

The Burden of Chronic Disease

C. G. Nicholas Mascie-Taylor^{1*} and Enamul Karim²

The shift from acute infectious and deficiency diseases to chronic noncommunicable diseases is not a simple transition but a complex and dynamic epidemiological process, with some diseases disappearing and others appearing or re-emerging. The unabated pandemic of childhood and adulthood obesity and concomitant comorbidities are affecting both rich and poor nations, while infectious diseases remain an important public health problem, particularly in developing countries. More attention should be given to the high burden of disease associated with soil-transmitted helminths and schistosomiasis, which until recently was not considered a priority even though regular drug treatment is obtainable at relatively little cost. In developing countries, the pressing requirement is to provide an accessible and good quality health-care system, whereas industrialized countries have a major need for greater public health education and the promotion of healthy life-styles.

The burden of disease and injury attributable to undernutrition, poor water supply, poor sanitation, and inadequate personal and domestic hygiene accounts for almost 23% of the disability-adjusted life years (DALY) from all causes worldwide and for 26% of DALY in developing regions (1). International initiatives are targeted primarily at conditions that cause higher mortality (such as AIDS, tuberculosis, malaria, and vaccine-preventable diseases), but there is also a need to focus attention on controlling conditions such as soil-transmitted helminths and schistosomiasis that lead to considerable morbidity.

Until recently, it was thought that human populations were experiencing a simple epidemiological transition. This idea, first put forward by Omran (2), envisaged three stages—"the age of pestilence and famine," "the age of receding pandemics," and "the age of degenerative and man-made diseases"—and assumed that as infectious diseases are eliminated, chronic diseases will increase as the population ages. However, chronic diseases are emerging as a major epidemic in many nonindustrialized countries because of their association with overweight and obesity. In addition, the upsurge of infectious diseases and the emergence of new ones also casts doubt on this simple, unidirectional epidemiological process.

Emerging and Reemerging Disease

A recent review (3) suggested that 175 human pathogens (12% of those known) were emerging or reemerging and that 37 pathogens have been recognized since

1973, including rotavirus, Ebola virus, HIV-1 and HIV-2, and most recently, Nipah virus. Among the infectious vector-borne diseases, dengue, dengue hemorrhagic fever, yellow fever, plague, malaria, leishmaniasis, rodent-borne viruses, and arboviruses are persisting, and sometimes re-emerging, with serious threats to human health. For example, malaria, which is the foremost vector-borne disease worldwide, continues to worsen in many areas, and there are now an estimated 300 million to 500 million cases of malaria worldwide each year with 2 million to 4 million deaths. Since 1975, dengue fever has surfaced in huge outbreaks in more than 100 countries, with as many as 100 million cases each year. These increases reflect societal changes arising from population growth, ecological and environmental changes, and especially suburbanization, together with widespread and frequent air travel.

The prevalence of obesity, with its known increased risk of developing chronic ailments, some forms of cancer, type 2 diabetes, and cardiovascular disease, is increasing in most countries. It is estimated that more than 1 billion adults worldwide are overweight and that 300 million are clinically obese. In the United Kingdom, obesity has tripled in the past 20 years, and about two-thirds of adults are overweight.

In the United States, 20 states have obesity prevalence rates of 15 to 19%, 29 have rates of 20 to 24%, and one has a reported rate of more than 25%. Overweight and obesity are not confined to adults, and there is evidence of an increase in the prevalence of childhood overweight and obesity in both developed and developing countries.

Helminths and Morbidity

Infection by soil-transmitted helminths has been increasingly recognized as an important public health problem, particularly in developing countries. Parasitic infection accounts for an estimated 22.1 million life years lost to hookworm (either *Necator americanus* or *Ancylostoma duodenale*), 10.5 million life years lost to roundworm (*Ascaris lumbricoides*), 6.4 million life years lost to whipworm (*Trichuris trichiura*), and 4.5 million life years lost to schistosomiasis (4). These figures take into account the range of morbidity associated with these infections and with hookworm-induced anemia. The total for all three soil-transmitted infections and schistosomiasis is 43.5 million life years lost, which is second only to tuberculosis (46.5 million) and well ahead of malaria (34.5 million) and measles (34.1 million).

Worm transmission is enhanced by poor socioeconomic conditions, deficiencies in sanitary facilities, improper disposal of human feces, insufficient supplies of potable water, poor personal hygiene, substandard housing, and lack of education [hence intestinal parasitism's label as the "disease of poverty" (5)]. About 25% of the world's population are infected with roundworm, 20% with hookworm, 17% with whipworm, and 3 to 4% with schistosomes (Table 1), and overall ~2 billion people worldwide (a third of the world's population) are affected with one or more of these soil-transmitted infections and schistosomiasis (6).

The estimated worldwide percentages of the three intestinal parasites have remained

Table 1. Estimated global prevalences and associated morbidity and mortality due to soil-transmitted helminths and schistosomes.

Parasite	Prevalence of infection (cases, millions)	Mortality (deaths, thousands)	Morbidity (cases, millions)
<i>Ascaris lumbricoides</i>	1450	60	350
<i>Trichuris trichiura</i>	1050	10	220
Hookworms	1300	65	150
Schistosomes	200	20	20

¹Department of Biological Anthropology, University of Cambridge, Cambridge CB2 3DZ, UK. ²Health and Life Sciences Partnership, London EC1V 9HL, UK.

*To whom correspondence should be addressed. E-mail: nmt1@cam.ac.uk

nearly constant over the past 50 years (7), but there have been some successes. For example, in Japan, intestinal helminth infections were virtually wiped out in a 15- to 20-year period after World War II through an integrated program of education, improved sanitation and water supply, and drug treatment (8).

What has changed over the past 25 years, however, is the recognition that these soil-transmitted helminth infections and schistosomiasis have serious health consequences ranging from reversible growth faltering, permanent growth retardation, clinically overt symptoms (e.g., nausea, diarrhea, dysentery, and fever) to acute complications (e.g., intestinal obstruction; rectal prolapse; granulomas in the mucosa of the urogenital system, intestine, and liver; cancer of the bladder; hepatomegaly; and ascites). These parasitic infections are associated with malnutrition and impaired growth and development (caused by decreased appetite, nutrient loss, malabsorption, and decreased nutrient utilization), iron deficiency anemia (the blood-sucking activities of hookworm leads to blood loss of between 0.03 and 0.15 ml per day per worm), decreased physical fitness and work capacity, and impaired cognitive function (9–11).

The formal recognition of the health consequences of worm infestation came as recently as May 2001 when the 54th World Health Assembly passed a resolution affirming that the control of schistosomiasis and soil-transmitted helminthiasis should be considered as a public health priority. The challenge ahead is converting words into deeds through a global helminth control program (12).

Global Helminth Control

Horton (13) calculated that ~500 million children will have to be treated regularly for ascariasis for the next 25 years for the absolute numbers to stay the same. However for a reduction to occur, at least 1 billion will need regular treatment. This figure is for ascariasis alone; to treat all soil-transmitted infections and schistosomiasis would require doubling this number. Furthermore, there is evidence of drug resistance in animals in which intensive helminth control measures have been used, and some concerns have been expressed that the same might happen with humans, although extrapolation from animals raised for food production to humans must take into account genetic and epidemiological differences (14). There are already indications that schistosomiasis cure rates (using praziquantal) are worse than those a decade ago (15), and mebendazole and pyrantel may be less effective against hookworm

now than in the past (16, 17). No alternatives exist to praziquantal, but using combinations of drugs or cycling their use may reduce drug resistance.

At first sight, the drug and infrastructure cost of global helminth control appears enormous. For example, the cost of drugs alone in treating 2 billion people annually will be about US\$100 million. This sum, although large, has to be seen within the context of worldwide health expenditure per capita, which ranges between about US\$12 and US\$2769 (18), whereas the cost of a single-dose anthelmintic treatment is only about US\$.03 per annum (and about US\$.20 to US\$.30 for praziquantal), excluding delivery costs (19).

The current laudable goal of helminth control is very different from the earlier, but disastrous, attempts at hookworm and malaria eradication. So far only smallpox has been eradicated (1980), but the World Health Organization is also committed to eradicating poliomyelitis (by 2005) and dracunculiasis (guinea worm), and a global lymphatic filariasis campaign has also commenced (20). The dracunculiasis eradication campaign (21) began in 1980, and the incidence fell from an estimated 3.2 million cases in 1986 to 64,000 cases in 2001. More than 150 countries and territories have been certified free of parasite transmission, and the eradication goal is in sight. However, programs are being disrupted, particularly in countries affected by civil conflict, such as Sudan, where ~78% of the world's cases were reported in 2001.

Global Health Trajectories and Solutions

The health and disease patterns of societies and countries evolve as a result of socioeconomic, demographic, technological, cultural, environmental, and biological changes. Wars and civil conflict continue to disrupt the human host-agent-environment equilibrium and elevate disease burden, while injuries caused by accidents and violence are also increasing.

So is "Health for All in the 21st Century" (22) any closer? The industrialized countries appear to be exchanging one enemy for another: Having in the main brought infectious diseases under control, the unabated increase in obesity in childhood and adulthood and its concomitant comorbidities are likely to result in massive social and economic burdens. Only with dramatic changes in life-style—decreases in food portion sizes, energy density of the diet, and fat intake, and increases in fruit and vegetable consumption and physical activity—can obesity and the metabolic syndrome epidemic be

brought under control. Successful strategies involve governments and local communities working together to initiate programs in schools, the workplace, and communities (23) and should involve food producers, the food-processing industry, and consumer associations.

Improving the health status of poor populations requires a twin approach. Not only are infectious diseases still common, but chronic diseases, including tobacco-related diseases, are on the rise. Many of the poorer countries lack accessible, affordable, and high quality health-care systems. Strengthening national health policies, managing and mobilizing resources, training personnel, and providing service delivery are key goals. Developing public health strategies at national and global levels and financing and organizing them will continue to present enormous challenges (24).

References

1. C. J. L. Murray, A. D. Lopez, *The Global Burden of Disease* (Harvard University Press, Cambridge, MA, 1996).
2. A. R. Omran, *Milbank Mem. Fund Q.* **49**, 509 (1971).
3. D. J. Gubler, *Emerg. Infect. Dis.* **4**, 442 (1998).
4. M.-S. Chan, *Parasitol. Today* **13**, 438 (1997).
5. E. Cooper, *Trans. R. Soc. Trop. Med. Hyg.* **85**, 168 (1991).
6. A. Montessoro, D. W. T. Crompton, T. W. Gyorkos, L. Savioli, *Helminth Control in School-Age Children* (World Health Organization, Geneva, 2002).
7. N. R. Stoll, *J. Parasitol.* **33**, 1 (1947).
8. M. Yokogawa, in *Ascariasis and its Public Health Significance*, D. W. T. Crompton, Ed. (Taylor and Francis, London, 1985), pp. 265–277.
9. D. W. T. Crompton, *Parasitology* **121**, S39 (2000).
10. L. S. Stephenson, M. C. Latham, E. A. Ottesen, *Parasitology* **121**, S23 (2000).
11. P. O'Lorcain, C. V. Holland, *Parasitology* **121**, S51 (2000).
12. L. Savioli, *Trans. R. Soc. Trop. Med. Hyg.* **86**, 353 (2002).
13. J. Horton, *Trends Parasitol.* **19**, 405 (2003).
14. S. Geerts, B. Gryseels, *Trop. Med. Int. Health* **6**, 915 (2001).
15. D. Cioli, *Curr. Opin. Infect. Dis.* **13**, 659 (2000).
16. M. Sacko et al., *Trans. R. Soc. Trop. Med. Hyg.* **93**, 195 (1999).
17. J. A. Reynoldson et al., *Acta Trop.* **68**, 301 (1997).
18. Human Development Reports, United Nations Development Programme, www.undp.org/hdr2003/indicator/indic_59_1_1.html.
19. H. Guyatt, in *The Geohelminths: Ascaris, Trichuris, and Hookworm*, C. V. Holland, M. W. Kennedy, Eds. (Kluwer Academic Publishers, Dordrecht, Netherlands, 2002), pp. 75–87.
20. The Global Alliance to Eliminate Lymphatic Filariasis, www.filaria.org/index.pl?id=2586.
21. Centers for Disease Control and Prevention, *Morb. Mortal. Wkly. Rep.* **52**, 881 (2003), www.cdc.gov/mmwr/preview/mmwrhtml/mm5237a1.htm.
22. World Health Organization, Health for All in the 21st Century, www.who.int/archives/hfa.
23. Rhode Island Department of Health, Obesity Control Program, www.healthri.org/disease/obesity/Home.htm.
24. R. D. Smith, *Bull. WHO* **81**, 475 (2003).

Web Resources

www.sciencemag.org/cgi/content/full/302/5652/1921/DC1