Foreword

This volume on supercentenarians, people 110 years old and older, is the seventh book of a series of Demographic Research Monographs published by Springer Verlag. It is the result of almost a decade of effort by a brigade of dedicated researchers who have discussed their work at seven research workshops, spaced at roughly annual intervals and held in Germany, Denmark, the United States, France, Japan, Italy and Canada, and who will soon meet again - in Spain.

The volume begins with a chapter on age validation and ends with two chapters that emphasize this endeavor; the three chapters include short accounts of specific supercentenarians that add life to the demographic research. Because most reports of reputed supercentenarians are erroneous, age validation is essential to compilation of accurate data. The accounts of specific supercentenarians reveal that there is apparently no secret of longevity: supercentenarians appear to be almost as diverse as individuals at younger ages, albeit almost all are women, most enjoyed comparatively good health until advanced old age and none were heavy cigarette smokers. The number who did not marry or who had fewer children than average appears high compared with marriage and childbearing patterns for people who died younger.

Evolutionary theory predicts that there should be a trade-off between survival and reproduction, so this finding-which needs to be carefully scrutinized and verified-may be a result of genes that reduce mortality at the expense of fertility (Baudisch, 2008; Doblhammer, 2003). That genes may be important is also suggested by the fact that longevity appears to run in families, but there could be non-genetic factors that run in families that account for this finding. Studies of twins suggest that about 25% of the variation in adult lifespans can be attributed to genetic variation among people and that this percent-

age may increase somewhat for elderly people (Herskind et al., 1996; Hjelmborg et al., 2006). No longevity genes, however, have been found-in replicated studies-to slow the process of ageing and only one gene, ApoE, is reliably known to have polymorphisms that somewhat raise or lower the chance of death at older ages (Christensen, Johnson, and Vaupel, 2006). All functioning genes either contribute to survival or fertility, so genetic variation at each of hundreds of loci may slightly affect the chance of surviving to 110.

The second chapter in this volume provides an overview of the International Database on Longevity (IDL) that is the repository for data on supercentenarians. The chapter emphasizes the importance of age validation and also the importance of obtaining data on all supercentenarians in some population that is defined by strict rules. This is important because some kinds of identification procedures may pick up people who are, say, 115, with greater probability than people who are merely 110. Such an age-bias in the inclusion of supercentenarians in a database can result in serious misestimates of mortality patterns.

Subsequent chapters examine data on supercentenarians in a series of countries. These chapters explain the unique features of data sources in different countries and how supercentenarians can be identified and validated. The chapters were completed at various times, some, including the chapter on the United States, a few years ago and the one on Spain just a few weeks ago: Spain joined the supercentenarian consortium only about a year ago. In all the main countries in the project, however, data collection continues and various improvements in methods are regularly introduced. It was difficult to say that now is the time to publish what we have up until now, but this volume is published and further work will have to be reported in subsequent articles and perhaps a follow-up book.

The analytical fruit of the demanding, time-consuming research on supercentenarians is presented in the chapter by Jutta Gampe. The main finding is remarkable: human mortality levels off at a probability of death of 50% per year, at least from ages 110 through 114 and apparently afterwards (although the data are too sparse to make a firm judgment). When the supercentenarian project was started, it was not known whether death rates continued to rise at advanced ages, leveled off, or started to decline. This uncertainty was highlighted in an article in Science in 1998 and was the main motivation for launching the supercentenarian endeavor (Vaupel et al., 1998). The chapter following Gampe's chapter, on the life expectancy of French supercentenarians, presents results that are generally consistent with Gampe's, especially

considering the small sample size of the French supercentenarian population compared with the entire IDL compilation. The French chapter demonstrates how much can be learned from a small number of supercentenarians, but the larger IDL database permits deeper, more confident analysis.

The leveling off of death rates is probably due to a balance between two tendencies: (1) individuals tend to become more decrepit with advancing age and (2) the frailest individuals at any age tend to die first, leaving a more robust population of survivors. Achieving and maintaining such a balance is difficult and probably impossible if individuals differ from each other in their rate of deterioration. Surprising as it may seem, however, such a balance at advanced ages is plausible if individuals differ in their level of deterioration, such that, for instance, some individuals reach a level of senescence at age 70 and a greater level of senescence at age 80, whereas other individuals reach these two milestones when they are 10 years older (Vaupel, 2010). Ongoing research at the Max Planck Institute for Demographic Research, building on a pathbreaking article by Roger Thatcher (Thatcher, 1999) (the author of the chapter on England and Wales in this volume) suggests that the death rates may increase at the same pace for nearly all older humans today-and also in the past. Exceptionally long-lived people appear to reach advanced ages not because they senesce more gradually than others but because they reach old age in a better state of health. This hypothesis is consistent with the finding that the process of senescence is being delayed over time rather than being decelerated. Genetic defects have been found that speed the process of ageing in unfortunate people who suffer progeria, but as noted above no mutation has been discovered that decelerates the process-and it may be that no such mutation is prevalent in human populations.

In any case, the hypothesis that individuals who survive to advanced old age do so because they reach older ages in better health and not because they age more slowly is worth careful further study and, working with the members of the supercentenarian consortium and others, I intend to make this a research priority. It would be useful to have more data and we plan to keep adding supercentenarians to the IDL database. We also have started to extend the database to younger ages-109, 108, and when feasible 105, and plan to intensify these efforts. The Kannisto-Thatcher Database (available at `www.demogr.mpg.de`) provides serviceable death rates up to 105, but death rates for semisupercentenarians between 105 and 110 are almost as murky as supercentenarian mortality was before publication of this volume. The an-

nual probability of death may be close to 50% at ages below 110: this demands investigation.

The series of Demographic Research Monographs is under the editorial supervision of the Max Planck Institute for Demographic Research. I am Editor-in-Chief. I am advised by an Editorial Board that currently consists of Prof. Elisabetta Barbi (Messina University, Italy), Prof. Gabriele Doblhammer (Rostock University, Germany), Dr. Jutta Gampe (Max Planck Institute), Prof. Joshua Goldstein (Max Planck Institute), and Prof. Bernard Jeune (University of Southern Denmark). Additional members are temporarily appointed to the Editorial Board as needed to review manuscripts submitted for possible publication. The current manuscript was reviewed and accepted by Gampe, Jeune and myself, based on advice from a group of referees that also included Elisabetta Barbi, Heiner Maier, Trifon Missov, Tenko Raykov, Jean-Marie Robine and Axel Skytthe. The Editors thank Frank Haake and Miriam Hills for helping prepare the manuscript for publication.

The Demographic Research Monographs series can be considered the successor to the series called Odense Monographs on Population Aging, edited by Jeune and me. The volumes in this now-terminated series were first published as hardcover books by an academic publisher, Odense University Press, and subsequently made available online at `www.demogr.mpg.de/books/odense`. The nine Odense Monographs on Population Aging include two collections of research articles that focus on specific subjects on the frontier of demographic research, three volumes by senior researchers that present path-breaking findings, a review of research on a topic of emerging interest, a presentation of a new method for analysis of demographic data, an outstanding doctoral dissertation, and a unique collection of important demographic data on non-human species.

The series of Demographic Research Monographs continues this mix, with books that are often under 200 pages in length but can, like the current volume, be much longer, that have a clear focus, and that significantly advance demographic knowledge. Research related to population aging continues to be a focus on the series, but it is not the only one. We hope that eventually the series will embrace all of demography, broadly defined. As indicated by the first volume in the series, an important subject is historical demography. We will also publish research on fertility and family dynamics, as in the case of the previous volume by Dr. Nadja Milewski. Mathematical demography is the core of the population sciences and we will strive to foster monographs, such as the one on How Long Do We Live?, that use mathematics and

statistics to further develop the theories and methods of demography. Biodemography is a small but rapidly growing and particularly innovative branch of demography: we will seize opportunities to publish monographs, such as the one by Dr. Annette Baudisch, at the intersection of biology and demography; such monographs can pertain both to humans and other species, and can include demographic research with ties to such fields as epidemiology, genetics, evolutionary biology, life-history biology, experimental demography, and paleodemography.

Each volume in the Demographic Research Monograph series will have a substantial link to the Max Planck Institute for Demographic Research. As well as being published as hardcover books by Springer-Verlag, the volumes of the Max Planck series of Demographic Research Monographs will subsequently be available at `www.demogr.mpg.de/books/drm`. The online version may include color graphs, supplemental analyses, databases and other ancillary or enhanced material. Parallel publication online and in print is a significant innovation that will make the monograph series particularly useful to scholars and students around the world.

James W. Vaupel
Editor-in-Chief

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