

The background of the cover is a repeating pattern of stylized human profiles. Most profiles are grey, but several are highlighted in orange. The profiles are arranged in a dense, overlapping grid.

# EPIDEMIOLOGY

PETRA BÜTTNER | REINHOLD MULLER

SECOND EDITION

OXFORD

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## ABOUT THE CONTRIBUTORS

**Lynne Bartlett** studied Business at the University of Technology Sydney, Australia. She completed her DrPH on faecal incontinence in north Queensland with James Cook University in 2014. Since 2007 she has co-authored 17 original research publications in peer-reviewed journals, 10 of which form the basis of her DrPH thesis. Lynne, a mature-aged student, volunteered significant time to managing a not-for-profit business for the combined Rotary clubs of Townsville, north Queensland, in addition to conducting public health research.

**Monika Buhner-Skinner** completed a Diploma in General Nursing in 1985 and a Graduate Diploma as a Certified Registered Nurse Anaesthetist (CRNA) in 1988. She subsequently worked as a CRNA for more than 10 years in several roles including aero-medical retrieval and clinical education in Switzerland. She completed a Bachelor of Nursing Science (1996) and a Master in Public Health and Tropical Medicine (1998) at James Cook University (JCU), Australia. Dr Buhner-Skinner started working in clinical and research nursing roles in sexual and reproductive health in Australia in 2000. In 2003, she joined JCU lecturing quantitative research methodology while also working as an advanced practice nurse. In 2014, she joined the Zurich University of Applied Sciences in Switzerland. Her main research interests are in the area of acute care in the primary care setting, with a focus on sexually transmissible infections, especially *Chlamydia trachomatis*.

**Alan Clough** is an epidemiologist with experience in designing, implementing, and evaluating community-based interventions over the past 25 years. He is recognised both internationally and in Australia for his work in reducing the disastrous effects of substance misuse in Indigenous Australian communities. His background in applied community development and advocacy underpins his long commitment to making positive changes at the population level. Having been awarded significant National Health and Medical Research Council grants over the past 15 years, Associate Professor Clough has successfully developed and led a research group at James Cook University, in the Australian Institute of Tropical Health and Medicine.

**Elissa Cox** is an Australian occupation therapist with interests in both the geriatric and paediatric population.

**Sue Devine** is a senior lecturer at James Cook University in Townsville, Australia, where she lectures in the areas of health promotion, tropical public health, and rural and remote health. She has a nursing and midwifery background and has completed a Doctorate of Public Health in which she researched the role of environmental modifications on neighbourhood physical activity. She also has a Master of Public Health and Tropical Medicine, a Postgraduate Diploma in Health Promotion and a Graduate Certificate in Tertiary Teaching. Sue has been working in public health or health promotion and education roles throughout rural north Queensland since 1992 and, prior to this, worked in Western Australia.

**Adèle C. Green** is a Senior Scientist at the QIMR Berghofer Institute of Medical Research in Brisbane, Australia, and Senior Research Scientist at the Cancer Research UK Manchester Institute. She trained

in medicine and her research career has focused on the causes, treatment, and prevention of cancers, especially melanoma and other skin cancers. She is currently a member of the International Commission on Non-Ionizing Radiation Protection.

**Simone Harrison** is an epidemiologist with more than two decades of experience in research relating to the adverse and beneficial effects of sun exposure. Simone is a Principal Research Fellow at James Cook University, and an Adjunct Associate Professor at the Queensland Institute of Technology. Her doctoral studies focused on risk factors for the development of pigmented moles (a major risk factor for melanoma) in young Australian children, and key findings from this work have been published in leading journals, including *The Lancet*. Her current research is focused primarily on improving the sun-protection habits of schoolchildren and infants.

**Clare Heal** is Associate Professor in General Practice at James Cook University, and also works as a visiting medical officer at Mackay Sexual Health Clinic. She has research interests in sexual health, minor surgery, and skin cancer. She has published extensively in national and international journals, and is a member of the Primary Care Research Advisor Group to the *British Medical Journal*.

**Richard Heller** was Professor of Clinical Epidemiology and Community Medicine and Director of the Centre for Clinical Epidemiology and Biostatistics at the University of Newcastle, and general physician at the John Hunter Hospital, until 2000. He was then Professor of Public Health at the University of Manchester, United Kingdom, until his retirement in 2006. Educational activities have included involvement with INCLEN, an organisation originally funded by the Rockefeller Foundation for capacity building in medical schools across the developing world. As part of this role, Professor Heller developed a distance learning masters course at the University of Newcastle, and subsequently built a fully online masters course in public health at the University of Manchester. He is a founder and coordinator of the Peoples-uni (<http://peoples-uni.org>), which aims to provide public health capacity building in developing countries at low cost, through e-learning using open access resources on the internet. Students at the Peoples-uni can attain a Masters degree in public health. Professor Heller's research interests have been in the causes and prevention of heart disease, the implementation of evidence-based practice, and developing measures to describe the population impact of disease risks and the benefits of interventions.

**Diana Mendez** is a French veterinarian who has been living in Australia since 1996. She has been working as a researcher at James Cook University (JCU) in the discipline of public health since 1999. She holds a Master of Public Health from JCU, where she started working as a histopathologist investigating amphibian and other wildlife diseases. In 2009, she reoriented her research interest towards the study of infection control, zoonoses and their management following the One Health concept. She is currently undertaking postdoctoral studies in the field of veterinary infection control and Hendra virus management using quantitative and qualitative research methodologies.

**Sanjay Patole** heads the Department of Neonatal Paediatrics at KEM Hospital for Women, in Perth, Western Australia. He is involved in translational research and teaching evidence-based practice of medicine at the Centre for Neonatal Research and Education, University of Western Australia. Professor Patole is internationally acclaimed for his research on prevention of feed intolerance and



necrotising enterocolitis, and probiotic supplementation for preterm neonates. Professor Patole has 140 publications in peer-reviewed journals. The systematic reviews by his team have had significant impact on prevention of necrotising enterocolitis in preterm infants.

**Rick Speare** is public health physician interested in control of communicable diseases. He has undergraduate degrees in medicine and veterinary science, and works with populations of humans and other animals. He has been involved in applied research for 35 years, mainly at James Cook University, aiming to use evidence to make a difference to health, frequently through advocating for evidence-informed policy. Training a competent public health workforce for the tropics was a major endeavour for many years. Expanding areas of activity include research capacity strengthening and practical applications of One Health.

Epidemiology is a fairly young discipline which is highlighted by the fact that the first ever epidemiology textbook, written by Brian MacMahon and Thomas Pugh, was published just about 50 years ago in 1960. The core business of 'classical epidemiology' was, and still is, the identification of occurrences and distributions of diseases in populations and the detection and evaluation of causes of diseases. However, epidemiology has been a very dynamic discipline with new focus areas being added constantly—molecular, social, spatial, and cognitive epidemiology are just a few examples of more recent specialisations.

In the early 2000s some geneticists predicted the end of epidemiology as we know it, suggesting that genetics would soon be proven as the ultimate cause for most if not all diseases. This rather simplistic view may still be hampering serious genetics research but in the meantime genetic epidemiology, assessing the interplay between environmental and genetic factors and their role for health events, is thriving.

### Why another epidemiology book?

Epidemiology belongs to the health sciences and medical scientists have traditionally dominated the discipline, bringing a disease-centred approach to epidemiology. Our backgrounds, however, are in general research methodology, including biostatistics, and we hope to be able to contribute with our book a somewhat different point of view to further promote and progress modern epidemiology towards its full potential: a methodologically well-grounded and versatile tool-kit to conduct evidence-based research in all health sciences.

This 'methods based' approach finds its expression already in the overall structure of this introductory level book that follows the logic of the epidemiological research 'cycle', which is probably better described as an upward spiral in the sense that each research study contributes novel evidence to the knowledge base of the respective discipline. We hope that this structure and our methods based approach as well as the plethora of examples from a broad spectrum of health-related disciplines render this textbook to be a practical guide for conducting quantitative research in the broad field of the health sciences.

We surely advocate the integration of qualitative and quantitative research designs. However, in this book we focus only on quantitative research methods since qualitative methods have become a very large discipline in its own right, including such varied concepts and techniques that only a separate book could do it justice.

This introductory textbook to epidemiology is largely based on our lecture notes for both postgraduate students of epidemiology for public health, and undergraduate students of public health and other health sciences (including medicine, nursing, physiotherapy, sports and exercise sciences, and occupational therapy). As with our lecture notes, we have opted for a two-level approach differentiating between 'introductory' knowledge that all students of epidemiology should be familiar with and 'beyond the basics' information for the interested or more advanced reader. The levels of the different sections are indicated in an overview table starting on page xxix.

The first four chapters of the book introduce the reader to epidemiology, its historical roots and some basic concepts. The remaining chapters 5 to 14 follow the logic of the epidemiological research spiral.

Chapter 5 clarifies the concepts of a literature review, the first step of every epidemiological research study. This is followed by the formulation of an operational research hypothesis, a complete and quantitative precise statement of the question the research will aim to confirm or reject. Since the study design and the development of the research hypothesis are closely interlinked, different types of studies, their applications, advantages, and disadvantages are subsequently discussed in some detail in Chapters 6, 7, and 8.

Chapter 9 discusses 'bias', systematic error in the conduct of epidemiological studies, and how bias can be avoided or at least controlled to achieve valid conclusions. Chapter 10 introduces basic sampling strategies and sample size considerations necessary to achieve an 'optimal' sample size for a planned study.

The logically following steps in the research spiral are then to develop measurement tools, such as questionnaires, collecting the data, entering the collected information into a data base (Chapter 11), and analysing the data statistically in order to reject or confirm the stated research hypothesis (Chapter 12). The chapter on statistical analyses is kept very concise and in non-technical language where possible; it is not intended to be a text for general statistical analysis but an introduction to the main concepts and techniques relevant in statistical hypothesis testing.

Chapter 13 deals with the important issues of ethics in human research. Finally, to achieve an 'upward' momentum in the research spiral, the results have to be published (Chapter 14) to be accessible to other scientists and to contribute novel evidence to the area-specific knowledge base.

Each chapter is accompanied by numerous critical thinking exercises (some conceptual, but more often practical also necessitating some calculations) with answers at the end of the chapter.

The Glossary at the end of the book provides an abridged 'dictionary' for epidemiology. However, the definitions provided there are working definitions as introduced and used in the context of this book; they may not be universally acceptable to all epidemiologists.

Throughout the book we apply examples of recent epidemiological research conducted in Australia and New Zealand. These examples are drawn from a wide range of disciplines demonstrating that epidemiological methodologies are essential research tools across the health sciences. We aimed at presenting as much original research as possible, though sometimes the actual figures had to be adjusted for ease of calculations or other pedagogical purposes. We hope that the examples showcase ongoing research in Australia and New Zealand and provide some inspiration to students of epidemiology.

Students sometimes may perceive epidemiology as a daunting subject. We thus aimed at introducing the concepts structured and in non-technical terms whenever possible and provided ample examples and exercises to stimulate reflection on theoretical concepts as well as on practical issues. However, every textbook has its limits—to really appreciate epidemiology you will have to jump into the deep end and conduct epidemiological research yourself. Our aim was to inspire readers to do exactly that!

## FOREWORD TO SECOND EDITION

Preparing a second edition of *Epidemiology* gave us the opportunity to carefully revise and update the text taking into account comments and suggestions from students, colleagues, and reviewers. Due to popular demand, we added several new case studies to various chapters. The case studies give insights into current epidemiological research as well as personal perspectives of the researchers. Some case studies also provided us with the chance to introduce new or previously missing content. For example, Simone Harrison's new case study on the measurement of vitamin D provides us with an example of a Bland–Altman plot, a graphical display of how well two methods agree in measuring a numerical variable, and which was previously missing from the book. Richard Heller has written a case study on population impact measures; these are recently developed measures that take the concept of attributable risk to the population level.

A new case study written by Diana Mendez allows us to show how qualitative methods can create key understandings in disciplines that have been predominantly quantitative. The section on infectious disease concepts has been substantially revised and modernised with the invaluable help of Rick Speare, who also added a relevant case study on transmission routes. Emerging infectious diseases are introduced and discussed using numerous examples. In Chapter 5, we now include the PRISMA flowchart and discuss the respective checklist for systematic literature reviews in some detail. In addition, a new case study provided by Sanjay Patole gives us some further insights into the Cochrane Collaboration. We added a new section on superiority, equivalence, and non-inferiority studies to Chapter 7, as equivalence and non-inferiority trials gain more and more relevance. This new section was substantiated by a further case study presenting an example of a recent non-inferiority trial conducted in general practice by Clare Heal.

We have also taken notice of Olli Miettinen's recent epidemiology books and his take on and definitions of some of the main epidemiological terms and concepts. In Chapter 11, we highlighted the work of Don Dillman and his contribution to survey designs. We also commented on some of the available and ever more frequently used online survey software. We added a note to Chapter 12 on what to do with missing values during data analysis. Although we feel that techniques such as multiple imputation are too special and too advanced for an epidemiology book which includes just one chapter on data analysis, we hope that the interested reader will find the links to the relevant in-depth texts helpful. A new case study written by Rick Speare was added to Chapter 13, under the header of 'justice'; as this case study shows that the elimination of strongyloidiasis from Indigenous Australian communities is possible once political support can be mobilised.

We hope that the updates and new inclusions are useful material to enhance your learning experience.

## ACKNOWLEDGMENTS

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