Strategies to intervene on social determinants of infectious diseases

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Systematic health inequalities exist in all European countries today. Individuals with lower socio-economic status suffer disproportionally from adverse health outcomes. While this is widely accepted for chronic diseases, a literature review covering the years 1999-2010 reveals that infectious diseases are also distributed unevenly throughout society, with vulnerable groups bearing a disproportionate burden. This burden is not restricted to a few 'signature infections of social determinants' such as tuberculosis or human immunodeficiency virus (HIV) infections, but also a wide array of other infectious diseases. Tremendous advances in public health over the last century have reduced the absolute magnitude of inequalities but relative differences remain. In order to explore the underlying reasons for such persistent inequalities in Europe, I examined interventions targeting social determinants of infectious diseases: interventions on social determinants tend to focus on chronic diseases rather than infectious diseases, and interventions for these mainly focus on HIV/AIDS or other sexually transmitted infections. Thus, there seems to be a need to intervene on inequalities in infectious diseases but ideally with a comprehensive public health approach. Three intervention strategies are discussed: population-at-risk, population, and vulnerable population approaches. Strengths and weaknesses of these options are illustrated.

Introduction

Social circumstances determine prospects in life. They differ throughout society and can manifest themselves for example through conditions in early childhood, education, employment, living conditions. Two types of contextual drivers can be differentiated [1]: (i) structural determinants of health, the social, political, cultural, and economic context give rise to the distribution of income, education, etc. as defined by specific social, gender, or race/ethnicity norms that set the process of social stratification in motion; (ii) intermediary determinants of health, crowded living and working conditions, inadequate food availability, high-risk sexual behaviour, etc. shape differences in exposure and vulnerability. As a result, socio-economic status determines health conditions [2]. For example, educational attainment determines mortality in different groups, with the highest mortality rates found in groups with lowest educational levels [3]. This mortality difference was observed throughout Europe, although less in some some urban, relatively prosperous southern European populations, and more in most eastern European countries and Baltic region such as Lithuania and Estonia [4]. The absolute differences between these health indicators (e.g. mortality or morbidity) for low compared with high socio-economic classes have decreased over the last decades [5]. However, relative differences between these two groups have remained stable in western European countries, if not increased, with individuals in a lower socio-economic class suffering from worse health outcomes [6]. In fact, income-related health inequalities expanded, the longer they persisted based on a longitudinal analysis of European survey data [7]. These findings suggest that a declining income over time is associated with growing health limitations when compared with a rising income. Because differences in health and socio-economic status persist over time they are a policy priority in Europe [4,8,9].

However, intervening on these health discrepancies is intricate at best [10] and a number of open questions remain. What specific infectious diseases in which groups should be targeted for effective control, and how? Moreover, interrupting transmission in certain subpopulations has proven to be remarkably resilient to public health interventions. Interventions on individual health behaviour changes, to prevent HIV infection (e.g. condom use) or for early cancer detection (e.g. cervical cancer screening with the Papanicolaou test) for example, often yield lower participation rates in marginalised groups [11,12]. Prevalence and incidence rates of many health endpoints tend to be elevated in these populations while response rates are generally lower for health promotion and health education interventions [13]. The purpose of this paper is to assess the range of infectious diseases in Europe that are determined by socio-economic factors, to examine respective interventions with a focus on infectious diseases and finally to discuss a theoretical framework for interventions on inequalities in infectious diseases.

In addition to micro-interventions focusing solely on behaviour change, other strategies should be considered such as (i) the populations-at-risk approach, (ii) the population approach, or (iii) the vulnerable population approach. Advantages and disadvantages of these three strategies for infectious disease control are discussed.

Footprint of social inequalities on infectious disease in Europe

Original research articles addressing socio-economic determinants of infectious diseases in Europe were retrieved from Medline (PubMed) and ScienceDirect bibliographic databases. The search strategies submitted were: ("socioeconomic factors"[MeSH Terms] OR "inequality"[All Fields]) AND ("infectious diseases"[MeSH Terms] OR "infectious"[All Fields]) AND ("Europe"[MeSH Terms] OR "Europe"[All Fields]); the search was expanded with a number of other terms

Table 1

Selected examples of infectious diseases impacted by socio-economic determinants in Europe, January 1999-July 2010

Pathogen	Health endpoint	Socio-economic determinants and site of study
Campylobacter spp.	Intestinal disease	Pakistani community at greater risk of infection than 'white'[a] community in England [36] [a] Classified according to the 1991 census, England.
Clostridium botulinum	Progressive bulbar palsy, diplopia,dysarthria	Injecting heroin drug users at risk, Dublin, Ireland [37]
Common childhood pathogens	Infectious/parasitic diseases	High infection rates found in children in an area characterised by lower socio-economic status in Romania (Moldova) [38]
Cytomegalovirus (CMV)	Infectious mononucleosis, with fever, mild hepatitis, congenital abnormalities	Low socio-economic status and social environment as risk factor for CMV seroprevalence and congenital CMV infection in Helsinki, Finland [39]
Bacillus anthracis	Inflammation or abscesses related to sites of heroin injection, death	Outbreak among (predominantly) intravenous drug users in Scotland [40]
Pathogens associated with injecting drug use	Numerous major health consequences	Risks from injecting drug use, sex, unhygienic living and injecting conditions in marginalised (Roma or homeless) intravenous drug users, Budapest, Hungary [41]
Flaviviridae (Arbovirus) transmitted by ticks	Tick-borne encephalitis (TBE)	Transmission of TBE in Central and Eastern European countries influenced by socio-economic factors [42]
Herpes simplex virus type 1 (HSV1) and 2 (HSV2)	Significant morbidity, Herpes simplex virus type 1 (HSV1) considered a risk factor for HIV transmission	Increase of HSV1 seroprevalence with age among people of Turkish and Moroccan origin, homosexual men, and individuals with low educational level in Amsterdam, the Netherlands [43]
Listeria. monocytogenes	Listeriosis	Incidence associated with neighbourhood deprivation in England [44]
Neisseria meningitidis (meningococcus)	Meningococcal disease	Parental smoking and unfavourable socio-economic circumstances among children in the Czech Republic [45]
Rubella virus	Congenital rubella syndrome (CRS)	Low socio-economic status associated with low rubella seropositivity in Dogankent Health Center, Turkey [46]
Gardnerella vaginalis, Mobiluncus, Bacteroides, Mycoplasma	Bacterial vaginosis	Increased risk for bacterial vaginosis in women who have daily coitus, are single, smokers, with a previous sexually transmitted disease, or with high alcohol consumption in pregnancy, Denmark [47]
Hepatitis A virus	Acute infectious disease of the liver	Outbreak in Lomnička, a village in the eastern part of Slovakia, among the Roma population associated with low socio-economic conditions [48]
Hepatitis B virus	Malignant and non-malignant liver disease	Significant higher prevalence rates in immigrant women in Greece [49]
Hepatitis C virus	Malignant and non-malignant liver disease	Prevalence of anti-HCV antibodies in underprivileged individuals without social insurance in France, much higher than in the general population [50]
Helicobacter pylori	Peptic ulcer disease, gastric cancer	Poor socio-economic status as an important risk factor for peptic ulcer disease in Denmark [51]
Influenza virus	Vaccine coverage	Lower vaccine uptake in socio-economically deprived populations in Britain [52]
Methicillin-resistant *Staphylococcus aureus* (MRSA)	Postoperative infection	Patients from the most deprived areas at higher infection risk than those from the least deprived areas in England [53]
Sexually transmitted pathogens (STI)	Sexually transmitted diseases (STD)	High-risk sexual behaviour among immigrant groups in Amsterdam, the Netherlands [54]
Toxoplasmosis	Encephalitis and congenital malformations	Incorrect monitoring for toxoplasmosis during pregnancy among migrants in northern Italy, precluding timely application of preventive measures [55]
Trichomonas vaginalis	Sexually transmitted diseases (STD)	High prevalence of *T. vaginalis* and multiple infections with other STDs among female inmates in Lisbon, Portugal [56]
Puumala virus (PUUV)	Nephropathia epidemica, a mild form of haemorrhagic fever with renal syndrome (HFRS)	PUUV infection risk higher among low-income populations in remote forest areas with low level of urbanisation, Belgium [57]

such as inequity, ethnicity, race, homeless, vulnerable, marginalised, prison, or drug use. Key words were used in the search strategies for papers in all languages with an English abstract, published between January 1999 and July 2010. Retrieved citations were screened by title and abstract review. Inclusion criteria were defined widely, in order to retrieve a broad range of articles. Papers that did not address infectious diseases and articles that did not pertain to Europe were excluded from further analysis. Selected articles underwent data extraction using a standardised form to capture infectious pathogens, health endpoints, social determinants, epidemiologic findings and geographic location covered in the studies (Table 1).

The majority of research on socio-economic determinants of health focused on chronic diseases, because infectious diseases only represent 9% of the total burden of diseases in Europe [14]. The review revealed vulnerable or marginalised groups to carry a disproportionate proportion of this infectious diseases burden (Table 1). The socio-economic gradient has been well established for human immunodeficiency virus (HIV) infections and tuberculosis with a large number of articles documenting this discrepancy; for example, in an ecologic analysis of European countries, tuberculosis notification rates increased with rising wealth inequality [15]. In addition to these 'signature infections of socio-economic determinants' a number of other infections were also indentified in this literature search (Table 1). They included not only minor infections with relatively benign health outcomes but also a number of infections with potentially serious health consequences: a discrepancy between socio-economic groups was found for the prevalence of human papillomavirus and *Heliobacter pylori* infections, which have been associated with cervical or gastric cancer, respectively [16,17]. Moreover, health endpoints associated with social determinants included infectious disease incidence, prevalence, mortality or vaccination coverage. Crowded living conditions, migration status, incarceration, substandard education, low income, or other socio-economic factors were associated with a disproportionate burden of infectious diseases in studies from every European Union (EU) Member State [18]. It is apparent that infectious diseases in Europe remain not only a serious public health threat to vulnerable populations but potentially also to the population at large. Since, as documented here, infectious disease incidence and prevalence are not distributed evenly throughout society, concentration of infections and risk factors can hasten the spread of communicable diseases. Vulnerable populations are at greater risk due to environmental or behavioural risk factors; moreover, these groups tend to lack access to healthcare to prevent further dissemination and adverse consequences of disease.

European interventions on inequalities in infections

Interventions addressing health inequalities, used in infectious disease prevention or management were identified from national websites (Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany,

Table 2

Selected examples of interventions on inequalities in infectious diseases in Europe, 1999–2009

Country	Outcome	Target groups	Intervention
Czech Republic	HIV, AIDS, sex education	Adolescents and adults from lower socio-economic status groups, including Roma and Sinti	Gradual improvement of knowledge, opinions and attitudes in the population, especially adolescents, with free, open and responsible patterns of behaviour and decision making [58]
Estonia	HIV, AIDS	Ethnic minorities (e.g. Sinti, Roma) and substance abusers	Improving access to quality services offered to HIV-positive pregnant women and their infants in East Viru County and reducing the risk of mother-to-child transmission of HIV during pregnancy and delivery [59]
Germany	HIV, AIDS, prevention	Asylum seekers, refugees, undocumented immigrants, migrants	Prevention of sexually transmitted infections [60]
Latvia	HIV, AIDS, counselling, testing, prevention, support, needle exchange	People living with HIV/AIDS and those at risk of developing HIV/AIDS (at risk youth, intravenous drug users, commercial sex workers, gay men, etc.), stakeholders interested/involved and the healthcare community	Operating a low threshold drop-in centre that provides support, counselling and information to people with HIV/AIDS and other relevant parties and to advocate for their interests [61]
the Netherlands	Sexually transmitted diseases, prevention, education	Migrants from the Dutch Antilles aged between 15 and 50 years	Promoting safe sex practices [62]
Spain	HIV, AIDS, sex education	(Ex)prisoners	Health promotion among the prison population [63]
United Kingdom	HIV, AIDS, sex education	11 - 25 year-olds, with difficult access to regular sex education (e.g. those with learning disabilities, deaf adolescents, homeless, excluded from education, autistic spectrum children)	Reducing the incidence of sexually transmitted infections and HIV in vulnerable young people [64]

AIDS: acquired immune deficiency syndrome; HIV: human immunodeficiency virus.

Greece, Hungary, Iceland, Ireland, Italy, Latvia, the Netherlands, Norway, Poland, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom) and The Good Practice Directory of the European Health Inequalities portal [19] with the following English search terms: infection, infectious, infectious, best practice, inequity, and inequality. Interventions were searched that set the reduction of health inequalities as a clear aim and target individuals or groups in a social disadvantage concerning education, occupational status or income, neighbourhood or ethnicity, etc. Three databases were identified from European Portal for Action on Health Equity [19] with relevant information (i) Closing the Gap, (ii) Health Promotion for Marginalised Groups (Gesundheitsförderung bei sozial Benachteiligten), (iii) and the QUI-database (health promotion and prevention).

The majority of interventions were designed for chronic diseases but only very few for infectious diseases. The paucity of examples in Table 2 may also reflect the lack of accessible information on existing programmes. Table 2 is unlikely a comprehensive list of all existing interventions in this field, since other programs might not be available on the internet or are only listed in their national language. Nevertheless, all infectious disease interventions identified specifically targeted sexually transmitted infections and/or HIV infection (Table 2). The narrow focus of these interventions on a specific transmission pathway and specific infections suggests that most interventions on social determinants of diseases target intermediary determinants, as discussed above. However, interventions could target both structural and intermediary determinants, to assure highest possible impact.

Intervening on inequalities in infections

Population-at-risk approach

This intervention entry point targets the population with the highest level of risk [20]. In this context, the population-at-risk can be defined as a group or groups with elevated risk for a specific infectious disease, irrespective of socio-economic status. All examples listed in Table 2 adhere to this approach since they focus on specific health endpoints in high-risk populations. Such a targeted approach can be highly efficacious in lowering the incidence of infectious diseases because it can effectively interrupt transmission. For example, in low tuberculosis prevalence countries, selective Bacillus Calmette-Guérin (BCG) vaccination of high-risk groups can be more cost-effective than a universal BCG programme [21]. In the hypothetical example illustrated in Figure 1A, assuming a normal distribution of risk, the curve is shifted to the left after the interventions, with clearly measurable benefits. Intervening on a single intermediary determinant of health is particularly efficacious when the high-risk group represents a small proportion of the population. Moreover, timely interventions targeting populations-at-risk could attenuate immediate health threats from exposure to infectious pathogens.

Limitations

Population-at-risk interventions can reduce the health threat for a specific infection singled out by the intervention. However, underlying structural determinants of health such as poverty, are not targeted with this approach [22]. Other risk factors or drivers of transmission for food, water, or vector-borne diseases might not be captured by the population-at-risk intervention (e.g. polio vaccination campaign) and thus new food, water, or vector-borne infections continue to occur. Consequently, overall health in the population-at-risk may not necessarily improve in the long run [23]. The shape of the population distribution with the overall level of risk is not altered either, with individuals remaining in the high-risk tail of the distribution in Figure 1A [24]. Even if disease transmission is interrupted, other infectious diseases continue to occur under the same contextual conditions.

The population approach

The population approach targets intermediary determinants of health through broad regulatory, environmental or health promotion measures [24]. Rather than intervening on specific populations-at-risk, this approach intervenes on the entire population. It has proven to be exceptionally successful in many settings by shifting the distribution of risk in a population to the left (Figure 1B). As a result a widespread impact in the general population can be measured. Some of these sweeping structural interventions include building codes (occupancy limits, building safety, etc.) or drinking water regulations, but also food hygiene, safe sex education or cervical cancer screening.

Limitations

This approach is based on the assumption that all groups have the same risk and same response rate to interventions, regardless of their socio-economic background. In other words, it assumes normality of the risk distribution and that individuals on the continuum of risk distribution respond equally well to the intervention, regardless if they are at the high-end of the distribution or the low end. Unfortunately, this is not necessarily the case. Populations low on the socio-economic scale tend not to respond equally well to health promotion campaigns compared with the general population [13]. For example, high-income women are more likely to take advantage of cervical cancer screening programmes compared with low-income women [12]. Therefore, the variance of the risk distribution can increase as illustrated in Figure 1C with wider tails. Moreover, the increased variance can be asymmetrical with a disproportional impact of the intervention on the left part of the distribution. Thus, those with lower risk derive more benefits from the intervention than those with greater risk and ironically, population approaches generate health inequalities.

Vulnerable population approach

In contrast to the population-at-risk approach, which targets just one risk factor, the vulnerable population

approach addresses structural determinants of health. Thus, a subset of the population, vulnerable to infections, is pursued. Several examples of marginalised populations can be found in Table 2. They include: migrants, asylum seekers, refugees, prisoners, Roma, etc. However, based on the information provided in Table 2, the interventions do not address structural determinants but rather focus on health education and health promotion for a specific health outcome (e.g. HIV infection, or acquired immune deficiency syndrome (AIDS)).

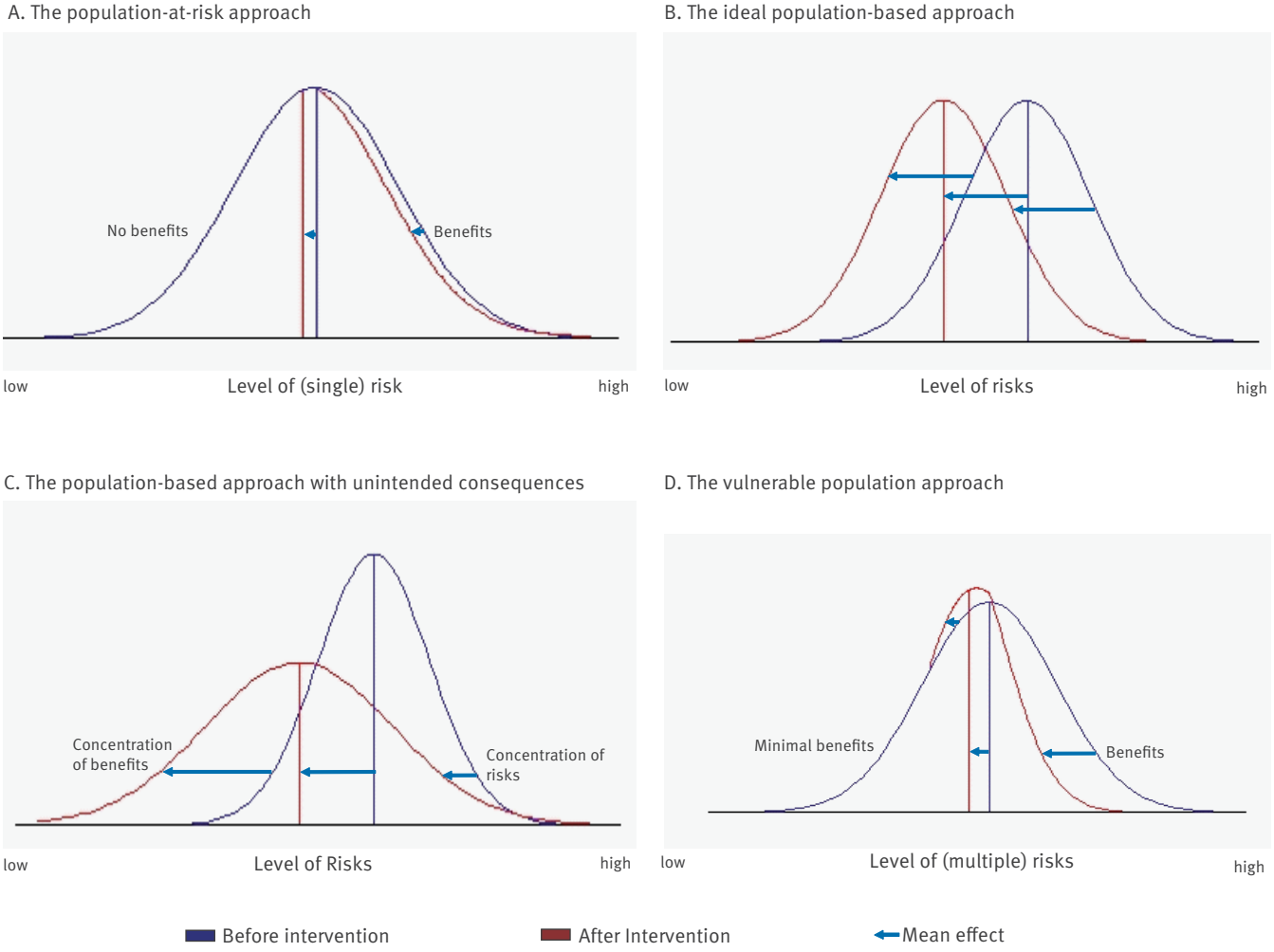
The vulnerable population approach targets underlying drivers that place individuals at 'risk for other risk factors' [25]. Rather than vaccinating against a specific infectious disease the vulnerable population approach aims at changing the social, political, cultural, or economic context that exposes marginalised populations to a number of infectious diseases. This strategy aims to lift individuals that share the same social characteristics out of a vulnerable position in society associated with a number of health threats (Figure 1D). By implementing interventions such as education and occupational training programmes for vulnerable groups their social position can be improved with tangible health benefits [26,27]. Specifically, moving children out of poverty, or childhood interventions with early childhood education, can shape the experiences of the developing child with benefits for the entire life course [28,29]. Thus, it empowers individuals to abandon the 'fundamental causes' of disease, the risk of being at risk, which are linked to the social position of vulnerable individuals within society [30]. The goal is to alter the life trajectory for vulnerable populations which concentrate risk factors for a range of outcomes.

Limitations

The urgency of infectious disease control in many instances calls for rapid interruption of disease transmission; thus, large scale, macro-social interventions with a long-term timeframe cannot do justice to immediate personal or public health needs [31]. Moreover, high exposure prevalence in vulnerable populations justifies swift interventions among high-risk individuals to minimise exposure. Thus, certain conditions are not amenable to a long-term vulnerable population

Figure

A-D. Hypothetical distribution of infectious diseases risk in a population and impact of selected interventions*



y-axis: population.

approach and might require interventions on a single risk factor.

Conclusion

This analysis calls for flexible and dynamic infectious disease control in Europe. No strategy fits all; rather a complementary approach is warranted. Different intervention strategies might have to be put in place simultaneously [32]. Vulnerable population interventions implemented in conjunction with population-at-risk and population interventions could lead to a substantial cost-effectiveness of such a programme. Currently, however, the interventions on inequality in infections identified in this study follow the population-at-risk approach. Potentially promising elements of these interventions were identified, such as improvements in knowledge and decision making, health promotion and health education. Nevertheless, macro-social or vulnerable population interventions were not found in this search. These complementary interventions are interdisciplinary in nature and difficult to implement. Public health is a societal enterprise and interventions aimed at improving the health of population groups ought to integrate a variety of different sectors, besides the health sector, to assure a comprehensive approach by drawing from civil engineering, urban planning, education, non-governmental organisations and other stakeholders. Interventions also need to consider the socio-political context and alter project goals accordingly. Each European country has specific socio-political circumstances requiring special attention and adjustment. Interventions should be evidence-based and prioritised according to their probability of success. Clear, measurable goals should be defined prior to project implementation and monitored for efficacy. Community participation in the intervention with collective decision making increases buy-in of vulnerable/marginalised groups and helps to advance social capital [33].

In light of the inequality in infectious diseases discussed above, interventions should simultaneously consider the population-at-risk approach, the population approach, and the vulnerable population approach. Fiscal and regulatory incentives must simultaneously and sustainably support behavioural change for interventions to succeed. In practical terms, this means that the healthiest behaviour option should also be the cheapest and easiest preference.

This analysis assumes a normal risk distribution which is clearly a simplification. Many infectious diseases show a bimodal distribution of risk but for the purpose of this 'thought experiment' a normal distribution is assumed that might apply to more common infectious diseases. Nevertheless, the scenarios presented illustrate intervention options available to the public health practitioners in Europe. With these options in the tool box, public health can strive towards effective infectious disease control and prevention and even elimination of certain infectious diseases.

Considerable challenges remain to reduce inequalities in health linked to social, economic and environmental factors, as recognised by the new EU Health Strategy [34]. In light of changing demographics in Europe, the policy debate on 'Health and Migration in the EU' encourages stakeholders to build partnerships and engage in cross-sectorial work, to achieve knowledge improvements, innovation and more effective interventions [35]. Effective interventions will assure fair treatment of all segments of society with an impartial share of society's benefits. Health is fundamental to the integration of vulnerable groups into a productive, diverse and fair society.

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*Erratum: In this figure, the colours in the legend were inverted. The mistake was corrected after publication of the article, on 9 July 2010.

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