

Cambridge University Press  
0521596513 - Demography in Archaeology  
Andrew T. Chamberlain  
Frontmatter  
[More information](#)

---

## DEMOGRAPHY IN ARCHAEOLOGY

*Demography in Archaeology* is a review of current theory and method in the reconstruction of populations from archaeological data. Starting with a summary of demographic concepts and methods, the book examines historical and ethnographic sources of demographic evidence before addressing the methods by which reliable demographic estimates can be made from skeletal remains, settlement evidence and modern and ancient biomolecules. Recent debates in palaeodemography are evaluated, new statistical methods for palaeodemographic reconstruction are explained, and the notion that past demographic structures and processes were substantially different from those pertaining today is critiqued. The book covers a wide span of evidence, from the evolutionary background of human demography to the influence of natural and human-induced catastrophes on population growth and survival. This is essential reading for any archaeologist or anthropologist with an interest in relating the results of field and laboratory studies to broader questions of population structure and dynamics.

ANDREW T. CHAMBERLAIN is Reader in Biological Anthropology at the University of Sheffield.

Cambridge University Press  
0521596513 - Demography in Archaeology  
Andrew T. Chamberlain  
Frontmatter  
[More information](#)

---

## CAMBRIDGE MANUALS IN ARCHAEOLOGY

*General Editor*  
Graeme Barker, *University of Cambridge*

*Advisory Editors*  
Elizabeth Slater, *University of Liverpool*  
Peter Bogucki, *Princeton University*

*Books in the series*  
*Pottery in Archaeology*, Clive Orton, Paul Tyers and Alan Vince  
*Vertebrate Taphonomy*, R. Lee Lyman  
*Photography in Archaeology and Conservation*, 2nd edition, Peter G. Dorrell  
*Alluvial Geoarchaeology*, A. G. Brown  
*Shells*, Cheryl Claasen  
*Zooarchaeology*, Elizabeth J. Reitz and Elizabeth S. Wing  
*Sampling in Archaeology*, Clive Orton  
*Excavation*, Steve Roskams  
*Teeth*, 2nd edition, Simon Hillson  
*Lithics*, 2nd edition, William Andrefsky Jr.  
*Geographical Information Systems in Archaeology*, James Conolly and Mark Lake  
*Demography in Archaeology*, Andrew T. Chamberlain

*Cambridge Manuals in Archaeology* is a series of reference handbooks designed for an international audience of upper-level undergraduate and graduate students, and professional archaeologists and archaeological scientists in universities, museums, research laboratories and field units. Each book includes a survey of current archaeological practice alongside essential reference material on contemporary techniques and methodology.

Cambridge University Press  
0521596513 - Demography in Archaeology  
Andrew T. Chamberlain  
Frontmatter  
[More information](#)

---

# DEMOGRAPHY IN ARCHAEOLOGY

---

---

Andrew T. Chamberlain



Cambridge University Press  
0521596513 - Demography in Archaeology  
Andrew T. Chamberlain  
Frontmatter  
[More information](#)

---

CAMBRIDGE UNIVERSITY PRESS

Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo

Cambridge University Press  
The Edinburgh Building, Cambridge CB2 2RU, UK

Published in the United States of America by Cambridge University Press, New York

[www.cambridge.org](http://www.cambridge.org)

Information on this title: [www.cambridge.org/9780521596510](http://www.cambridge.org/9780521596510)

© Andrew T. Chamberlain 2006

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2006

Printed in the United Kingdom at the University Press, Cambridge

*A catalogue record for this publication is available from the British Library*

ISBN-13 978-0-521-59367-0 hardback

ISBN-10 0-521-59367-0 hardback

ISBN-13 978-0-521-59651-0 paperback

ISBN-10 0-521-59651-3 paperback

---

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

---

Cambridge University Press  
0521596513 - Demography in Archaeology  
Andrew T. Chamberlain  
Frontmatter  
[More information](#)

---

To Clive and Stephen, who pointed the way.

# CONTENTS

<i>List of figures</i>	<i>page</i> xiii
<i>List of tables</i>	xvi
<i>Preface</i>	xviii
1 INTRODUCTION	1
1.1 The principal concerns of demography	1
1.1.1 What is a population?	1
1.1.2 Population characteristics	2
1.1.3 Demographic data: from individual life histories to population parameters	3
1.2 Demography in archaeology	4
1.2.1 Archaeology and people	4
1.2.2 Population pressure: cause or effect?	4
1.2.3 Population structure	6
1.2.4 Health and disease	7
1.2.5 Migration	8
1.3 Sources of evidence	10
1.3.1 Theoretical models	10
1.3.2 Ethnographic and historical evidence	11
1.3.3 Archaeological evidence: skeletal remains, settlements and site catchments	11
1.3.4 Genetic and evolutionary evidence	12
1.3.5 Evidence from disease	13

## viii CONTENTS

2	DEMOGRAPHIC CONCEPTS, THEORY AND METHODS	15
2.1	Population structure	15
2.1.1	Age categories and age distributions	15
2.1.2	Sex distributions	18
2.1.3	Other structuring categories	19
2.2	Population growth and demographic transition	19
2.2.1	Geometric and exponential growth	19
2.2.2	Logistic growth	21
2.2.3	Demographic transition	23
2.3	Mortality, survivorship and life tables	25
2.3.1	Mortality	25
2.3.2	Survivorship	25
2.3.3	Stable populations	26
2.3.4	The life table	27
2.3.5	Hazard functions for modelling mortality and survivorship	32
2.4	Fertility and population projection	35
2.4.1	Fertility	35
2.4.2	Population projection	36
2.5	Migration and colonisation	38
2.5.1	Migration	38
2.5.2	Colonisation	40
2.6	Population standardisation and comparison	41
2.6.1	Population standardisation	41
2.6.2	Population comparison	43
3	HISTORICAL AND ETHNOGRAPHIC DEMOGRAPHY	45
3.1	Documentary sources of demographic data	45
3.1.1	Vital registration	45
3.1.2	Censuses	46

3.1.3	Commemorative inscriptions	47
3.1.4	Other written sources	48
3.2	Families and households	50
3.2.1	Family units	50
3.2.2	Family reconstitution	50
3.2.3	Household size	52
3.3	Longevity, menarche and menopause	52
3.3.1	Perceptions and misperceptions of longevity	52
3.3.2	Menarche and menopause	54
3.4	Historical evidence of migration and colonisation	55
3.4.1	Migration in pre-industrial Europe	55
3.4.2	Mass migration and colonisation in the modern era	57
3.5	Hunter-gatherer demography	58
3.5.1	Population structure in hunter-gatherers	58
3.5.2	Mortality and fertility in hunter-gatherers	62
3.6	Demography of agricultural populations	64
3.6.1	Population structure in agricultural populations	64
3.6.2	Mortality and fertility in agricultural populations	67
3.7	Conditions of high mortality	69
3.7.1	Crisis mortality and natural disasters	69
3.7.2	Famine	70
3.7.3	Epidemic disease	74
3.7.4	Conflict mortality	77
4	ARCHAEOLOGICAL DEMOGRAPHY	81
4.1	Past population structure	81
4.1.1	Background to the palaeodemography debate	81
4.1.2	The challenge by Bocquet-Appel and Masset	84



X CONTENTS

4.1.3	Uniformitarian assumptions in palaeodemography	87
4.1.4	Bias in samples and in estimation	89
4.2	Estimation of sex	92
4.2.1	Human sex differences	92
4.2.2	Morphological sex differences in pre-adolescent skeletons	93
4.2.3	Morphological sex differences in adult skeletons	95
4.2.4	Accuracy of sex estimation	97
4.2.5	Biomolecular methods of sex estimation	97
4.3	Estimation of age at death	98
4.3.1	Human skeletal development and ageing	98
4.3.2	Age estimation in fetuses and children	101
4.3.3	Age estimation in adults: macroscopic methods	105
4.3.4	Age estimation in adults: microscopic methods	110
4.4	Bayesian and maximum likelihood approaches to age estimation	112
4.4.1	General principles in estimating age from morphological indicators	112
4.4.2	Bayes' theorem and its application to age estimation	113
4.4.3	Evaluative studies of Bayesian methods in age estimation	116
4.4.4	Alternative ways of modelling likelihoods: transition analysis and latent traits	119
4.4.5	Perinatal age estimation from long bone length	120
4.4.6	Age estimation and catastrophic mortality profiles	123
4.4.7	Prospects for the future	125
4.5	Estimation of population numbers from archaeological data	126
4.5.1	House sizes and floor areas	126
4.5.2	Settlement sizes	127
4.5.3	Site catchments and resource utilisation	128

4.5.4	Monitoring population size from radiocarbon dating distributions	131
5	EVOLUTIONARY AND GENETIC PALAEODEMOGRAPHY	133
5.1	Age and sex structure in animal populations	133
5.1.1	Natural animal populations	133
5.1.2	Demography of non-human primates	134
5.2	Demography of fossil hominids	137
5.2.1	Maturation times and longevity in fossil hominids	137
5.2.2	Demography of <i>Australopithecus</i> and early <i>Homo</i>	140
5.2.3	Demography of <i>Homo heidelbergensis</i> and <i>Homo neanderthalensis</i>	143
5.3	Human genetic palaeodemography	146
5.3.1	Genetic studies of present-day populations	146
5.3.2	Genetic studies of ancient populations	148
6	DEMOGRAPHY AND DISEASE	151
6.1	Disease in archaeological populations	151
6.1.1	Concepts and evidence of disease	151
6.1.2	Infectious and epidemic diseases	154
6.1.3	Metabolic, nutritional and deficiency diseases	160
6.1.4	Neoplastic and congenital diseases	165
6.1.5	Trauma and homicide	168
6.2	Social and demographic impacts of disease	172
6.2.1	Demographic responses to disease	172
6.2.2	Social responses to disease	173
7	CONCLUDING REMARKS	177
7.1	The relevance of demography for archaeology	177
7.2	How meaningful are the results of palaeodemographic analysis?	179

## xii CONTENTS

7.3	How different were populations in the past?	180
7.4	Demographic processes and cultural change	183
7.5	Challenges for the future	185
	<i>References</i>	189
	<i>Index</i>	225

## FIGURES

2.1	Age distribution in the Ache, a hunter-gatherer group in eastern Paraguay.	<i>page 16</i>
2.2	Triangular graph of mortality depicting the relative proportions of juvenile, prime-adult and old-adult individuals.	18
2.3	Exponential and logistic growth.	21
2.4	Estimated population growth in England and Wales between AD 1100 and 1800.	22
2.5	Population transition in France, eighteenth and nineteenth centuries.	24
2.6	Age-specific mortality in female Ache hunter-gatherers.	34
2.7	Examples of the general pattern of age-specific variation in human female fertility.	36
2.8	Age-specific migration rates in Australia.	39
2.9	Survivorship at the Tlajinga 33 apartment compound at Teotihuacan, Mexico.	43
3.1	Age heaping and year avoidance in the burial registers from a nineteenth-century hospital.	46
3.2	Age-specific probability of death calculated from Roman tombstone inscriptions.	49
3.3	Age structures of four hunter-gatherer populations.	61

xiv	FIGURES	
3.4	Age-specific probability of death in three hunter-gatherer populations.	64
3.5	Age-specific fertility in hunter-gatherer women.	65
3.6	Age structure in agricultural populations.	66
3.7	Survivorship in agricultural populations.	67
3.8	Age-specific fertility in women from agricultural populations.	68
3.9	Age-specific mortality in catastrophic floods.	71
3.10	Age-specific mortality during famines in Berar province, India.	72
3.11	Crude birth and death rates in Berar province, India.	73
3.12	Age-specific death rates from influenza.	75
3.13	Distribution of deaths from plague in Penrith.	76
3.14	Age distribution of civilian deaths in Srebrenica.	79
3.15	Age distribution of combatant deaths.	80
4.1	Age-specific mortality (percentage of deaths) in the Libben cemetery.	83
4.2	Juvenility index in stable populations with different mortality levels and rates of population growth.	86
4.3	Age-specific mortality in four archaeological samples of human skeletal remains.	90
4.4	Age-specific mortality in hunter-gatherers and subsistence agriculturalists.	91
4.5	Unfused epiphysis at the proximal end of the femur.	100
4.6	Growth profiles constructed from archaeological samples of skeletal remains, compared to the modern Denver growth standard.	104
4.7	Age-related changes in the pubic symphysis.	107
4.8	Pattern of wear on the occlusal surfaces of the lower teeth.	109
4.9	Estimated distribution of age at death for Loisy-en-Brie.	118
4.10	Distribution of gestational ages estimated from the diaphyseal lengths of femurs.	124

4.11	Distribution of adult ages at death for two catastrophic skeletal assemblages.	125
4.12	Proxy archaeological data indicating relative changes in population size in Roman London.	130
4.13	Distribution of <sup>14</sup> C dates obtained on human bone from Mesolithic and early Neolithic archaeological sites in Britain.	131
5.1	Survivorship curves and average mortality for natural cervid populations.	134
5.2	Survivorship curves for cercopithecine monkeys, <i>Pan troglodytes</i> and <i>Homo sapiens</i> .	136
5.3	Survivorship curves for cercopithecine monkeys, <i>Pan troglodytes</i> and <i>Homo sapiens</i> , compared to a common developmental scale.	137
5.4	Age distributions in samples of <i>Homo heidelbergensis</i> and <i>Homo neanderthalensis</i> .	144
6.1	Osteomyelitis in an arm bone.	155
6.2	Season of mortality in Rome.	160
6.3	<i>Cribra orbitalia</i> .	163
6.4	Nitrogen isotope ratios in infant skeletons.	166

## TABLES

2.1	Changes in population parameters during the demographic transition.	<i>page</i> 23
2.2	Life table for Northern Ache females.	29
2.3	Leslie matrix for Northern Ache females.	37
2.4	Comparison of mortality in the Early Period (AD 300–550) and the Late Period (AD 550–700) at the Tlajinga 33 site at Teotihuacan, Mexico.	42
3.1	Data recorded on a family reconstitution form (FRF).	51
3.2	Population structure from census data for hunter-gatherer and subsistence-farming populations.	59
3.3	Age-specific risk of death in hunter-gatherer populations.	63
4.1	Factors contributing to differences between the skeletons of human adult males and females.	94
4.2	Options for the selection of prior probabilities of age in Bayesian age estimation.	116
4.3	Distribution of femoral-head trabecular involution in a reference series.	117
4.4	Diaphyseal length of femurs in known-age individuals.	121
4.5	Posterior probabilities of gestational age given femur length.	122
5.1	Average duration (in years) of the formation of teeth.	139
5.2	Numbers and proportions of old adults in mortality samples.	140
5.3	Proportions of subadults in samples of fossil hominids.	142

5.4	Distributions of age at death in <i>Homo heidelbergensis</i> and <i>Homo neanderthalensis</i> .	143
6.1	Changes in prevalence of selected health conditions at the transition from foraging to farming.	159
6.2	Modern frequencies of congenital diseases (per thousand live births) that are diagnosable from skeletal remains.	167
6.3	Proportions of juveniles and of adult females in skeletal assemblages from European prehistoric conflict sites.	171



## PREFACE

---

The original impetus to write this volume emerged nearly a decade ago. It stemmed from a dissatisfaction, in fact a cognitive dissonance, between on the one hand the need to instruct graduate students in the available procedures for the reconstruction of past populations from skeletal remains, and on the other hand a profound unease at the results generated by such exercises. Fortunately it turned out that several researchers were simultaneously trying to square the same circle, and although the gestation of this book has been inordinately long, it has benefited from the insights provided by the combined endeavours of a new generation of anthropologists, archaeologists, population geneticists and biostatisticians whose research has reinvigorated the science of palaeodemography. In this book I have attempted to summarise and evaluate some of these exciting new developments, as well as to revisit some of the older and more established procedures for inferring population parameters from archaeological evidence.

Many individuals and organisations have knowingly or unwittingly contributed to the production of this book. Thanks are due first of all to the stimulating intellectual environment provided by colleagues and students at the University of Sheffield, and to the long-standing policy of the Department of Archaeology to resource periods of study leave for some of its academic staff. Some of the ideas expressed in this book have been trialled on successive cohorts of students enrolled on the Human Osteology masters

training programme at the University of Sheffield. A few of those students have helped me substantially by contributing to the research reported here through their graduate and postdoctoral studies, in particular Dr Rebecca Gowland of the University of Cambridge and Dr Jo Buckberry of the University of Bradford. Other colleagues have been generous with their data, ideas and opinions – too many to name them all individually, but a particular debt of thanks is owed to Professor Charlotte Roberts of the University of Durham who sensibly reminded me of the inverse correlation between health and mortality! And quietly watching from the sidelines have been my editors at Cambridge University Press, whose enduring patience and support, flavoured with occasional gentle cajoling, have been invaluable.

Funding for some of my research has been provided by the Arts and Humanities Research Council, and several individuals and organisations have facilitated the study of unpublished skeletal remains. Louise Humphrey (Natural History Museum) and Eugenia Cunha (Coimbra) permitted access to their collections of known-age skeletons, and James Vaupel (Director of the Max Planck Institute of Demographic Research) kindly invited me to participate in some of the research projects sponsored by his Institute.