consistency of the piped water supply. In other contexts (e.g. in terms of access to safe water) it may be considered appropriate to allow a relatively long distance of travel for water collection and access – e.g. 15 minutes). In the context of accidents and injuries, however, it is evident the need to carry water any significant distance will continue to pose risks for children. A narrower threshold (e.g. 5 minutes walk) should therefore be used. Continuity of water supply is also important, for otherwise people may have to resort to non-piped sources on many occasions. Piped supplies should thus provide continuous water throughout the day. Problems are also likely to occur in obtaining data for this indicator. Data on homes provided with direct, piped supplies are likely to be maintained by the supply companies (though the numbers of children in these homes may not be easily defined). Data on access to community supplies, on the other hand, may need to be obtained either by some form of modelling (e.g. to assess travel distance of homes from the supply) or through household surveys. In either case, considerable errors are likely to occur. An age range of 0-14 years is used for this indicator, because risks extend throughout the child's early life and adolescence.
SPECIFICATION	
Definition	Percentage of children aged 0-14 living in households without a piped and continuous water supply either to the home or to the immediate neighbourhood.

Terms and concepts	***Piped and continuous water supply:*** a piped water supply, providing an adequate supply of water to meet household needs continuously throughout the day***.*** ***In the home:*** a supply that provides at least one controlled outlet inside the home, or in the yard/garden associated with the home. ***In the immediate neighbourhood:*** a supply that provides at least one controlled outlet, with unrestricted access, no more than 5 minutes walk from the home.
Data needs	Numbers of children aged 0-14 by water supply status of the home. Total number of children.
Data sources, availability and quality	Data on the availability of, and access to, piped or public water supplies or water supplies provided under a formal licensing scheme (e.g. licensed abstractions from wells) may be obtained both from censuses and from relevant administrative authorities (e.g. water companies, public works departments). Data on access to informal supplies will usually need to be obtained via household surveys. Data on total population are available from national censuses and should be reliable.
Level of spatial aggregation	Community or water supply zone
Averaging period	Annual or longer term
Computation	The indicator can be computed as a simple percentage: *100 * (Cacc / Ctot)* where: *Cacc* is the number of children aged 0-14 years with access to a continuous piped water supply either in the home or within a 5 minute walk of the home; *Ctot* is the total population of children aged 0-14 years.
Units of measurement	Percentage
Worked example	Assume that a survey of households shows that 600 children, out of a total of 1 050 children, live in households without access either to a piped and continuous water supply either in the home or within easy walking distance. In this case, the value of the indicator will be: 100 * (600 / 1 050) = 57.1%
Interpretation	This indicator provides a measure of the access to continuous piped water supplies within easy reach of the home. It is used here as an indicator of risks of physical injuries (e.g. by drowning, traffic or other accidents) whilst collecting water, bathing or washing. In general therefore, an increase in the indicator represents a raised risk, a reduction a diminished risk. In interpreting the indicator, it is nevertheless important to recognize that the data used to compile the indicator may be subject to major uncertainties, and comparisons between different areas (that might use different definitions or measurement methods) need to be undertaken with care.

Variations and alternatives	Variations in this indicator are possible by defining it in terms of different age ranges (e.g. children aged 0-4 years), or by using different classifications of a continuous and accessible water supply: e.g. percentage of children living in homes linked to a piped and treated water supplies.
Examples	UN Indicators of sustainable development • **Access to safe drinking water** UNCHS (Habitat) *Urban indicators programme* • **Household connection levels** WHO *Catalogue of health indicators* • **Access to safe drinking water** WHO *Environmental health indicators: framework and methodologies* • **Access to safe and reliable supplies of drinking water**
Useful references	UN *1996 Indicators of sustainable development. Framework and methodologies*. New York: United Nations. UNCHS(Habitat) 1997 Monitoring human settlements with urban indicators. Nairobi: United Nations Centre for Human Settlements. WHO 1982 National and global monitoring of water supply and sanitation. CWS series of Cooperative Action for the decade, No.2. WHO 1996 *Catalogue of health indicators: a selection of health indicators recommended by WHO programmes*. Geneva: World Health Organization (under revision). WHO 1999 *Environmental health indicators: framework and methodologies.* Geneva: World Health Organization. (Available at http://www.who.int/docstore/peh/archives/EHIndicators.pdf) WHO/UNICEF 1996 Water supply and sanitation sector monitoring report 1996. World Health Organization/UNICEF Joint Monitoring Programme. WHO/UNICEF 1999 Global water supply and sanitation assessment 2000. Water supply and sanitation sector questionnaire (Draft report).

MORTALITY RATE OF CHILDREN AGED 0-14 YEARS DUE TO PHYSICAL INJURIES

GENERAL CONSIDERATIONS	
Issues	Physical injuries
Type of indicator	Health outcome
Rationale	Physical injuries are a major cause of death amongst children. Injuries occur for many different reasons: amongst the most important are road traffic collisions, drownings, falls, natural disasters and physical assault. This indicator provides a measure of the health effect of injuries, in terms of the mortality rate amongst one of the most vulnerable groups – children aged 0-4 years.
Issues in indicator design	This indicator raises relatively few design issues, since it expresses a clear health outcome, deriving from an explicit cause. Some data problems may be experienced because of uncertainties in coding and inadequate georeferencing of the place of accident. Data on external cause of injury are also often unreliable and weak. It is also essential to compute separate measures for boys and girls because of the strong effect of gender on levels of risk. An age range of 0-14 years is used for this indicator, because risks extend throughout the child's life.
SPECIFICATION	
Definition	Mortality rate amongst children aged 0-14 years due to physical injuries.
Terms and concepts	***Deaths due to physical injury:*** death in which the main cause was physical damage to the body caused by an external force.
Data needs	Number of deaths due to physical injury by external cause, age and gender. Total number of children aged 0-14 years by gender.
Data sources, availability and quality	Data on mortality rates due to physical injuries are likely to be available from routine death registrations, and as such should be broadly reliable. Problems of diagnosis are likely to be less than for many other causes of death, but data on external cause of injury are often weak and unreliable. Data on total population are available from national censuses and should also be broadly reliable.
Level of spatial aggregation	Health district
Averaging period	Annual
Computation	The indicator can be computed as a simple mortality rate: 1 000 * (*Dinj / Ctot)* where: D_{inj} is the total number of deaths due to physical injuries amongst children aged 0-14 years; *Ctot* is the total population of children aged 0-14 years.
Units of measurement	Number per thousand head of population.
Worked	Assume that there are 690 deaths of children due to physical injury in an

example	area containing 36 420 children aged 0-14 years. In this case, the value of the indicator would be: 1 000 * (690 / 36 420) = 18.9 per thousand
Interpretation	This indicator provides a measure of the death rate amongst young children due to physical injuries. It can thus be interpreted as a direct indication of risks to children's health from this source. Because physical injuries may be due to many different factors, care is needed in interpreting causality.
Variations and alternatives	This indicator might usefully be devised for more specific classes of physical injury: for example, traffic collisions, drownings, injuries at home, workplace injuries. In these cases, also, it may be appropriate to target the indicator at different age ranges (e.g. 0-4, 5-14 years).
Examples	None known
Useful references	Manciaux, M. and Romer, C.J. 1991 *Accidents in childhood and adolescence*. The role of research. Geneva: World Health Organization. Peden, M., McGee, K., Krug, E. (Eds.) *2002 Injury: A leading cause of the global burden of disease, 2000*. Geneva: World Health Organization.

INCIDENCE OF PHYSICAL INJURIES TO CHILDREN AGED 0-14 YEARS REQUIRING TREATMENT

GENERAL CONSIDERATIONS	
Issues	Physical injuries
Type of indicator	Health outcome (expressed as a static measure of rate)
Rationale	Children are amongst the most vulnerable groups to injury, both in the home and on the street for a range of reasons: because of the tendency for the world around them to be designed and structured with little regard for children's safety; because of the limited development of their own risk perceptions and behaviours; and because of their inherent physical vulnerability. Successful intervention to reduce risks of injuries to children should be reflected in the injury rate. This can already be seen in some countries, where injury rates from some causes (e.g. road traffic, occupational injuries) have fallen as a result of improved technologies, policies and awareness raising. The annual rate of change in the injury rate thus provides a useful indicator of the direction and trajectory of policy impacts. Expressed as a static measure of rate, this indicator provides a general measure of these risks, based upon injury rates to children under 5 years of age.
Issues in indicator design	Injuries take many different forms, and occur in many different ways. Non-fatal injuries may also be treated by, and reported to, many different authorities – and many may not be reported at all. One of the major difficulties in developing this indicator is thus to ensure consistency in the definitions and the reliability of the data used. Injury rates also vary substantially between different age ranges and by gender (boys tend to be more injury prone than girls). Careful definition of the sub-population range is therefore essential if the risks to children's health are to be represented effectively. The indicator should also usefully be stratified by gender. An age range of 0-14 years is used for this indicator, since risks from physical injuries (albeit often from different causes) extend throughout the child's life.
SPECIFICATION	
Definition	Incidence of physical injury to children aged 0-14 years by gender
Terms and concepts	***Physical injury***: unintentional injury of sufficient severity to require medical attention. ***Total number of children aged 0-14 years****:* total resident population of children aged 0-14 years, at the time of survey.
Data needs	Incidence of unintentional physical injuries to children aged 0-14 years, by gender and external cause Total number of children aged 0-14 years, by gender

Data sources, availability and quality	Data on the number of childhood injuries should usually be available from routine medical statistics (e.g. hospital admissions/discharges). Data on external causes of injury are fundamental to prevention policy and planning, and essential for this indicator, but are likely to be weak and unreliable because of differences in referral rates, diagnosis and reporting methods. Where these data are not available, special surveys may be needed. Data on the total number of children aged 0-14 years should be available from national censuses and should be broadly reliable.
Level of spatial aggregation	Health district
Averaging period	Annual
Computation	As a measure of effect, the indicator can be computed as: *1000 * (Cinj / Ctot)* where: *Cinj* is the number of reported cases of injury to children aged 0-14 years; *Ctot* is the total population of children aged 0-14 years
Units of measurement	Rate per 1000 children (as a measure of exposure) Annual percentage rate of change (as a measure of action)
Worked example	As a measure of exposure: assume that in one area, over one year, 1090 reported injuries occur amongst a population of 37'600 children aged 0-14 years. In this case the value of the indicator is calculated as: 1000 * (1090 / 37600) = 29.0 injuries per 1000 children
Interpretation	This indicator provides a simple and direct measure of the incidence of physical injuries to children. As a measure of health outcome, an increase in the incidence of childhood injuries may be interpreted as evidence of increased levels of risk; a reduction implies the reverse. Care is, however, needed in making interpretations because of likely inadequacies in the available data and the range of other factors which may affect injury rates. Significant differences in reported rates may occur either geographically or over time, for example, because of differences in reporting methods and referral rates - e.g. due to differences in accessibility of the health care services. Rates of injury are also affected by often subtle variations in cultural, lifestyle and behavioural factors (e.g. in play behaviour of children, in the design and layout of homes and play areas, in parental attitudes to supervision). Where possible, the indicator should therefore be interpreted in the context of other cultural information.
Variations and alternatives	More specific versions of this indicator should be used where possible (classified by ICD code), relating to specific causes of injury (e.g. from falls, traffic accidents, physical assault, burns and scalds).
Examples	WHO *Environmental health indicators: framework and methodologies* • **Injuries to children**
Useful references	Manciaux, M. and Romer, C.J. 1991 *Accidents in childhood and adolescence*. The role of research. Geneva: WHO.

CHILDREN AGED 0-14 YEARS LIVING WITHIN REACH OF SPECIALIST EMERGENCY MEDICAL SERVICES

GENERAL CONSIDERATIONS	
Issues	Physical injuries
Type of indicator	Action
Rationale	Rapid access to emergency medial services is one of the main ways of reducing fatalities from injuries. Improvements of these services, therefore, represents one of the most effective means of action to reduce mortality amongst children. This indicator, therefore, provides a measure of access to emergency services.
Issues in indicator design	The main problems in developing this indicator are the definition of specialist emergency health care and the measurement of travel times to the available facilities. Specialist care centres may take many forms, vary greatly in their quality, and differ substantially in terms of the range of services they offer, the numbers of people they can deal with, and their response times. The simple existence of such facilities, therefore, does not necessarily indicate that effective care is available. Estimation of travel time to specialist emergency health care requires the ability to define both the place of residence and the location of the care centre with some degree of accuracy, as well as the travel route and speed. With the help of GIS techniques, and with suitable georeferenced data, this is possible; where these data are not available, only rough approximations can be made. For these reasons, the indicator may be subject to major uncertainties. An age range of 0-14 years is used for the indicator, because risks extend throughout the early years of life and adolescence.
SPECIFICATION	
Definition	Percentage (or number) of children aged 0-14 years living within 1 hour's travel time of specialist emergency health care.
Terms and concepts	***Specialist emergency health care:*** a hospital or other care centre providing a full range of accident and emergency facilities, including surgical treatment and intensive care. ***Living within 1 hour's travel time:*** living at a place of residence within less than one hour's travel time of the nearest specialist facilities, given available emergency transport facilities
Data needs	Location of specialist emergency medical facilities and associated road and air ambulance coverage. Numbers of children aged 0-14 by place of residence. Road network.
Data sources, availability and quality	Data on the location of health care facilities are generally available from the health services or ministry. Data on population distribution can usually be obtained from national censuses. Where census tracts are small, these may be sufficient to estimate the numbers of women of childbearing age within the specified travel time of the specialist health care facilities. Where these data are not of a sufficiently high resolution, it may be necessary to use modelling techniques to estimate the more local population distribution (e.g. on the basis of land cover type derived from satellite data, or land use maps).

	Data on road networks may be available in a digital or map form (e.g. from mapping or highways agencies). Where data on population or transport facilities are unavailable, questionnaire surveys of emergency medical services may be necessary to estimate their population coverage.
Level of spatial aggregation	Census tract, community or health district
Averaging period	3-5 years
Computation	The indicator can be computed as a simple percentage, as follows: *100 * Cnear / Ctot* where: *Cnear* is the number of children aged 0-14 years living within 1 hour's travel of an emergency medical department; *Ctot* is the total number of children aged 0-14 years.
Units of measurement	Percentage
Worked example	Assume that, within an area containing 210 300 children aged 0-4 years, 41 670 live within 1 hour's travel of a specialist maternal and perinatal health care facility. In this case, the value of the indicator is calculated as: 100 * 41 670 / 210 300 = 19.8%
Interpretation	Where reliable data exist, this indicator can be interpreted as a measure of the ease of access to emergency medical services. An increase in the indicator represents an improvement in accessibility; a fall in the indicator implies a reduction in accessibility. These changes can, of course, occur for different reasons: because of changes in the extent and availability of the services, or because of changes in population numbers and distribution. Care is also needed in interpreting the indicator because the existence of services within the specified travel time does not necessarily mean that it is freely accessible. In addition, variations may occur in the definition (and quality) of emergency medical services from one area to another, so that caution is needed in making geographical comparisons. Uncertainties may also be expected in the indicator, due to data limitations and the need to estimate travel times.
Variations and alternatives	The main variations that may be required in this indicator are in the way in which access is defined and calculated. The specification of 1 hour as the threshold for travel time is, for example, arbitrary; other thresholds may be more appropriate in some cases. Where travel times cannot easily be calculated, it may be more practicable to base the indicator on a distance measure (e.g. percentage of children living within 30 km of emergency medical facilities). Another alternative is to base the indicator on the average distance to the nearest emergency medical department. Both these alternatives can readily be estimated using GIS techniques. A simpler alternative is the average population-weighted density of the available services (i.e. number of people per facility); this, however, takes no direct account of proximity and is not sensitive to clustering of the services in certain (e.g. more affluent) areas.
Examples	None known
Useful references	American Academy of Pediatrics, Committee on Pediatric Emergency Medicine. 1995 Guidelines for Pediatric Emergency Care Facilities RE9536. *Pediatrics* 96 (3), 526-537. American Academy of Pediatrics, Committee on Pediatric Emergency Medicine. 1999. Emergency preparedness for children with special

	healthcare needs. *Pediatrics* 104 (4), 526-537. American College of Emergency Physicians Emergency care of children. Fact Sheet. (Available at http://www.acep.org/1,167,0.html) Bissell RA, Seaman KG, Bass RR, Racht E, Gilbert C, Weltge AF, Doctor M, Moriarity S, Eslinger D, Doherty R. 1999 Change the scope of practice of paramedics? An EMS/public health policy perspective. *Prehospital Emergency Care* 2(2), 140-9.

ATTRIBUTABLE CHANGE IN INCIDENCE OF PHYSICAL INJURIES TO CHILDREN AGED 0-14 YEARS REQUIRING TREATMENT

GENERAL CONSIDERATIONS	
Issues	Physical injuries
Type of indicator	Action
Rationale	Children are amongst the most vulnerable groups to injury, both in the home and on the street for a range of reasons: because of the tendency for the world around them to be designed and structured with little regard for children's safety; because of the limited development of their own risk perceptions and behaviours; and because of their inherent physical vulnerability. Successful intervention to reduce risks of injuries to children should be reflected in the injury rate. This can already be seen in some countries, where injury rates from some causes (e.g. road traffic, occupational injuries) have fallen as a result of improved technologies, policies and awareness raising. The annual rate of change in the injury rate thus provides a useful indicator of the direction and trajectory of policy impacts.
Issues in indicator design	Injuries take many different forms, and occur in many different ways. Non-fatal injuries may also be treated by, and reported to, many different authorities – and many may not be reported at all. One of the major difficulties in developing this indicator is thus to ensure consistency in the definitions and the reliability of the data used. Injury rates also vary substantially between different age ranges and by gender (boys tend to be more injury prone than girls). Careful definition of the subpopulation range is therefore essential if the risks to children's health are to be represented effectively. The indicator should also usefully be stratified by gender. More substantially, the problem with this as with any measure of the effectiveness of actions is to specify the changes that can, in truth, be seen as consequences of intervention. This is often difficult because of the confounding effect of long-term trends, and of other, often random and short-term events, that may affect accident rates. One way of minimizing these problems is to standardize the indicator by comparing injury rates after intervention in the area of interest with the projected rates over the same period, derived by extrapolating the rates from beforehand. An age range of 0-14 years is used for this indicator, since risks from physical injuries (albeit often from different causes) extend throughout the child's life.
SPECIFICATION	
Definition	Attributable change in the incidence of physical injury to children aged 0-14 years by gender due to policy intervention
Terms and concepts	***Physical injury***: unintentional injury of sufficient severity to require medical attention. ***Total number of children aged 0-14 years****:* total resident population of children aged 0-14 years, at the time of survey. ***Attributable change:*** the percentage (or number) of fewer or additional accidents to children as a direct or indirect consequence of the intervention.
Data needs	Incidence of unintentional physical injuries to children aged 0-14 years, by gender and external cause Total number of children aged 0-14 years, by gender
Data sources, availability and	Data on the number of childhood injuries should usually be available from routine medical statistics (e.g. hospital admissions/discharges). Data on

quality	external causes of injury are fundamental to prevention policy and planning, and essential for this indicator, but are likely to be weak and unreliable because of differences in referral rates, diagnosis and reporting methods. Where these data are not available, special surveys may be needed. Data on the total number of children aged 0-14 years should be available from national censuses and should be broadly reliable.
Level of spatial aggregation	Health district
Averaging period	Annual
Computation	The indicator can be computed as the percentage change in the incidence of physical injuries before and after intervention, over and above any change that would have occurred without intervention. This is done by finding the difference between the rates of injuries after intervention and the projected rates based on a 'no-intervention' scenario. Three steps are involved in the process of indicator development. First the trend in annual injury rates should be computed for the pre-intervention period. This is best done using regression analysis methods (as available in most statistical packages and spreadsheets such as Excel). This provides a formula that can be used to predict rates in the post-intervention period. If no trend is observable (i.e. if the association with time is statistically not significant at the 95% level), then the arithmetic average from the pre-intervention period should be used. Alternatively, it may be possible to derive a trend 'by eye' by graphing the data as a scattergram and interpolating a trendline. Whichever method is used, attention should be paid to the nature of the relationship; in the event of a strongly non-linear trend, for example, an appropriate curvilinear trendline should be fitted, either by transforming the data or by using polynomial curve-fitting functions. Using the fitted trend, the number of injuries for the period after policy intervention should then be calculated, by projection of the trendline. Values for each year since intervention should be computed. Finally, the reported number of injuries post-intervention are compared with the projected number and the differences calculated. The indicator is expressed as the percentage difference, compared with the projected number of injuries, as follows: $100 * [\Sigma(Cinj_{rpost} - Cinj_{proj}) / \Sigma (Cinj_{proj})] / Years$ where: $Cinj_{proj}$ is the projected number of injuries during the post-intervention period; $Cinj_{post}$ is the reported number of injuries during the post-intervention period.
Units of measurement	Attributable percentage change
Worked example	A worked example is presented in the Table below. In this case, policy intervention aimed at reducing injury rates was introduced in 1999, and the effectiveness of the policy is determined over the following five years.

Year	1994	1995	1996	1997	1998

1996	5280	109	48.44		
1997	5116	111	46.09		
1998	5107	113	45.19		
2000	4900	115	42.61	42.20	4853.00
2001	4620	117	39.49	40.92	4787.6
2002	4174	119	35.08	39.64	4717.1
2003	4540	121	37.52	38.36	4641.6
2004	4228	123	34.37	37.08	4560.8
Total (post)	**22462**				**23560.3**

In this case, analysis of the injury rates for the pre-intervention years (1994-1998) gives a small, downwards trend, with the formula:

*Injury rate = 2602.3 – 1.28*Year*

In the fifth column of the table, this rate has been applied to predict the injury rate without intervention, and this is then converted, in the sixth column, to the expected number of injuries, taking account of the population of children aged 0-14 years.

The difference between the projected and reported totals of injuries for the intervention period is then calculated and expressed as a percentage of the projected total:

100 *(22462 – 23560.3) / 23560.3 = -4.7% - i.e. a reduction of 4.7% in the expected injury rate.

Interpretation	This indicator provides a general measure of changes in accident and injury rates to children as a result of policy intervention. A positive value indicates that the injury rate has increased; a negative value indicates a reduction in the injury rate. The extent to which these changes can be truly attributable to the intervention does, of course, need to be interpreted with caution. Many other events may contribute to the measured change, and if these are acting differentially between the intervention and control area they can seriously bias the indicator. Careful selection of the control area is essential to minimize this risk. Care is, however, needed in making interpretations because of likely inadequacies in the available data and the range of other factors which may affect injury rates. Significant differences in reported rates may occur either geographically or over time, for example, because of differences in reporting methods and referral rates - e.g. due to differences in accessibility of the health care services. Rates of injury are also affected by often subtle variations in cultural, lifestyle and behavioural factors (e.g. in play behaviour of children, in the design and layout of homes and play areas, in parental attitudes to supervision). Where possible, the indicator should therefore be interpreted in the context of other cultural information.
Variations and alternatives	Where policies to prevent injuries are introduced in only part of the area of interest, this indicator can be improved, by comparing trends before and after intervention in the intervention area (i.e. where the policy has been applied) with trends before and after intervention in a matched control area (one with similar pollution characteristics but in which the policy has not been applied). More specific versions of this indicator should be used where possible (classified by ICD code), relating to specific causes of injury (e.g. from falls, traffic accidents, physical assault, burns and scalds).
Examples	WHO *Environmental health indicators: framework and methodologies* • Injuries to children
Useful references	Manciaux, M. and Romer, C.J. 1991 *Accidents in childhood and adolescence*. The role of research. Geneva: WHO.