

SKELETAL VARIATION AND ADAPTATION IN EUROPEANS

UPPER PALEOLITHIC TO THE TWENTIETH CENTURY

A comprehensive analysis of changes in body form and skeletal robusticity from the Terminal Pleistocene through the Holocene, leading to the modern European human phenotype.

Skeletal Variation and Adaptation in Europeans: Upper Paleolithic to the Twentieth Century brings together for the first time the results of an unprecedented large-scale investigation of European skeletal remains. The study was conducted over ten years by an international research team, and includes more than 2,000 skeletons spanning most of the European continent over the past 30,000 years, from the Early Upper Paleolithic to the 20th century. This time span includes environmental transitions from foraging to food production, small-scale to large-scale urban settlements, increasing social stratification and mechanization of labor, and climatic changes. Alterations in body form and behavior in response to these transitions are reconstructed through osteometric and biomechanical analyses.

Divided into four sections, the book includes an introduction to the project and comprehensive descriptions of the methods used; general continent-wide syntheses of major trends in body size, shape, and skeletal robusticity; detailed regional analyses; and a summary of results. It also offers a full data set on an external website.

- Brings together data from an unprecedented large-scale study of human skeletal and anatomical variations
- Includes appendix of specific information from each research site
- Synthesizes data from spatial, temporal, regional, and geographical perspectives

Skeletal Variation and Adaptation in Europeans will be a valuable resource for bioarchaeologists, palaeoanthropologists, forensic anthropologists, medical historians, and archaeologists at both the graduate and post-graduate level.

About the Editor

Christopher B. Ruff is Director of the Center for Functional Anatomy and Evolution at Johns Hopkins University School of Medicine, Baltimore, MD, USA. Dr. Ruff has published widely in the fields of human osteology, bioarchaeology, and paleontology, and has served as editor of the *American Journal of Physical Anthropology* and the *Yearbook of Physical Anthropology*.

Cover Design: Wiley

Cover Image: Simon Bening. September: plowing and sowing seed.

Book of Hours ("Da Costa Hours"), Bruges, c. 1515. MS. M.399, f.10v.

Image courtesy of Akademische Druck- u. Verlagsanstalt, Graz/Austria.

The Morgan Library & Museum, New York, NY, USA

Photo Credit: The Morgan Library & Museum / Art Resource, NY

www.wiley.com/wiley-blackwell

WILEY Blackwell



Also available
as an e-book

ISBN 978-1-118-62796-9



9 781118 627969

List of Contributors *xiii*

Preface *xv*

1 Introduction *1*

Christopher B. Ruff

1.1 Study Sample *3*

1.2 Osteological Measurements *5*

1.3 Other Variables *8*

1.4 Organization of the Book *9*

References *10*

2 Body Size and Shape Reconstruction *15*

Markku Niskanen and Christopher B. Ruff

2.1 Introduction *15*

2.2 Body Size and Shape Estimation *15*

2.3 Materials and Methods *17*

2.3.1 Estimation of Missing Elements *17*

2.3.2 Statistical Procedures *19*

2.4 Estimating Body Size and Shape from Skeletal Dimensions *20*

2.4.1 Stature *20*

2.4.2 Sitting Height and Total Lower Limb Length *22*

2.4.3 Limb Segment Lengths *23*

2.4.4 Body Breadths *24*

2.4.5 Body Mass *25*

2.5 Evaluation of Errors in Estimating Body Size and Shape from Skeletal Dimensions *26*

2.5.1 Stature Estimation *26*

2.5.2 Sitting Height, Lower Limb Subischial Length, and Lower Leg Length *28*

2.5.3 Trunk Breadths *30*

2.5.4 Body Mass Estimation *30*

2.5.5 Sex and Age Effects *32*

2.6 Discussion and Conclusions *33*

Acknowledgments *34*

References *34*

3 Quantifying Skeletal Robusticity *39*

Christopher B. Ruff

3.1 Cross-Sectional Properties *39*

3.2 Cross Section Reconstruction *40*

3.3	Section Moduli	42
3.4	Standardizing for Body Size	44
	References	45
4	Temporal and Geographic Variation in Body Size and Shape of Europeans from the Late Pleistocene to Recent Times	49
	<i>Markku Niskanen, Christopher B. Ruff, Brigitte Holt, Vladimir Sládek, and Margit Berner</i>	
4.1	Environmental Adaptation	49
4.2	European Population History	52
4.3	Materials and Methods	54
4.3.1	Skeletal Samples and Variables	54
4.3.2	Estimating Body Size and Shape from Skeletal Dimensions	55
4.3.3	Anthropometric Samples and Variables	56
4.3.4	Statistical and Graphical Analyses	57
4.4	Results	58
4.4.1	General Temporal Trends in Body Size and Body Proportions	58
4.4.2	Body Size and Shape of Foragers Before and After the Last Glacial Maximum	66
4.4.3	Changes Across the Mesolithic–Neolithic Transition and During the Neolithic	67
4.4.4	The Little Ice Age, the Industrial Revolution, and Very Recent Changes	67
4.4.5	Geographic Differences in Body Size and Proportions	68
4.5	Discussion	76
4.6	Conclusions	81
	References	82
5	Temporal and Geographic Variation in Robusticity	91
	<i>Brigitte Holt, Erin Whittey, Markku Niskanen, Vladimir Sládek, Margit Berner, and Christopher B. Ruff</i>	
5.1	Introduction	91
5.2	Background	91
5.2.1	Limb Bone Robusticity and Subsistence Changes	91
5.2.2	Cultural and Economic Factors	92
5.2.3	Terrain	96
5.3	Materials	96
5.4	Methods	97
5.4.1	Aging and Sexing	97
5.4.2	Reconstruction of Cross-Sectional Dimensions	97
5.4.3	Robusticity Variables	97
5.4.4	Standardizing Cross-Sectional Dimension for Differences in Body Size	98
5.4.5	Quantification of Terrain	98
5.4.6	Categorization of Urbanization	98
5.4.7	Analysis of Robusticity	98
5.5	Results	99
5.5.1	Temporal Trends	99
5.5.1.1	Upper Limb	99
5.5.1.2	Lower Limb	107
5.5.2	Urbanization	116
5.5.3	Social Complexity	116

5.5.4	Terrain	117
5.6	Discussion	118
5.7	Conclusions	126
	Acknowledgments	127
	References	127
6	Sexual Dimorphism	133
	<i>Margit Berner, Vladimír Sládek, Brigitte Holt, Markku Niskanen, and Christopher B. Ruff</i>	
6.1	Introduction	133
6.2	Materials and Methods	136
6.3	Results	137
6.3.1	Overall Variation in SD	137
6.3.2	Temporal Trends in Sexual Dimorphism	143
6.3.3	Body Size and Body Proportions	143
6.3.4	Average Strength	144
6.3.5	Cross-Sectional Shape	145
6.3.6	Cross-Sectional Area	146
6.3.7	Comparison of Neolithic Subsistence Groups	146
6.3.8	Urban Versus Rural	148
6.3.9	Femoro-Humeral Strength Ratio (FZ_p/HZ_p)	148
6.4	Discussion	149
6.4.1	Body Size and Shape	153
6.4.2	Lower Limb Strength	154
6.4.3	Humerus	155
6.5	Conclusions	157
	Acknowledgments	157
	References	158
7	Past Human Manipulative Behavior in the European Holocene as Assessed Through Upper Limb Asymmetry	163
	<i>Vladimír Sládek, Margit Berner, Brigitte Holt, Markku Niskanen, and Christopher B. Ruff</i>	
7.1	Introduction	163
7.2	Materials and Methods	167
7.2.1	Samples	167
7.2.2	Linear Measurements and CSG Parameters	169
7.2.3	Computation of Asymmetry and Sexual Dimorphism	169
7.2.4	Statistical Techniques	171
7.3	Results	171
7.3.1	Asymmetry Variation	171
7.3.1.1	General Differences Between Structural Properties	171
7.3.1.2	Temporal Trends in Asymmetry	173
7.3.1.3	Regional Differences in Asymmetry	190
7.3.2	Right Versus Left Dominance	194
7.3.3	Variation in Right and Left Humeral CSG	196
7.4	Discussion	201
7.5	Summary and Conclusions	203
	Acknowledgments	204
	References	204

8	Britain	209
	<i>Christopher B. Ruff, Evan Garofalo, and Sirpa Niinimäki</i>	
8.1	Introduction	209
8.2	Body Size and Shape	213
8.2.1	Body Size	213
8.2.2	Body Shape	218
8.2.3	Comparisons to other Europeans	220
8.3	Cross-Sectional Properties	221
8.3.1	Bone Strength	221
8.3.2	Percentage Cortical Area	225
8.3.3	Comparisons to other Europeans	225
8.3.4	The 'Amesbury Archer'	228
8.4	Discussion	233
8.4.1	Body Size and Shape	233
8.4.2	Bone Structure	235
8.5	Conclusions	236
	Acknowledgments	237
	References	237
9	France and Italy	241
	<i>Brigitte Holt, Erin Whittey, and Dannielle Tompkins</i>	
9.1	Introduction	241
9.2	Samples	241
9.3	Methods	244
9.3.1	Body Shape	244
9.3.2	Robusticity	244
9.3.3	Statistical Analysis	244
9.4	Body Size and Shape	244
9.4.1	Temporal Changes Within the FI group	244
9.4.2	Body Size and Shape Sexual Dimorphism	248
9.4.3	Impact of Urbanization	249
9.4.4	Comparisons with Europe	251
9.5	Long Bone Robusticity	252
9.5.1	Temporal Trends	252
9.5.1.1	Upper Limb	252
9.5.1.2	Lower Limb	255
9.5.2	Sexual Dimorphism	259
9.5.3	Bilateral Asymmetry	261
9.5.4	Rural/Urban Status	261
9.5.5	Terrain	263
9.5.6	Comparisons with Europe	263
9.5.6.1	Upper Limb	263
9.5.6.2	Lower Limb	265
9.6	Discussion	270
9.7	Conclusions	276
	Acknowledgments	276
	References	277

10	Iberia	281
	<i>Christopher B. Ruff and Heather Garvin</i>	
10.1	Introduction	281
10.2	Body Size and Shape	286
10.2.1	Body Size	286
10.2.2	Body Shape	290
10.2.3	Comparisons to other Europeans	293
10.3	Cross-Sectional Properties	294
10.3.1	Bone Strength	294
10.3.2	Percentage Cortical Area	300
10.3.3	Comparisons to other Europeans	304
10.4	Discussion	305
10.4.1	Body Size and Shape	305
10.4.2	Bone Structure	307
10.5	Conclusions	310
	Acknowledgments	311
	References	311
11	Central Europe	315
	<i>Vladimír Sládek, Margit Berner, Eliška Makajevová, Petr Velemínský, Martin Hora, and Christopher B. Ruff</i>	
11.1	Introduction	315
11.1.1	Central Europe: Geography and Paleoenvironment	315
11.1.2	Central Europe: Archaeological Context	316
11.2	Materials and Methods	319
11.2.1	Sample	319
11.2.2	Measurements and Variables	321
11.2.3	Statistical Techniques	322
11.3	Results	323
11.3.1	Body Size and Shape Variation	323
11.3.1.1	Stature, Body Mass, and Body Mass Index	323
11.3.1.2	Changes in Body Size Between Central European Holocene and Living Humans	323
11.3.1.3	Relative Bi-iliac Breadth	326
11.3.1.4	Crural and Brachial Indices	326
11.3.1.5	Sexual Dimorphism in Body Size and Shape	326
11.3.2	Mobility and Sedentism	327
11.3.2.1	Femoral and Tibial Cortical Area and Bending Strength	327
11.3.2.2	Femoral and Tibial Shape Ratio (Z_x/Z_y)	330
11.3.2.3	Sexual Dimorphism in Lower Limb CSG Properties	330
11.3.3	Manipulative Behavior Changes	330
11.3.3.1	Humeral Cortical Area	330
11.3.3.2	Humeral Bending Strength	331
11.3.3.3	Humeral Directional Asymmetry	332
11.3.3.4	Sexual Dimorphism in Humeral CSG Properties	335
11.3.4	Comparison of Central European Body Size, Shape, and CSG Properties to European Holocene	335

11.4	Discussion	337
11.4.1	Central European UP and Mesolithic	337
11.4.2	Adoption of Agriculture	340
11.4.3	Secondary Products Revolution	341
11.4.4	Origin of Metallurgy	343
11.4.5	The Avars and Nomadic Subsistence in Central Europe	343
11.4.6	The Transition to the Archaic State in Central Europe	344
11.4.7	Comparison to Living Central Europeans and Impact of Secular Trend	345
11.5	Conclusions	346
	Acknowledgments	347
	References	347
12	Scandinavia and Finland	355
	<i>Markku Niskanen, Heli Maijanen, Juho-Antti Junno, Sirpa Niinimäki, Anna-Kaisa Salmi, Rosa Vilkama, Tiina Väre, Kati Salo, Anna Kjellström, and Petra Molnar</i>	
12.1	Introduction to Region, Samples, and Techniques	355
12.1.1	Region and its Population History	355
12.1.2	Samples	357
12.1.3	Technique Summary	360
12.2	Body Size and Body Shape	361
12.2.1	Temporal Trends	361
12.2.2	Comparison with pan-European	371
12.2.3	Other Comparisons	374
12.3	Cross-Sectional Properties	377
12.3.1	Temporal Trends	377
12.3.2	Comparisons with pan-European	384
12.3.3	Other Comparisons	385
12.4	Discussion	388
12.4.1	Body Size and Body Shape	388
12.4.2	Cross-Sectional Properties	390
12.5	Conclusions	391
	Acknowledgments	391
	References	392
13	The Balkans	397
	<i>Christopher Ruff and Brigitte Holt</i>	
13.1	Introduction	397
13.2	Body Size and Shape	399
13.2.1	Schela Cladovei	399
13.2.2	Mistihalj	402
13.3	Cross-Sectional Properties	402
13.3.1	Schela Cladovei	402
13.3.2	Mistihalj	407
13.4	Discussion	408
13.4.1	Body Size and Shape	408
13.4.2	Bone Structure	411
13.5	Conclusions	414
	Acknowledgments	415
	References	415

14 Conclusions 419

*Christopher B. Ruff, Brigitte Holt, Markku Niskanen, Vladimír Sládek,
and Margit Berner*

14.1 Body Size and Shape 419

14.2 Long Bone Strength 421

14.3 Other Bone Structural Observations 423

References 424

Appendix 1: Study Samples 427

References 436

Appendix 2(a) 443

Notes and Sources 446

References 447

Appendix 2(b) 449

Appendix 3(a) 451

References 452

Appendix 3(b) 455

References 461

Appendix 4 463

Appendix 5 471

Index 477