FEATURE

Grand challenges in chronic non-communicable diseases

The top 20 policy and research priorities for conditions such as diabetes, stroke and heart disease.

Abdallah S. Daar[1], Peter A. Singer[1], Deepa Leah Persad[1], Stig K. Pramming[2], David R. Matthews[3], Robert Beaglehole[4], Alan Bernstein[5], Leszek K. Borysiewicz[6], Stephen Colagiuri[7], Nirmal Ganguly[8], Roger I. Glass[9], Diane T. Finegood[10], Jeffrey Koplan[11], Elizabeth G. Nabel[12], George Sarna[6], Nizal Sarrafzadegan[13], Richard Smith[14], Derek Yach[15] and John Bell[16]

Chronic non-communicable diseases (CNCDs) are reaching epidemic proportions worldwide[1–3]. These diseases — which include cardiovascular conditions (mainly heart disease and stroke), some cancers, chronic respiratory conditions and type 2 diabetes — affect people of all ages, nationalities and classes.

The conditions cause the greatest global share of death and disability, accounting for around 60% of all deaths worldwide. Some 80% of chronic disease deaths occur in low- and middle-income countries. They account for 44% of premature deaths worldwide. The number of deaths from these diseases is double the number of deaths that result from a combination of infectious diseases (including HIV/AIDS, tuberculosis and malaria), maternal and perinatal conditions, and nutritional deficiencies.

Over the coming decades the burden from CNCDs is projected to rise particularly fast in the developing world. Without concerted action some 388 million people worldwide will die of one or more CNCDs in the next ten years. With concerted action, we can avert at least 36 million premature deaths by 2015. Some 17 million of these prevented deaths would be among people under the age of 70 (ref. 2).

CNCDs have a huge negative economic impact[4]. In the next 10 years, China, India and the United Kingdom are projected to lose $558 billion, $237 billion and $33 billion, respectively, in national income as a result of heart disease, stroke and diabetes, partly as a result of reduced economic productivity[2].

Several factors are implicated in this increasing burden, including longer average lifespan, tobacco use, decreasing physical activity, and increasing consumption of unhealthy foods. Fortunately, CNCDs are largely preventable[5]. Up to 80% of premature deaths from heart disease, stroke and diabetes can be averted with known behavioural and pharmaceutical interventions[2].

Poor diet and smoking are two factors that contribute to the millions of preventable deaths that occur each year.

Yet the prevention of disability and death from CNCDs gets scant attention worldwide. In sub-Saharan Africa it is understandable that governments, donors and research-funding agencies have channelled most resources into infectious diseases: 5.9% of adults between the ages of 15 and 49 are HIV positive[6] and malaria alone kills a million children per year under the age of five[7]. In most richer countries the focus of biomedical research on CNCDs has been on treatment rather than prevention.

A crucial aspect of establishing programmes for disease control globally is to identify priorities. To galvanize the health, science and public-policy communities into action on this epidemic, we present here an inventory of 20 grand challenges, grouped under 6 goals, arrived at through a global, structured consensus process.

The grand challenges approach

Two previous 'grand challenge' exercises — the historical one by David Hilbert[8] in mathematics more than a century ago, and the 2003 Grand Challenges in Global Health initiative spearheaded by the Bill & Melinda Gates Foundation[9] — showed that the approach focuses significant new attention on an area of study, energizes communities to rise to meet the challenges, and brings new talent to the field. Although there has been interest in CNCDs among governments in developed countries, research-funding agencies and others[10], this has been incremental and rare in developing nations.

The Delphi method

The Grand Challenges in CNCDs we describe here are intended to reduce the global epidemic of these diseases by making the case for worldwide debate, support and funding, and by guiding policy and research in an evidence-based manner.

To develop the grand challenges, we used the Delphi method — the structured, sequential questioning of a panel, with controlled feedback[11–14] — to distil knowledge and build reliable consensus among 155 geographically and culturally diverse stakeholders, from 50 countries. We used the following definitions.

A 'grand challenge' was defined as a specific critical barrier that if removed would help to solve an important health problem. The intervention(s) it could lead to might be innovative and, if successfully implemented, would have a high likelihood of impact and feasibility.

'Chronic non-communicable diseases' were defined as diseases or conditions that occur in, or are known to affect, individuals over an

GRAND CHALLENGES IN CHRONIC NON-COMMUNICABLE DISEASES

	Grand Challenges	Research needed to address goals
Goal A **Raise public awareness**	1 Raise the political priority of non-communicable disease 2 Promote healthy lifestyle and consumption choices through effective education and public engagement 3 Package compelling and valid information to foster widespread, sustained and accurate media coverage and thereby improve awareness of economic, social and public health impacts	• Study how to engage governments in partnerships for disease prevention • Develop research activities for health that bridge government departments (for example, transport, civic planning, health, education and environment) • Identify reasons for low awareness and advocacy of chronic disease in societies • Study how to create public forums that sustainably raise awareness of issues relating to chronic non-communicable diseases
Goal B **Enhance economic, legal and environmental policies**	4 Study and address the impact of government spending and taxation on health 5 Develop and implement local, national and international policies and trade agreements, including regulatory restraints, to discourage the consumption of alcohol, tobacco and unhealthy foods 6 Study and address the impacts of poor health on economic output and productivity	• Evaluate the health impacts of agricultural policy interventions • Study the health and economic impacts of comprehensive community-based interventions • Create general population metrics and outcome indicators for policy and programme surveillance. • Quantify impact of chronic non-communicable diseases on domestic economies • Study the international ramifications of changes in food and tobacco consumption • Probe motivations behind domestic expenditures, and how these affect lifestyle choices • Investigate the impact and effectiveness of food-labelling legislation
Goal C **Modify risk factors**	7 Deploy universally measures proven to reduce tobacco use and boost resources to implement the WHO Framework Convention on Tobacco Control 8 Increase the availability and consumption of healthy food 9 Promote lifelong physical activity 10 Better understand environmental and cultural factors that change behaviour	• Do prospective cohort studies to identify risk factors, the magnitude of their effects, and the factors that reduce risk in chronic non-communicable diseases • Evaluate fetal and early-life influences on chronic disease risk • Find and evaluate new or combined medical preparations to prevent cardiovascular disease and diabetes or reduce their morbidities • Evaluate behavioural modifications to reduce risks • Establish metrics, and relationships between metrics, that are culturally and ethnically specific • Investigate cultural and ethnic variation in risk factors to refine behavioural interventions • Quantify personal risk related to phenotypes, genotypes and multiplicative risks • Study the interaction of environment and genes in risk factors and in outcomes • Develop new biomarkers and diagnostics for risk and for early disease detection
Goal D **Engage businesses and community**	11 Make business a key partner in promoting health and preventing disease 12 Develop and monitor codes of responsible conduct with the food, beverage and restaurant industries 13 Empower community resources such as voluntary and faith-based organizations	• Study marketing techniques and marketing data derived from commercial companies on behaviour modification • Investigate mechanisms for consumers and the public to exert a positive influence on the food industry • Research the impact of taste, flavour, packaging, labelling and advertising on choice and health • Create and evaluate community-based strategies to promote healthy living • Identify modes of effective public–private partnerships that support health • Develop better understanding of nutrient benefit in foods
Goal E **Mitigate health impacts of poverty and urbanization**	14 Study and address how poverty increases risk factors 15 Study and address the links between the built environment, urbanization and chronic non-communicable disease	• Investigate the biological basis of health risks related to poverty • Examine the influence of poverty on the adoption of high-risk behaviour • Identify negative effects of economic growth on health • Study how to work with planners, architects and city representatives to enhance the environment for healthier living
Goal F **Reorientate health systems**	16 Allocate resources within health systems based on burden of disease 17 Move health professional training and practice towards prevention 18 Increase number and skills of professionals who prevent, treat and manage chronic non-communicable diseases, especially in developing countries 19 Build health systems that integrate screening and prevention within health delivery 20 Increase access to medications to prevent complications of chronic non-communicable disease	• Develop strategies to integrate health-system management of communicable and non-communicable disease • Form collaborations to find best practices in delivering affordable and equitable health care • Study how to provide more structured knowledge for health promotion • Develop strategies to ensure that medical training and curricula focus on chronic non-communicable diseases • Develop and provide culturally specific and nationally appropriate resources for training of health-care workers • Study how best to ensure that disadvantaged communities have adequate resource allocations in health care and in preventative practice • Optimize use of electronic health records for predicting disease and measuring the effect of health interventions • Study how best to develop and establish real-time surveillance tools • Discover and develop tools for screening and stratifying populations according to risk

extensive period of time and for which there are no known causative agents that are transmitted from one affected individual to another. For the purpose of this study the major focus was on cardiovascular diseases, type 2 diabetes, chronic respiratory diseases and certain cancers. Commonly known risk factors for these include lack of exercise, improper diet and smoking. Note that we excluded mental health and chronic neurological conditions because their risk factors and interventions are so different[2].

We asked the panel: what do you think are the grand challenges in chronic non-communicable diseases? The first of the three Delphi rounds elicited 1,854 ideas, many of which overlapped. We distilled these into 109 from which the panel selected, ranked and commented on its top 30. These comments and rankings structured the final round: panellists were asked either to accept the list or to re-rank the choices.

The executive committee and scientific board refined the wording and presentation of the panel's conclusions into the Table presented here (the order does not denote relative importance). Also summarized in the Table are key research needs that the committee and board matched to the goals.

Blueprint for change

The integration of science, technology, policy and social sciences makes the Grand Challenges in CNCDs a particularly comprehensive — if demanding — blueprint for change. For each group of grand challenges we suggest the research now needed.

Many of the grand challenges relate primarily to policy interventions, such as reform of professional training and modification of health systems. These, too, will need evaluation during implementation and ideally should have an evidence base that links research to policy. For example we know about preventing heart attacks and strokes associated with smoking or high blood pressure, but how should we best put these ideas into practice, especially in low-resource settings or on a large scale?

"With concerted action, we can avert at least 36 million premature deaths by 2015."

It is not possible to provide a complete list of the research activities that will be required for these grand challenges to be solved systematically, but here we highlight the important ones. Interdisciplinary research will be needed, for example, to explore the interactions of behaviour, environment and genetics in framing risks and determining outcomes. Such research will also need to focus on equity, and on the effects of gender and culture on risk, the effectiveness of interventions and access to health care. Ethical, social, cultural and sustainability issues must be addressed before emerging interventions and technologies can be taken up by communities and incorporated into public-health and health-care systems[15,16]. Data and research repositories will also be essential, and standardization, where possible, will allow international comparisons and help global partnerships.

Although these challenges are applicable to all countries, different nations should identify local priorities from among those identified here for immediate attention, depending on resources and disease patterns.

Next steps

Addressing the challenges identified here requires the participation of governments, the World Health Organization, the World Bank, regional development banks, foundations, research-funding agencies, donor agencies and others. The business community and civil society organizations will also be crucial partners. A global governance mechanism to coordinate this work across different sectors will be important to prevent dissipation or duplication of effort.

With this publication, the Grand Challenges Global Partnership is being established with a secretariat in the Oxford Health Alliance (OxHA). It will be funded for the first 5 years by members of OxHA (www.oxha.org). The partnership is intended primarily as a coordinating body for research-funding organizations and to harmonize efforts among other relevant initiatives[10,17]. The founding partners, OxHA, the UK Medical Research Council, the Canadian Institutes of Health Research, the Indian Council of Medical Research and the US National Institutes of Health intend to expand the partnership, forge collaborative research opportunities, and monitor progress towards solving these challenges. An advocacy programme will also be developed, to encourage adoption of the challenges and goals.

With the Grand Challenges in Global Health (www.gcgh.org) initiative there was an upfront commitment of US$200 million (later increased to $450 million) in research funding. By contrast, the Grand Challenges in CNCDs are not linked directly to a funding programme. These problems require initial financing, a long-term commitment and a coordinated effort between multiple funding agencies around a set of clear priorities. Providing such priorities is the major goal of this grand challenge exercise. The growing interest in this area of research now being registered by governments and funding agencies suggests that substantial resources may be available in the future.

In the first instance, the main function of the Grand Challenges Global Partnership will be monitoring and reporting. It will provide cross-referencing between agencies to ensure efforts are complementary and that major objectives are not overlooked. We will therefore prepare for the research-funding agencies and foundations an annual progress report, beginning a year from now.

Chronic non-communicable diseases constitute the major burdens of illness and disability in almost all countries of the world. They must urgently receive more resources, research and attention, as mapped out in these grand challenges. Inaction is costing millions of premature deaths throughout the world. ■

1. Lopez, A. D., Mathers, C. D., Ezzati, M., Jamison, D. T. & Murray, C. J. L. (eds) *Global Burden of Disease and Risk Factors* (Oxford Univ. Press and World Bank, Washington DC, 2006).
2. World Health Organization *Preventing Chronic Diseases: A Vital Investment* (WHO, Geneva, 2005).
3. Adeyi, O., Smith, O. & Robles, S. *Public Policy and the Challenge of Chronic Noncommunicable Diseases* (World Bank, Washington DC, 2007) .
4. Suhrcke, M., Nugent, R. A., Stuckler, D., & Rocco, L. *Chronic Disease: An Economic Perspective* (Oxford Health Alliance, London, 2006).
5. Jamison, D. T. *et al.* (eds) *Priorities in Health* (World Bank, Washington DC, 2006); available at http://www.dcp2.org
6. UNAIDS *AIDS Epidemic Update: Special Report on HIV/AIDS December 2006* (UNAIDS/WHO, Geneva, 2006); available at http://data.unaids.org/pub/EpiReport/2006/2006_EpiUpdate_en.pdf
7. Breman, J. G., Alilio, M. S. & Mills, A. (eds) *Am. J. Trop. Med. Hyg.* **71** (suppl. 2), 1–282 (2004).
8. Hilbert, D. *Bull. Am. Math. Soc.* **8,** 437–479 (1902).
9. Varmus, H. *et al. Science* **302,** 398–399 (2003).
10. Yach, D. & Pramming, S. *Bulletin of Medicus Mundi Switzerland* No. 106, 12–15 (November 2007).
11. Jones, J. & Hunter, D. *Br. Med. J.* **311,** 376–380 (1995).
12. Martin, B. R. *Technology Analysis & Strategic Management* **7,** 139–168 (1995).
13. Powell, C. *Journal of Advanced Nursing* **41,** 376–382 (2003).
14. Rowe, G. & Wright, G. in *Principles of Forecasting* (ed. Armstrong, J. S.) 125–144 (Kluwer Academic Publishers, Norwell, MA, 2001).
15. Singer, P. A. *et al. Nature* **449,** 160–163 (2007).
16. Berndtson, K. *et al. PLoS Med.* **4,** e268 (2007).
17. *Lancet* **370,** 630 (2007).

Acknowledgements The study was carried out at the McLaughlin-Rotman Centre for Global Health (University Health Network/University of Toronto). It was funded by the Oxford Health Alliance, with contributions from the UK Medical Research Council and the McLaughlin-Rotman Centre for Global Health. We are grateful for valuable advice from Harold Varmus. We thank Gunjeet Minhas, Dilnoor Panjwani, Mark Messih, Munira Tayabali and Marisa Pulaski for their valuable assistance with this project.

Supplementary information See www.mrcglobal.org/supplemental/nature_grandchallenges or www.OxHA.org for supplementary materials, including details of methodology, results, the Delphi study panel, and membership of the executive committee and scientific board.

Author contributions A.S.D. and D.L.P. carried out the Delphi study. J.B., A.B., R.B., L.K.B., A.S.D., R.G. and J.K. are members of the executive committee. S.C., N.G., D.F., D.R.M., S.K.P., G.S., N.S., R.S., P.A.S. and D.Y. are members of the scientific board. They all contributed to the study. All authors contributed to the writing of the paper.

Author declaration The authors declare no competing financial interests.

Author details [1]Program on Life Sciences, Ethics and Policy, McLaughlin-Rotman Centre for Global Health, University Health Network/University of Toronto, 101 College Street, Toronto, Ontario, M5G 1L7, Canada. [2]The Oxford Health Alliance, 1st Floor, 28 Margaret Street, London W1W 8RZ, UK. [3]Oxford Centre for Diabetes, Endocrinology and Metabolism, University of Oxford, Churchill Hospital, Headington, Oxford, OX3 7LJ, UK. [4]University of Auckland, Auckland, New Zealand. [5]Canadian Institutes of Health Research, 160 Elgin Street, 9th Floor, Address Locator 4809A, Ottawa, Ontario, K1A 0W9, Canada. [6]Medical Research Council, 20 Park Crescent, London W1B 1AL, UK. [7]Diabetes Centre and Department of Endocrinology, Metabolism and Diabetes, Prince of Wales Hospital, University of Sydney, Randwick, New South Wales, Australia. [8]Indian Council of Medic al Research, Ansari Nagar, New Delhi, 110029, India. [9]Fogarty International Center, National Institutes of Health, Building 31, Room B2C02, 31 Center Drive, MSC 2220 Bethesda, Maryland 20892-2220, USA. [10]Canadian Institutes of Health Research, Institute of Nutrition, Metabolism and Diabetes, 160 Elgin Street, 9th Floor, Address Locator 4809A, Ottawa, Ontario, K1A 0W9, Canada. [11]Global Health Institute, Emory University, 1440 Clifton Road, Atlanta, Georgia 30322, USA. [12]National Heart, Lung, and Blood Institute, National Institutes of Health, Building 31, 5A48 , 31 Center Drive, MSC 2486, Bethesda, Maryland 20892-2486, USA. [13]Cardiology Department, Isfahan University of Medical Sciences and Isfahan Cardiovascular Research Center, Seddigheh Tahereh Research and Treatment Hospital, Khorram Ave, Isfahan, Iran. [14]Ovations Chronic Disease Initiative, UnitedHealth Europe, London SW1P 1SB, UK. [15]PepsiCo, 700 Anderson Hill Road, Purchase, New York 10577, USA. [16]University of Oxford; Chair, Oxford Health Alliance, John Radcliffe Hospital, Oxford, OX3 9DU, UK.