
THE EPIDEMIOLOGY of DIABETES MELLITUS

Second Edition

Edited by

Jean-Marie Ekoé *Endocrinologie, Métabolisme et Nutrition, Centre de Recherche CHUM, Montreal, Canada*

Marian Rewers *Barbara Davis Center for Childhood Diabetes, Colorado, USA*

Rhys Williams *Clinical Epidemiology at the School of Medicine, University of Swansea, Swansea, UK*

Paul Zimmet *International Diabetes Institute, Caulfield, Australia*

THE EPIDEMIOLOGY of DIABETES MELLITUS

Second Edition

THE EPIDEMIOLOGY of DIABETES MELLITUS

Second Edition

Edited by

Jean-Marie Ekoé *Endocrinologie, Métabolisme et Nutrition, Centre de Recherche CHUM, Montreal, Canada*

Marian Rewers *Barbara Davis Center for Childhood Diabetes, Colorado, USA*

Rhys Williams *Clinical Epidemiology at the School of Medicine, University of Swansea, Swansea, UK*

Paul Zimmet *International Diabetes Institute, Caulfield, Australia*

This edition first published 2008 © 2008, John Wiley & Sons Ltd

Wiley-Blackwell is an imprint of John Wiley & Sons, formed by the merger of Wiley's global Scientific, Technical and Medical business with Blackwell Publishing.

Registered office: John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Other Editorial Offices:

9600 Garsington Road, Oxford, OX4 2DQ, UK
111 River Street, Hoboken, NJ 07030-5774, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell

The right of the author to be identified as the author of this work has been asserted in accordance with the Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by the UK Copyright, Designs and Patents Act 1988, without the prior permission of the publisher.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

The contents of this work are intended to further general scientific research, understanding, and discussion only and are not intended and should not be relied upon as recommending or promoting a specific method, diagnosis, or treatment by physicians for any particular patient. The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of fitness for a particular purpose. In view of ongoing research, equipment modifications, changes in governmental regulations, and the constant flow of information relating to the use of medicines, equipment, and devices, the reader is urged to review and evaluate the information provided in the package insert or instructions for each medicine, equipment, or device for, among other things, any changes in the instructions or indication of usage and for added warnings and precautions. Readers should consult with a specialist where appropriate. The fact that an organization or Website is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers should be aware that Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read. No warranty may be created or extended by any promotional statements for this work. Neither the publisher nor the author shall be liable for any damages arising herefrom.

Library of Congress Cataloging-in-Publication Data:

The epidemiology of diabetes mellitus / edited by Jean-Marie Ekoé . . . [et al.].—2nd ed.

p. ; cm.

Includes bibliographical references and index.

ISBN 978-0-470-01727-2 (alk. paper)

1. Diabetes—Epidemiology. I. Ekoé, J.-M.

[DNLM: 1. Diabetes Mellitus—epidemiology. 2. Diabetes

Complications—epidemiology. WK 810 E641 2008]

RA645.D5E654 2008

614.5'9462—dc22

2008029103

ISBN 978-0-470-01727-2

A catalogue record for this book is available from the British Library.

Set in 10/12 Times New Roman by Laserwords Private Ltd, Chennai, India.
Printed in Great Britain by Antony Rowe Ltd, Chippenham, Wiltshire.

First Impression 2008

Contents

About the Editors	xv
Contributors	xvii
Foreword	xxiii
Acknowledgments	xxv
1: Introduction, Jean-Marie Ekoé, Marian Rewers, Rhys Williams and Paul Z. Zimmet	1
Introduction to the Second Edition	1
Introduction to the First Edition	2
2: The Clinical Syndrome and the Biochemical Definition, Jean-Marie Ekoé, Paul Z. Zimmet and Jean-Francois Yale	5
Definition of the Diabetic State	5
The Clinical Syndrome	6
The Biochemical Definition	7
Significance of Blood Glucose in a Population	7
3: Diagnosis and Classification, Jean-Marie. Ekoé and Paul Z. Zimmet	11
Diagnosis and Diagnostic Criteria	11
The Demonstration of an Abnormal Blood Glucose Level Using an Oral Glucose Tolerance Test	12
The Oral Glucose Tolerance Test	12
New Criteria in Diagnostic Value for Fasting Plasma Blood Glucose Concentrations	13
Epidemiological Studies	14
Classification of the Diabetes Mellitus Syndrome and Other Categories of Glucose Intolerance	14
Changes in Terminology	15
Clinical Classification of Diabetes Mellitus and other Categories of Glucose Tolerance	17
The Newly Proposed Staging Classification	18
The Newly Proposed Etiological Types	19
Genetic Defects of β -cell Function	21
Genetic Defects in Insulin Action	22
Diseases of the Exocrine Pancreas	22
Endocrinopathies	22
Drug- or Chemical-induced Diabetes	22

Infections	22
Uncommon but Specific Forms of Immune-mediated Diabetes Mellitus	22
Other Genetic Syndromes Associated with Diabetes	23
Gestational Diabetes Mellitus	23
Diagnosis of Gestational Diabetes	24
Conclusions	25
4: Epidemiology of Metabolic Syndrome, Dianna J. Magliano, Adrian Cameron, Jonathan E. Shaw and Paul Z. Zimmet	31
Introduction	31
What is Metabolic Syndrome?	31
Historical Overview	31
Etiology of Metabolic Syndrome	32
Approaches to Defining Metabolic Syndrome	33
Current Working Definitions of Metabolic Syndrome	34
Metabolic Syndrome and other Diseases	38
All-cause Mortality	39
Risk Factors for Metabolic Syndrome	41
Prevalence of Metabolic Syndrome	41
Genetics of Metabolic Syndrome	48
Summary and Conclusion	49
5: Obesity and Diabetes, Rachel Huxley, Abdullah Omari and Ian D. Caterson	57
Introduction: Defining Obesity	57
Epidemiological Trends in Obesity	57
Obesity and Diabetes are Causally Linked	59
Attributable Burden of Diabetes due to Excess Weight	59
Age and Regional Variation in the Association between Obesity and Diabetes	59
Central Obesity Versus BMI as a Predictor of Diabetes	60
Physiological Mechanisms Mediating Excess Weight with Diabetes	61
Other Key Risk Factors for Obesity and Diabetes	62
Impact of Social Class on Obesity	62
Early Life Environment and the 'Programming' Hypothesis	64
The Increasing Global Burden of Diabetes and Obesity	65
Global Burden of Diabetes	66
Does Weight Loss Improve Diabetic Outcomes? Evidence from Randomized Trials	67
6: Methodology for Physical Activity Assessment, Kristi L. Storti, Edward W. Gregg and Andrea M. Kriska	71
Introduction	71
What Is Physical Activity?	72
How Has Physical Activity Been Measured?	72
Application of Physical Activity Assessment: Population and Outcome Considerations	79
Concluding Remarks	80

7: Epidemiology of Nutrition and Diabetes Mellitus: Etiology and Environmental Factors, Jim Mann and Monika Toeller	87
Introduction	87
Carbohydrate and Dietary Fiber	88
Dietary Fats	89
Protein	90
Alcohol	90
Other Dietary Factors and Smoking	91
Physical Inactivity	91
Potential for Intervention	91
Conclusions	92
8: Genetic Epidemiology of Type 2 Diabetes, Leif Groop, Valeriya Lyssenko, Charlotte Ling and Marju Orho-Melander	95
Introduction	95
Genetic Risk	95
Evidence that Type 2 Diabetes is Inherited	96
Thrifty Genotypes or Phenotypes?	96
Prediction of Future Type 2 Diabetes	97
Genetic Variability	97
Mapping Genetic Variability	98
Linkage	98
Calpain 10 and Type 2 Diabetes	99
Association Studies and Candidate Genes for Type 2 Diabetes	99
Common Variants in Mody Genes	102
Genetic Prediction of Type 2 Diabetes	103
Why is it Difficult to Replicate a Finding of an Association with a Complex Disease?	104
Why Do Not Linkage Studies Detect All Associations?	105
Whole-genome Association Studies	105
Genetic Influences on Age-Related Decline in Mitochondrial Dysfunction	106
Gene–Environment Interactions	107
Pharmacogenetics	107
Future Directions	107
9: Epidemiologic Aspects of Type 2 Diabetes Mellitus in Europe, Harry Keen	111
Introduction	111
A Diabetes Epidemic?	111
Changing Patterns	111
Conclusion	117
10: The Burden of Diabetes and its Complications in the Middle East and Eastern Mediterranean Region, Imad M. El-Kebbi and Michael M. Engelgau	121
Introduction	121
Type 1 Diabetes	121
Type 2 Diabetes	123
Risk Factors for Diabetes in the Middle East and Eastern Mediterranean Region	126
Adult Obesity	126

Childhood Obesity	127
Complications of Diabetes	127
Diabetes Prevention	128
Diabetes Surveillance	128
Conclusions	128
11: Epidemiology of Diabetes in Africa, Ayesha A. Motala, Mahomed A. K. Omar and Fraser J. Pirie	133
Introduction	133
Prevalence of Diabetes	134
Intermediate Categories of Abnormal Glucose Tolerance/Glycemia; Total Glucose Intolerance (TGI)	135
Urban–Rural Differences	139
Ethnic Differences and the Effect of Migration	139
Prevalence of Known Diabetes	140
Gender Distribution	140
Impact of Age	140
Measures of Adiposity: Body Mass Index (BMI) and Waist Circumference; Waist:Hip Ratio (WHR)	142
Family History	143
Physical Activity	143
Is the Prevalence of Diabetes Increasing in Africa?	143
Other Biochemical Variables	143
Longitudinal Studies	143
Other Factors	143
Complications	143
Costs of Diabetes Care	144
Future Trends	144
12: Epidemiology of Diabetes Mellitus in Latin America, Laércio J. Franco and Sandra R. G. Ferreira	147
Introduction	147
Epidemiology of Type 1 Diabetes in Latin America	147
Epidemiology of Type 2 Diabetes in Latin America	150
Mortality by Diabetes	157
Diabetic Complications	158
Conclusion	159
13: Diabetes in the Caribbean . . . an Epidemiological Review!, Errol Morrison and Dalip Ragoobirsingh	163
Introduction	163
Some Related Health Issues	164
Diabetes and Obesity	166
Atypical Diabetes	168
The Burden of Diabetes Mellitus in the Caribbean	168
Acknowledgments	168

14: Japan, Naoko Tajima	171
Introduction	171
Incidence and Prevalence Study	171
Mortality Study	174
15: Epidemiology of Diabetes Mellitus in China, Juliana C. N. Chan and Clive S. Cockram	179
Introduction	179
Socioeconomic Impact of Diabetes	179
Prevalence of Hyperglycemia and Type 2 Diabetes	180
Diagnosis of Hyperglycemia in Chinese Populations	180
Gestational Diabetes Mellitus	182
Childhood Obesity and Diabetes	183
Type 1 Diabetes	184
Type 2 Diabetes and Metabolic Syndrome (METS)	185
Diabetic Complications	190
From Epidemiology to Prevention	194
Conclusion	196
16: Epidemiology of Diabetes in South East Asia, Ambady Ramachandran and Chamukuttan Snehalatha	207
Diabetes: Burden, Global Prevalence and Projections	207
Scenario in South East Asia	207
Rising Prevalence of Diabetes in the Indian Subcontinent	208
Impaired Glucose Tolerance and Impaired Fasting Glucose	211
Genetic Factors	212
Acquired Risk Factors	212
Environmental Risk Factors	213
Diabetes Risk Score	216
Prevention of Diabetes	216
Chronic Complications of Diabetes	217
Type 2 Diabetes in Children	218
Costs of Treating Diabetes	218
17: The Epidemiology of Diabetes in Pacific Island Populations, Stephen Colagiuri, Taniela Palu, Satupaitea Viali, Zafiml Hussain and Ruth Colagiuri	225
Introduction	225
Geography	225
Epidemiological Transition	226
General	226
Prevalence of Diabetes	227
Rates of Undiagnosed Diabetes	236
Diagnosing Undiagnosed Diabetes	236
Screening for Undiagnosed Diabetes	236
Diabetes Complications	237
Obesity	237
Conclusion	238

18: Epidemiology of Type 2 Diabetes in North America, Linda S. Geiss, Jing Wang, Edward W. Gregg and Michael M. Engelgau	241
Introduction	241
North American Sources of Data to Monitor Diabetes	241
Current and Future Prevalence of Diabetes	242
Incidence of Diabetes	247
Diabetes Complications	247
Mortality	249
Summary	250
19: Non-Caucasian North American Populations: Native Americans, Meda E. Pavkov, K. M. Venkat Narayan, Robert G. Nelson, Robert L. Hanson and William C. Knowler	255
Native Americans	255
Diabetes in Native Americans	255
Magnitude of the Problem of Type 2 Diabetes in Native Americans	256
Determinants of Type 2 Diabetes	257
Potentially Modifiable Risk Factors	259
Complication of Type 2 Diabetes	261
Conclusion	265
20: Epidemiology of Type 2 Diabetes in Hispanic North Americans, Judith Baxter and Richard F. Hamman	273
Introduction	273
Hispanic Population Profile	273
Size and Distribution of Hispanic Population—Regional Trends	274
Age and Socioeconomic Characteristics	275
Prevalence of Diabetes	276
Incidence of Diabetes	278
Lifetime Risk	279
Trends in Diabetes Prevalence and Incidence	279
Future Projections	282
Diabetes Mortality Trends	283
Risk Factors	285
Genetic Admixture	288
Possibilities for Prevention	288
Preventive Practices for Complications	289
Directions for Future Research	290
21: Non-Caucasian North American Populations: African Americans, Mary A. Banerji and Harold Lebovitz	295
Introduction	295
Prevalence	296
Incidence	297
Risk Factors for Type 2 Diabetes	297
Is there a Metabolic Insulin Resistance Syndrome in African Americans?	300
Pathogenesis of Type 2 Diabetes in African Americans	303
Clinical Variants of Diabetes in African Americans	304
Complications of Diabetes	308

22: Epidemiology of Diabetes in Asian North Americans, Marguerite J. McNeely and Wilfred Y. Fujimoto	323
Introduction	323
Prevalence of Type 1 Diabetes in Asian North Americans	323
Prevalence of Type 2 Diabetes in Asian North Americans	323
Incidence of Type 2 Diabetes in Asian North Americans	327
Risk Factors for Type 2 Diabetes in Asian North Americans	327
Pathogenesis of Type 2 Diabetes in Asian North Americans	330
Diagnosis of Diabetes in Asian North Americans	332
Complications of Diabetes in Asian North Americans	332
Conclusions	333
23: Epidemiology of Type 2 Diabetes in Children and Adolescents, Jonathan E. Shaw and Dana M. Dabelea	339
Introduction	339
Prevalence and Incidence	339
Profile of Children and Adolescents with Type 2 Diabetes	343
Factors in the Development of Type 2 Diabetes	344
Conclusions	349
24: Global Epidemiology of Type 1 Diabetes, Lars C. Stene, Jaakko Tuomilehto and Marian Rewers	355
Introduction	355
Natural History and Islet Autoantibodies	355
Incidence of Type 1 Diabetes in Different Countries	356
Familial Aggregation and Relation to Other Diseases	364
Epidemiologic Evidence for Environmental Risk Factors	365
Conclusion	371
25: Epidemiology of Childhood Diabetes Mellitus in Non-Caucasian Populations, Rebecca B. Lipton	385
Introduction	385
Descriptive Epidemiology of Childhood-Onset Diabetes: Prevalence and Incidence Across the World	385
Descriptive Epidemiology of Childhood-Onset Diabetes: Temporal Trends and Migrant Studies	390
The Range of Diabetes in Youth Across the World: the Question of Mixed Phenotype	391
Risk Factors for Childhood Diabetes in Non-Caucasian Populations	393
Summary	397
26: Genetic Epidemiology of Type 1 Diabetes Mellitus, Kirsten O. Kyvik and Anders Green	403
Introduction	403
Evidence of a Genetic Contribution to Type 1 Diabetes	403
Evidence of Environmental Determinants	404
Predicting Risk of Type 1 Diabetes: Available Markers	405

Predicting Risk of Type 1 Diabetes: Methodological Considerations	406
Predicting Risk of Type 1 Diabetes: A Hypothetical Example	408
Concluding Remarks	410
27: Recent Trends in Screening and Prevention of Type 1 Diabetes, <i>Marian Rewers</i>	413
Introduction	413
Risk Prediction	414
Prevention	420
Conclusions	425
28: Non pharmacological Prevention of Type 2 Diabetes, <i>Jaakko Tuomilehto</i>	435
Introduction	435
Why Primary Prevention of T2D?	435
Major Lifestyle Trials in Prevention of T2D	436
Long-term Effectiveness of Lifestyle Prevention of T2D	439
Clinical Trial Evidence of the Effect of Lifestyle Factors on T2D Risk	440
Does the Risk Reduction Work in the Entire Population?	441
Costs Associated with Lifestyle Intervention to Prevent T2D	441
Detection of People at High Risk for Developing T2D	442
Conclusion	443
29: Pharmacological Prevention of Type 2 Diabetes, <i>André J. Scheen</i>	449
Introduction	449
Prevention by Glucose-lowering Agents	451
Prevention by Antiobesity Agents	456
Prevention by Lipid-Lowering Agents	459
Effects of RAAS Inhibition on Development of Diabetes	460
Prevention by Various Drugs	463
Conclusion	466
30: The Epidemiology of Eye Diseases in Diabetes, <i>Tien Y. Wong and Ron Klein</i>	475
Introduction	475
Diabetic Retinopathy	475
Retinal Vascular Diseases	484
Neuro-ophthalmic Manifestations	485
Cataract	485
Glaucoma	486
Conclusion	486
31: The Epidemiology of Diabetic Kidney Disease, <i>Anne T. Reutens, Louise Prentice and Robert C. Atkins</i>	499
Introduction	499
Definition	499
Incidence and Prevalence of Diabetic Kidney Disease	500
Association with CVD	503
Etiological Factors: Markers of Risk for Development of DN	504

CONTENTS

xiii

Lipids	507
Familial Predisposition	507
Smoking	508
Fibrinogen	508
Kallikrein	509
Novel Cardiovascular Risk Factors	509
The Epidemiology of Prevention	510
32: Epidemiology of Large-vessel Disease in Diabetes: Coronary Heart Disease and Stroke, <i>Elizabeth Barrett-Connor</i>	519
Introduction	519
Risk Factors	519
Outcomes	526
Type 1 Diabetes Risk Factors	528
Outcomes	529
Summary	529
33: The Epidemiology of Peripheral Vascular Disease, Nalini Singh, Stephanie Wheeler and <i>Edward J. Boyko</i>	539
Introduction	539
Measurement and Validity	539
PAD Prevalence	540
PAD Incidence	544
PAD and Mortality	544
Risk Factors for PAD	545
Epidemiology of Renal Arterial Stenosis and Diabetes Mellitus	548
Epidemiology of Abdominal Aortic Aneurysm and Diabetes Mellitus	550
Epidemiology of Venous Thromboembolic Disease and Diabetes	557
Conclusions	559
34: Epidemiology of Diabetic Neuropathy, Andrew J. M. Boulton	565
Introduction	565
Classification of the Diabetic Neuropathies	566
Etiology of Diabetic Neuropathies	568
How Common is Diabetic Neuropathy?	570
The Diabetic Foot	571
Risk Factors for the Diabetic Foot	572
Epidemiological Data on Diabetic Foot Problems	572
Prevention of Ulceration and Amputation in Diabetic Patients	573
35: Epidemiology of Acute Complications: Diabetic Ketoacidosis, Hyperglycemic Hyperosmo- lar State and Hypoglycemia, Alberta B. Rewers	577
Diabetic Ketoacidosis	577
HHS	584
Hypoglycemia	586

36: Mortality and Life Expectancy Associated with Diabetes, Elizabeth L. M. Barr, Paul Z. Zimmet and Jonathan E. Shaw	603
Introduction	603
Methodological Issues Associated with Mortality Data	603
Mortality Trends of Type 1 Diabetes	604
Mortality Trends of Type 2 Diabetes	605
Type 1 Diabetes and Mortality	607
Type 2 Diabetes and Mortality	612
Conclusions	618
37: Economic Costs, Rhys Williams and Thomas J. Songer	627
Introduction	627
Health Economics	628
Identifying the Costs of Diabetes	628
Direct Medical Costs	628
Indirect Morbidity and Mortality Costs	628
Direct Cost Estimates	629
Estimates of Costs Faced by People with Diabetes	633
Evaluative Studies in Diabetes Health Economics	634
Estimates from Evaluation Studies	635
Indirect Cost Estimates	637
Conclusions	638
38: Clinical Practice Guidelines: A Global Perspective, Barbara Currie, Ehud Ur and Thomas Ransom	641
History of Clinical Practice Guidelines	641
Guidelines for Guidelines	643
Comparison of International Guidelines	644
The Future of Guidelines	648
39: Antipsychotic Therapies and Glucose Dysregulation in the Mental Illness Population, Gilbert L'Italien and John Newcomer	657
Introduction	657
The Epidemiology of Metabolic Syndrome in the Mentally Ill	658
Atypical Antipsychotics and Diabetes	659
Reversal of Metabolic Syndrome and Glucose Dysregulation/Diabetes	660
Conclusions	660
40: Diabetes, Insulin Resistance and Glucose Metabolism in HIV Infection and its Treatment, Kathy Samaras and Don J. Chisholm	665
Introduction	665
Prevalence	665
Pathogenesis	668
Lipodystrophy Treatment Considerations	672
Summary	672
Index	677

About the Editors

Jean-Marie Ekoé is Professor of Medicine, Endocrinology, Metabolism and Nutrition, Faculty of Medicine, University of Montreal, Quebec, Canada. He is a member of the Epidemiology Research Unit, Research Centre of the Centre Hospitalier Universitaire de Montréal (CHUM). He was the first recipient of the World Health Organization and International Diabetes Federation Kelly West Memorial Lilly Award in 1983. His major clinical and research interests are in the epidemiology of diabetes, diabetic foot problems and other long-term complications of diabetes mellitus.

Dr Ekoé is or has been principal investigator, co-investigator and collaborator of numerous clinical trials and projects involving epidemiology and management of diabetes and its late complications among Caucasian, Native and other populations in Canada and elsewhere. He received the 2004 Annual Award of Specialized Medicine of L'Association des Médecins de Langue Française du Canada and the Sir Alister McIntyre Distinguished Award for the year 2007 from the University of the West Indies Outreach Programme (UDOP). He has served as the Diabète Québec, Canada, Professional Council Chairman since 2006.

Marian Rewers' primary research has been in the area of epidemiology/etiology of type 1 diabetes, as well as insulin resistance and cardiovascular complications of both type 1 and type 2 diabetes. Dr Rewers is the principal investigator of five large active National Institutes of Health-funded projects: the Diabetes Autoimmunity Study in the Young (National Institute of Diabetes and Digestive and Kidney (NIDDK)/National Institute of Allergy and Infectious Diseases), The Environmental Determinants of Diabetes in the Young, the Coronary Artery Calcification in Type 1 Study (National Heart, Lung, and Blood Institute (NHLBI)), the Determinants of Premature Atherosclerosis in Type 1 Diabetes Study (NHLBI), and the Genetic and Environmental Causes of Celiac Disease (NIDDK). In the past, he has directed two additional large NHLBI-funded projects: The Insulin Resistance Atherosclerosis Study (IRAS) and The IRAS Family Study. He serves as the Clinical Investigation & Bioinformatics Core director for the University of Colorado at Denver and Health Sciences Center Diabetes Endocrinology Research Center (DERC). He is a co-investigator on additional multiyear projects in the area of diabetes and autoimmunity.

Dr Rewers is directing one of the studies that have been instrumental in learning the causes and risks of diabetes, the Diabetes Autoimmunity Study in the Young (DAISY). In 2000, Dr Rewers initiated a study of early detection of heart disease in 1400 adult patients with type 1 diabetes and their spouses/partners. The study is pioneering the use of electron beam computed tomography in detecting microscopical calcification of coronary arteries.

In addition to his research endeavors, Dr Rewers is directing a clinical team of 16 physicians and over 50 ancillary staff serving a population of nearly 6000 patients with type 1 diabetes. He received American Diabetes Association (ADA) Michaela Modan Memorial Award and served as the ADA Council on Epidemiology & Statistics Program Chair and Chair from 1996 to 2001. Currently, Dr Rewers serves as the Associate Editor of *Diabetes Care*.

Rhys Williams is Dean of Medicine and Professor of Clinical Epidemiology at the School of Medicine, Swansea University. He is the Head of Learning and Teaching at the School and the chair of the Centre for Information, Research and Evaluation. His main research interests relate to diabetes epidemiology and health care, metabolic syndrome and childhood obesity. He is Chair of Diabetes UK's Wales Advisory Council and, until recently, was a Vice President of the International Diabetes Federation (IDF), chair of the IDF's Task Force on Diabetes Awareness and Editor-in-Chief of IDF's in-house magazine *Diabetes Voice*. He is a

member of the IDF's Prevention Task Force and of the *Diabetes Atlas* Editorial Board. He is also a visiting consultant to the World Health Organization, Geneva.

Paul Zimmet is Director of the International Diabetes Institute and Hon. Professor at Monash University in Australia. He co-chairs the International Diabetes Federation Task Force on Epidemiology and Prevention. He designed and leads the team carrying out the 'AusDiab Study,' the first national diabetes and obesity study in Australia. He is widely recognized for his studies in Indian and Pacific Ocean populations, which have provided new insights into the genetic and environmental contribution to type 2 diabetes and obesity as well as the role of socio-cultural change. He has received numerous international awards for his research, including the 2007 international Novartis Award for accomplishments in research that have had a major impact in diabetes. He received the national award of Officer of the Order of Australia for distinguished services to medicine, nutrition and the biotechnology industry.

Contributors

ROBERT C. ATKINS

*Department of Epidemiology and Preventive
Medicine
Monash University
Alfred Hospital
Melbourne
Australia*

MARY A. BANERJI

*SUNY Health Science Center
New York, NY
USA*

ELIZABETH L. M. BARR

*International Diabetes Institute
Caulfield, Victoria
Australia*

ELIZABETH BARRETT-CONNOR

*Division of Epidemiology/Department of Family
and Preventive Medicine
University of California, San Diego
La Jolla, CA
USA*

JUDITH BAXTER

*Colorado School of Public Health
University of Colorado Denver
Aurora, CO
USA*

ANDREW J. M. BOULTON

*Department of Medicine
Manchester Royal Infirmary
Manchester
UK*

EDWARD J. BOYKO

*Department of Medicine
University of Washington School of
Medicine
Epidemiologic Research and Information
Center
VA Puget Sound Health Care System
Seattle, WA
USA*

ADRIAN CAMERON

*International Diabetes Institute
Caulfield, Victoria
Australia*

IAN D. CATERSON

*The George Institute and the Human
Nutrition Unit
University of Sydney
Sydney, New South Wales
Australia*

JULIANA C.N. CHAN

*Department of Medicine & Therapeutics
The Chinese University of Hong Kong
The Prince of Wales Hospital
Shatin
Hong Kong*

DON J. CHISHOLM

*Diabetes and Obesity Program
Garvan Institute of Medical Research
Darlinghurst, New South Wales
Australia*

CLIVE S. COCKRAM

*Department of Medicine & Therapeutics
The Chinese University of Hong Kong
The Prince of Wales Hospital
Shatin
Hong Kong*

RUTH COLAGIURI

*Diabetes Unit, Australian Health Policy Unit
Sydney University
Sydney, New South Wales
Australia*

STEPHEN COLAGIURI

*Department of Endocrinology, Diabetes and
Metabolism
Prince of Wales Hospital
Randwick
Australia*

BARBARA CURRIE

*Division of Endocrinology
QEII Health Sciences Centre
Halifax, Nova Scotia
Canada*

DANA M. DABELEA

*University of Colorado School of Medicine
Denver, CO
USA*

JEAN-MARIE EKOÉ

*Endocrinologie, Métabolisme et Nutrition, Cen-
tre de Recherche du CHUM
Montreal
Canada*

IMAD M. EL-KEBBI

*Division of Endocrinology, Metabolism and
Lipids
Emory University School of Medicine
Atlanta, GA
USA*

MICHAEL M. ENGELGAU

*Division of Diabetes Translation
National Center for Chronic Disease Prevention
and Health Promotion,
Centers for Disease Control and Prevention
Atlanta, GA
USA*

SANDRA R. G. FERREIRA

*School of Public Health—University of São
Paulo
Paulo-SP
Brazil*

LAÉRCIO J. FRANCO

*Faculty of Medicine of Ribeirão
Preto—University of São Paulo
Ribeirão Preto-SP
Brazil*

WILFRED Y. FUJIMOTO

*University of Washington Department of
Medicine
Seattle, WA
USA*

LINDA S. GEISS

*Division of Diabetes Translation
Centers for Disease Control and Prevention
Atlanta, GA
USA*

ANDERS GREEN

*Department of Research and Applied
Health Technology Assessment, Odense
University Hospital and
Epidemiology
Institute of Public Health
University of Southern Denmark
Odense, Denmark*

EDWARD W. GREGG

*Department of Epidemiology
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, PA
USA*

LEIF GROOP

*Department of Clinical Sciences/Diabetes &
Endocrinology
and Lund University Diabetes Centre
Lund University
University Hospital Malmö
Malmö
Sweden*

RICHARD F. HAMMAN

*Colorado School of Public Health
University of Colorado Denver
Aurora, CO
USA*

ROBERT L. HANSON

*National Institute of Diabetes and Digestive and
Kidney Diseases
Phoenix, AZ
USA*

ZAFIML HUSSAIN

*Department of Endocrinology, Diabetes and
Metabolism
Prince of Wales Hospital
Randwick
Australia*

RACHEL HUXLEY

*The George Institute and the Human Nutrition
Unit
University of Sydney
Sydney, New South Wales,
Australia*

HARRY KEEN

*Unit for Metabolic Medicine
Guy's Hospital Campus, King's College London
London
UK*

RON KLEIN

*Department of Ophthalmology and Visual Sci-
ences
University of Wisconsin School of Medicine and
Public Health
Madison, WI
USA*

WILLIAM C. KNOWLER

*National Institute of Diabetes and Digestive and
Kidney Diseases
Phoenix, AZ
USA*

ANDREA M. KRISKA

*Department of Epidemiology
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, PA
USA*

KIRSTEN O. KYVIK

*Institute of Regional Health Services Research
and Epidemiology
Institute of Public Health
University of Southern Denmark
Odense
Denmark*

HAROLD LBOVITZ

*SUNY Health Science Center
New York, NY
USA*

CHARLOTTE LING

*Department of Clinical Sciences/Diabetes &
Endocrinology
and Lund University Diabetes Centre
Lund University
University Hospital Malmö
Malmö
Sweden*

REBECCA B. LIPTON

*Section of Pediatric Endocrinology and Depart-
ment of Health Studies
University of Chicago
Chicago, IL
USA*

GILBERT L'ITALIEN

*Global Epidemiology and Outcomes Research
Bristol Myers Squibb
Pharmaceutical Research Institute;
Yale University Medical School
New Haven, CT
USA*

VALERIYA LYSENKO

*Department of Clinical Sciences/Diabetes &
Endocrinology
and Lund University Diabetes Centre
Lund University
University Hospital Malmö
Malmö
Sweden*

DIANNA J. MAGLIANO

*International Diabetes Institute
Caulfield, Victoria
Australia*

JIM MANN

*Department of Human Nutrition
University of Otago
Dunedin
New Zealand*

MARGUERITE J. MCNEELY

*University of Washington Department of
Medicine
Seattle, WA
USA*

ERROL MORRISON

*Departments of Biochemistry &
Endocrinology
The University of the West Indies
Mona Campus, Jamaica*

AYESHA A. MOTALA

*Department of Diabetes and Endocrinology
Division of Medicine
Nelson R Mandela School of Medicine
Faculty of Health Sciences
University of KwaZulu-Natal
Durban
South Africa*

K. M. VENKAT NARAYAN

*National Center for Chronic Disease
Prevention and Health Promotion
Centers for Disease Control and Prevention
Atlanta, GA
USA*

ROBERT G. NELSON

*National Institute of Diabetes and Digestive
and Kidney Diseases
Phoenix, AZ
USA*

JOHN NEWCOMER

*Department of Psychiatry
Washington University School of Medicine
St Louis, MO
USA*

MAHOMED A.K. OMAR

*Department of Diabetes and Endocrinology
Division of Medicine
Nelson R Mandela School of Medicine
Faculty of Health Sciences
University of KwaZulu-Natal
Durban
South Africa*

ABDULLAH OMARI

*The George Institute and the Human Nutrition
Unit
University of Sydney
Sydney, New South Wales
Australia*

MARJU ORHO-MELANDER

*Department of Clinical Sciences/Diabetes &
Endocrinology
and Lund University Diabetes Centre
Lund University
University Hospital Malmö
Malmö
Sweden*

TANIELA PALU

*Diabetes Centre
Vaiola Hospital
Nulu'alofa
Tonga*

MEDA E. PAVKOV

*National Institute of Diabetes and Digestive and
Kidney Diseases
Phoenix, AZ
USA*

FRASER J. PIRIE

*Department of Diabetes and Endocrinology
Division of Medicine
Nelson R Mandela School of Medicine
Faculty of Health Sciences
University of KwaZulu-Natal
Durban
South Africa*

LOUISE PRENTICE

*Department of Epidemiology and Preventive
Medicine
Monash University
Alfred Hospital
Melbourne
Australia*

DALIP RAGOOBIRSINGH

*Departments of Biochemistry and Diabetology
The University of the West Indies
Mona Campus
Jamaica*

AMBADY RAMACHANDRAN

*India Diabetes Research Foundation
Dr. A. Ramachandran's Diabetes Hospitals
Chennai
India*

THOMAS RANSOM

*Division of Endocrinology
QEII Health Sciences Centre
Halifax, Nova Scotia
Canada*

ANNE T. REUTENS

*Department of Epidemiology and Preventive
Medicine
Monash University
Alfred Hospital
Melbourne
Australia*

ARLETA B. REWERS

*Department of Pediatrics
University of Colorado at Denver and Health
Sciences Center
Denver, CO
USA*

MARIAN REWERS

*Barbara Davis Center for Childhood Diabetes
University of Colorado School of Medicine
Aurora, CO
USA*

KATHY SAMARAS

*Diabetes and Obesity Program
Garvan Institute of Medical Research
Darlinghurst, New South Wales
Australia*

ANDRÉ J. SCHEEN

*Division of Diabetes, Nutrition and
Metabolic Disorders
Department of Medicine
CHU Sart Tilman
University of Liège, Liège
Belgium*

JONATHAN E. SHAW

*Baker IDI, Heart & Diabetes Institute
Caulfield, Victoria
Australia*

NALINI SINGH

*Healthcare Partners
Arcadia, CA
USA*

CHAMUKUTTAN SNEHALATHA

*Department of Biochemistry
India Diabetes Research Foundation
Dr. A. Ramachandran's Diabetes
Hospitals
Chennai
India*

THOMAS J. SONGER

*Department of Epidemiology
University of Pittsburgh
Pittsburgh, PA
USA*

LARS C. STENE

*Division of Epidemiology
Norwegian Institute of Public Health
Oslo
Norway*

KRISTI L. STORTI

*Department of Epidemiology
Graduate School of Public Health
University of Pittsburgh
Pittsburgh, PA
USA*

NAOKO TAJIMA

*Division of Diabetes, Metabolism and
Endocrinology
Department of Medicine
Jikei University School of Medicine
Tokyo
Japan*

MONIKA TOELLER

*German Diabetes Center
University of Dusseldorf
Dusseldorf
Germany*

JAAKKO TUOMILEHTO

*Department of Epidemiology and Health Pro-
motion
National Public Health Institute
Helsinki
Finland*

EHUD UR

*Division of Endocrinology
QEII Health Sciences Centre
Halifax, Nova Scotia
Canada*

SATUPAITEA VIALI

*Oceania Medical School
Apia
Samoa*

JING WANG

*Division of Diabetes Translation
Centers for Disease Control and Prevention
Atlanta, GA
USA*

STEPHANIE WHEELER

*University of Washington School of Medicine
VA Puget Sound Health Care System
Seattle, WA
USA*

RHYS WILLIAMS

*Clinical Epidemiology at the School of
Medicine
University of Swansea
Swansea
UK*

TIEN Y. WONG

*Centre for Eye Research Australia
University of Melbourne
Melbourne
Victoria
Australia*

JEAN-FRANCOIS YALE

*McGill Nutrition and Food Science Centre
Department of Medicine
McGill University
Montreal
Quebec
Canada*

PAUL Z. ZIMMET

*International Diabetes Institute
Caulfield, Victoria
Australia*

Foreword

The epidemiology of diabetes has become a growth industry over the past 25 years—since WHO and NDDG revised the criteria for the classification and diagnosis of diabetes. This occurred shortly after the unique observations of very high prevalence rates of type 2 diabetes in Pacific islanders and Amerindians and the pioneering international comparative studies by Kelly West. Epidemiology as a discipline has matured and become much more refined over the same period. Diagnostic criteria for diabetes and the classification have been updated as knowledge has increased—and intermediate degrees of hyperglycaemia introduced as risk states for diabetes. The first edition of this book broke new ground as the definitive text focusing on the epidemiology of diabetes. At that time it was obvious that an epidemic of diabetes—particularly type 2—was in progress & much of the focus of the book was to discuss the reasons for this and tactics needed for primary prevention. Do we need a further edition—the answer is a resounding yes! Knowledge has increased greatly over the intervening years, our knowledge of the prevalence and incidence of both type 2 and type 1 diabetes has increased, and more knowledge is available on prevention. We also have better information on the complications of diabetes, the emergence of the Metabolic Syndrome as a risk state and awareness of the increasing occurrence of type 2 diabetes in young people and children.

Type 1 diabetes has perhaps received less attention than type 2 over the past decade—primarily because people with this sort of diabetes are far outnumbered by those with type 2. Nonetheless, numbers are increasing almost everywhere with Finland and Newfoundland for example now reporting alarming rates. This has massive consequences for healthcare—and for affected individuals. Knowledge on genetic aspects of type 1 and ethnic differences has increased although we are still frustratingly far from realistic preventive or curative strategies. Up to date accounts of these areas are presented in this volume.

Type 2 diabetes now presents as one of the great pandemics of the 21st Century. In some populations more than half of adults either already have the disease or are at high risk with evidence of IGT, IFG or metabolic syndrome. It affects all peoples but particularly some of our rapidly developing groups. South Asians appear to have a particular predisposition to diabetes—and the Indian subcontinent will have nearly one-third of the world's type 2 diabetic people. The disorder is however emerging as a massive threat to health everywhere. In particular diabetes increases the risk of developing macrovascular disease and is now one of the major factors behind the resurgence of heart disease and stroke world-wide—and in particular their increase in the developing world. They also of course carry the risk of the microvascular complications, particularly when glycaemic control is inadequate.

The only real solution is prevention. The results of prevention trials were beginning to emerge at the time of the last edition of this volume with much hope engendered by the large trials in the USA and Finland. Several further trials have now reported & it seems clear that by focussing on high risk people (those with IGT or IFG or both) the development of tp2 diabetes can be delayed in more than 50% with lifestyle adjustment and or metformin & even more with glitazones. Obviously this now needs testing formally in whole communities and in “real life”—and also the thorny question of the safe long term use of drugs with potential side effects has to be tackled.

Prevention of development of the long-term complications is of course vital for those who have already developed diabetes. New drug entities are appearing which will help—as will improving blood glucose control. Here patient and professional education become all important and there is a massive task ahead if we are to get at everyone with diabetes—and all their carers.

The epidemiological background to these problems—and others—is presented exhaustively in this volume. There is an excellent introduction on the clinical syndrome and on current views on classification and diagnosis. Broad chapters on type 2 diabetes and obesity, physical activity and nutrition then provide the backdrop against which detailed accounts are given of type 2 diabetes in all the major continents and many individual countries. Type 1 diabetes then follows with separate chapters thereafter on each of the complications. There are then informative essays on mortality and economics.

Undoubtedly this book will provide a *vade mecum* for all those interested in not just diabetic epidemiology but diabetes in general.

Professor Sir George Alberti
Imperial College
London
UK
June 2008

- physical inactivity (*continued.*)
 Hispanic North Americans, 285, 286, 396
 in Middle East, 126
 in South East Asia and Pacific Islands, 213
- Physicians' Health Study, 91
- Pima Indians, 79, 116, 255–6
 childhood diabetes, 340, 345, 349, 387
 diabetes prevalence, 257
 diabetic nephropathy, 505, 506, 509
 genetic factors, 329, 347
 hyperinsulinemia, children and adolescents, 397
 incidence of diabetes, 257
 effect of BMI, 259
 Mexican compared with US communities, 116, 256
 mortality rates, 607
- PIPOD trial, 454
- Pittsburgh Epidemiology of Diabetes Complications (EDC) Study, 478, 500, 501, 505, 509, 529, 541, 543, 548, 605, 611
- Poland, 114, 115
 incidence of type 1 diabetes, 359
 'polio model', type 1 diabetes and, 368
 polycystic ovary syndrome, 347, 397
 polygenic disease, 95
- Polynesia, 225
 BMI values, 228–9
 diabetes prevalence, 227, 228–9, 234
 IGT prevalence, 227, 228–9, 234
- polyneuropathy, 567, 568
- polyunsaturated fatty acids (PUFAs), diabetes affected by, 90
- polyuria, 5, 6
- population attributable risk, 96
 type 2 diabetes mortality, 613, 614
- population-based studies, 242, 273
 children and adolescents, 339–41
 mortality rates, 606–7
- Portugal, incidence of type 1 diabetes, 359
- positive predictive value (PPV), as risk-prediction performance measure, 407, 409, 415
- postload plasma glucose values, as diagnostic criteria, 13, 112
see also oral glucose tolerance test (OGTT)
- PPAR γ genes, 100, 103, 104, 258, 329
- Pre-POINT trial, 413, 421
- prediabetes, 19, 246
 in Japan, 173
 in North America, 246
see also impaired fasting glycemia; impaired glucose tolerance
- pregnancy
 diabetes during, 23
 diabetic retinopathy and, 482–3
see also gestational diabetes mellitus
- premature deaths, risk factors for, in Japan, 175
- prenatal factors, type 1 diabetes risk affected by, 369–71
- prevalence
 abdominal aortic aneurysm, 550, 551–5
 diabetes, 2, 61, 96, 113, 121
 in Africa, 113, 121, 133, 134–40, 143
 African Americans, 296–7
 Asian North Americans, 323–7
 in Canada, 244
 Chinese people, 181, 182
 in Europe, 111–16, 121
 factors affecting, 96, 111, 112–13, 213–15
 HAART-treated HIV-infected subjects, 665, 666–8
 Hispanic North Americans, 276–8, 279–80
 in Japan, 171–2, 172–3
 Japanese Americans, 174, 324, 325, 326, 327, 328
 in Latin American and Caribbean countries, 113, 150–7, 165
 in Middle East, 113, 124–5
 Native Americans, 256–7
 in North America, 113, 121, 242–4, 296
 Pacific Islanders, 227–36
 in South and Central America, 113, 150–7
 in Southeast Asia, 113, 208
 in USA, 242, 243, 244, 245
 diabetic nephropathy, 500–2
 diabetic retinopathy, 475–7
 gestational diabetes, 24
 Chinese people, 182, 183
 impaired fasting glycemia
 children and adolescents, 340
 Hispanic North Americans, 278
 in Middle East, 123, 124
 impaired glucose tolerance, 113
 in Africa, 113, 136, 137, 137, 138
 African Americans, 298
 children and adolescents, 344
 Chinese people, 181
 in Europe, 113, 115
 HAART-treated HIV-infected patients, 667
 in India, 210, 211
 in Latin American and Caribbean countries, 154, 155, 156, 157, 165
 in Middle East, 113, 123, 124, 125
 in North America, 113, 246
 in Pacific Islands, 227–36
 in South and Central America, 113, 154, 155, 156, 157
 in South East Asia, 113, 211
 in West Pacific, 113
 metabolic syndrome, 31, 41–8
 Chinese people 185, 189
 microalbuminuria 501, 505
 obesity, 57–9
 Africa, 58, 64
 African Americans, 298
 Hispanic North Americans, 285, 286
 Middle East, 58, 126–7
 Native Americans, 260
 North America, 58, 245
 peripheral arterial disease, 540–4
 Prevalence of Diabetes in India Study (PODIS), 209
 preventive care practices for complications, 289, 511
 PROACTIVE trial, 522
 productivity losses, 629, 637
 various countries compared, 633, 637
 proinsulin, as marker of β -cell dysfunction, 332, 464, 522
 protease inhibitors
 diabetes and, 665, 667, 668
 glucose transport affected by, 670
 insulin resistance and, 665, 666
 lipodystrophy and, 665, 666
 protein intake, type 2 diabetes etiology affected by, 90
 protein-deficient pancreatic diabetes (PDPD), 1, 17
 protein-energy malnutrition, 168
 proteinuria
 African Americans, 311
 Chinese people, 190, 192
 definition, 263
 diabetic nephropathy and, 505
 diabetic retinopathy and, 482, 486
 Middle East, 127
 Native Americans, 262, 263, 264
 South East Asia, 217
 pruritus vulvae, 6
 psychiatric factors
 hypoglycemia affected by, 590–1
 ketoacidosis affected by, 582
 psychosocial factors, type 1 diabetes mortality affected by, 612
 puberty, diabetic retinopathy and, 483
 Puerto Ricans in North America
 childhood diabetes, 388
 death rates due to diabetes, 284
 demographics, 274
 Puerto Rico
 childhood diabetes, 388
 death rate due to diabetes, 158
 type 1 diabetes in, 148, 150, 360, 388
 pulmonary embolism, 557
 risk factors, 557
- quality-adjusted life year (QALY), cost per, 634
 eye examination (for diabetic retinopathy), 636
 foot ulcer treatment, 636
 intensive glycemic control and BP control, 637
 lifestyle intervention to prevent type 2 diabetes, 441
- quality of life
 effect of erectile dysfunction, 571
 effect of hypoglycemia, 592–3
- Rabson–Mendenhall syndrome, 16, 22
- Rancho Bernardo Study, 91, 464
- reagent-strip methods, 26

- receiver operator curve (ROC) analysis, metabolic syndrome, 185
- refined carbohydrates, effect on type 2 diabetes, 88
- register studies, children/adolescents data, 341–3, 357, 358
- relative genetic risk, 95–6
- remission in diabetes, 304–5, 306
- RENAAL study, 505, 506, 507
- renal arterial stenosis (RAS), 548–50
- renal disease *see* diabetic nephropathy; end-stage renal disease
- renal failure, 168, 175, 501
- renal replacement therapy (RRT), 175, 194, 262, 264, 500–1, 502
- renin–angiotensin–aldosterone system (RAAS) inhibitors, effect on type 2 diabetes, 450, 460–3
- renin–angiotensin system (RAS) blockers, diabetic nephropathy affected by, 510–11
- respiratory chambers, 73
- retinal artery occlusion (RAO), 485
- retinal vascular diseases, 484–5
- retinal vein occlusion (RVO), 485
- retinopathy
 - diabetic, 475–84
 - in nondiabetic persons, 483–4
 - see also* diabetic retinopathy
- rimonabant (weight-loss agent), 458
- risk factors
 - abdominal aortic aneurysm, 551–5, 556
 - cardiovascular disease, 519–26
 - childhood diabetes, non-Caucasian populations, 393–7
 - diabetes, 97, 98, 436
 - in Africa, 143
 - African Americans, 297–300
 - Asian North Americans, 327–30
 - Chinese people, 186–8
 - Hispanic North Americans, 285–8
 - Japanese populations, 173–4
 - in Middle East, 126
 - Native Americans, 259–61
 - in North America, 247
 - in South East Asia, 212–15
 - diabetic ketoacidosis, 579, 580, 581, 582, 583
 - diabetic nephropathy, 507–9
 - diabetic retinopathy, 479–83
 - hyperglycemic hyperosmolar state, 585
 - hypoglycemia, 589–92
 - metabolic syndrome, 41, 96–7, 186, 189
 - obesity, 62
 - peripheral arterial disease, 545–8
 - type 1 diabetes, 611–12
 - type 2 diabetes, 435, 449, 616–18
 - Native Americans, 259–61
 - North Americans, 247
- rituximab, 424–5
- ROADMAP study, 510
- Rochester Diabetic Neuropathic Study, 568
- Romania, incidence of type 1 diabetes, 359
- room calorimeters, 73
- Rose questionnaire, 262, 540
- rosiglitazone, 450, 454, 666
- Rotterdam Study, 484, 542, 543, 550
- rubella, diabetes associated with, 17, 22, 366, 404
- Russia
 - incidence of type 1 diabetes, 359
 - number of people with diabetes, 66
- St Kitts and Nevis, 164, 165
- St Lucia, 164, 165
- St Vincent and the Grenadines, 164, 165
- Samoa
 - BMI values, 228–9
 - complications due to diabetes, 237
 - diabetes and IGT prevalence, 227, 228–9, 234
- San Antonio Heart Study, 45, 48, 278, 279, 282, 287, 288
- San Luis Valley Diabetes Study, 89, 278, 279, 288, 541, 543, 546
- Sardinia (Italy), incidence of type 1 diabetes, 356, 359, 361
- saturated fats, diabetes affected by, 89–90
- Saudi Arabia
 - complications due to diabetes, 127
 - diabetes prevalence, 123, 124
 - childhood diabetes, 341, 387
 - IFG prevalence, 123, 124
 - obesity prevalence, 58, 126
 - type 1 diabetes in, 122
 - type 2 diabetes in, 123, 124, 341
- schizophrenia patients, metabolic syndrome in, 658–9
- Scotland *see* UK
- SCOUT study, 458
- screening programs
 - Chinese people, 183, 341
 - Japan, 173, 183, 340–1, 385–6
 - Pacific Islands, 236–7
- screening for type 1 diabetes, 413–14
 - first-degree relatives, 416
 - in general population children, 416–18
- SEARCH for Diabetes in Youth study, 340, 344, 578, 580
- seasonal variation, childhood-onset type 1 diabetes incidence, 362
- second-generation antipsychotic (SGA) agents, 657
 - diabetes risk and, 659–60
 - metabolic syndrome affected by, 658, 660
- sedentary lifestyle
 - as risk factor for diabetes, 166, 213, 327
 - see also* physical inactivity
- Senegal, obesity prevalence, 64
- sensitivity, as risk-prediction performance measure, 407, 409
- septic shock, 585
- sex differences, coronary heart disease, 526
- sex ratio of diabetic patients, 112
 - childhood-onset type 1 diabetes, 361
 - in Latin America, 149, 153
- sibutramine (weight-loss agent), 457–8
- Singapore
 - diabetes prevalence, 61, 180, 208, 214
 - diabetes prevention program, 194
 - diabetic retinopathy prevalence, 477
 - metabolic syndrome prevalence, 185, 186
 - obesity prevalence, 58
- single nucleotide polymorphisms (SNPs), 97
 - genotyping, 105
- Slovakia
 - incidence of type 1 diabetes, 357, 358
 - metabolic syndrome in, 47
- Slovenia, incidence of type 1 diabetes, 357, 358
- smoking, as risk factor, 91, 312, 483, 505, 525, 545
- social class, obesity affected by, 62–4
- socioeconomic impact of diabetes, 179–80
 - see also* costs of diabetes
- socioeconomic status, diabetes risk associated with, 186, 298, 328, 370
- Solomon Islands, 232, 235
- somatostinoma, 16, 22
- South Africa
 - diabetes prevalence, 134, 135, 136, 137, 138
 - effect of HAART treatment of HIV-infected subjects, 668
 - ethnic differences, 140
 - proportion of known diabetes, 141, 142
 - health expenditure for diabetes, 630, 631
 - IGT prevalence, 136, 137, 138
 - obesity prevalence, 58, 59, 64
- South and Central America
 - diabetes prevalence, 113
 - health expenditure for diabetes, 632
 - IGT prevalence, 113
 - incidence of type 1 diabetes, 360
 - metabolic syndrome in, 45
 - see also* Latin America
- South East Asia
 - diabetes prevalence, 113, 208
 - children and adolescents, 218, 342
 - health expenditure for diabetes, 630, 632
 - IGT prevalence, 113, 211
 - incidence of type 1 diabetes, 358
 - population, 207
 - see also* India
- South Korea
 - diabetes prevalence, 61
 - incidence of type 1 diabetes, 359
 - metabolic syndrome in, 45
- Spain
 - diabetes prevalence, 114
 - incidence of type 1 diabetes, 359
 - metabolic syndrome in, 43, 45

- specificity, as risk-prediction
 performance measure, 407, 409
- 'spring harvest' hypothesis, type 1
 diabetes incidence, 363
- Sri Lanka, diabetes prevalence, 208
- standardized mortality ratios (SMRs)
 ischemic heart disease, 610
 meaning of term, 607, 609
 type 1 diabetes, 174, 609, 610
- statins
 anti-inflammatory properties, 465
 diabetic retinopathy and, 481
 as lipid-lowering agents, 459, 524, 617
 type 2 diabetes affected by, 459
- Steno Centre studies, 500, 508
- Steno Memorial Hospital (Denmark),
 mortality data, 609, 611
- Steno-2 Study, 504, 617, 637
- 'stiff man' syndrome, 17, 23
- Stockholm Diabetes Intervention Study,
 504
- STOP-NIDDM trial, 450, 455
- STORM study, 458
- stress factors, diabetogenesis affected by,
 214–15
- stressful life event, as possible risk
 factor, 404–5
- stroke, 527–8
 diabetes-associated,
 in Asia, 217, 218
 Asian North Americans, 333
 Chinese people, 190, 193, 613
 in Latin America, 159
 Native Americans, 262, 263, 265
 in North America, 248
 prevention of, 525
 risk factors, 527, 528
- Strong Heart Study (SHS), 39, 261, 262,
 263, 463
- sub-Saharan Africa
 childhood diabetes, 386–7
 diabetes prevalence, 133, 135, 137,
 138, 141, 142
 obesity prevalence, 59, 64
- submaximal oxygen uptake tests, 75
- sucrose, effect on type 2 diabetes, 88
- Sudan
 diabetes prevalence, 135, 138, 141,
 142
 incidence of type 1 diabetes, 357, 359
- sudden nocturnal death, in young people
 with type 1 diabetes, 592
- sugar-sweetened drinks, 88
- sulfonylureas
 β -cell function preserved by, 306
 hypoglycemia risk affected by, 589
 type 2 diabetes risk affected by, 450,
 453
- surgical interventions, weight loss
 achieved by, 67
- Suriname, 164, 165
- surveillance programs, 128
- susceptibility genes, 99–101, 106, 108,
 298, 403–4, 414–15
- Sweden
 diabetes prevalence, 114
- incidence of type 1 diabetes, 357, 358,
 361, 363
 metabolic syndrome in, 44
 obesity prevalence, 58
 syndrome X, 32
see also metabolic syndrome
- systolic blood pressure (SBP), diabetic
 nephropathy and, 505–6
- Systolic Hypertension in the Elderly
 Program, 546
- Taiwan
 birthweight/diabetes risk survey, 348
 diabetes prevalence, 61
 children and adolescents, 183, 341
- Tanzania
 childhood diabetes, 386–7
 diabetes prevalence, 135, 136, 137,
 138
 ethnic differences, 140
 proportion of known diabetes, 141,
 142
 IGT prevalence, 136, 137, 138
 incidence of type 1 diabetes, 357
 obesity prevalence, 64
 productivity losses, 637
 TCF7L2 gene, 101, 102, 103, 103, 104,
 105, 106, 117
- TEDDY (The Environmental
 Determinants of type 1 Diabetes
 in the Young), 413
- terminology changes, 15, 17
- Th1/Th2 paradigm, 365
- Thailand
 childhood diabetes, 386
 diabetes prevalence, 61, 208, 342
- thiazolidinediones, 288–9, 450, 453–5,
 522
 anti-inflammatory properties, 465
- thrifty gene/genotype hypothesis, 49, 96,
 106, 116, 163, 329
- thrifty phenotype hypothesis, 65, 96–7,
 116, 347, 547–8
- Togo, diabetes prevalence, 135, 136
- tolbutamide, 453
- Tonga
 BMI values, 229, 237
 complications due to diabetes, 237
 diabetes and IGT prevalence, 227,
 229, 234
 obesity, 237–8
 screening survey, 236–7
- total glucose intolerance (TGI), 135
 in Africa, 137, 138
- transcutaneous oximetry, 539
- transmission disequilibrium test, 100
- TrialNet consortium, 422
- TRIGR (Trial to Reduce
 Insulin-dependent diabetes
 mellitus in the Genetically at
 Risk), 413, 420–1
- Trinidad and Tobago, 164, 165, 166,
 166, 630, 631
- TRIPOD trial, 288–9, 450, 454
- troglistazone trial(s), 288–9, 450, 453–4
- tuberculosis, 187, 265, 606
- Tunisia
 diabetes prevalence, 136, 141, 142
 incidence of type 1 diabetes, 359
- Turkey, 45, 114, 341
- Turner's syndrome, 17, 23
- type 1 diabetes, 15, 16, 19–20
 aggregation of other autoimmune
 diseases, 365
 cardiovascular disease associated with
 outcomes, 529
 risk factors, 528–9
 causes of death, 143, 175, 249, 582,
 605, 610–11
 diabetic ketoacidosis
 causes, 20, 580, 582
 incidence, 580–2
 prevalence, 578, 579
 disease process and development, 406
 opportunities for screening and
 prevention, 414
 environmental risk factors, 365–71,
 404–5
 dietary factors, 368–9, 404
 microbial factors, 366–8, 404
 prenatal factors, 369–71, 404
 etiology, 184, 307–8
 familial aggregation of, 364–5, 403
 genetic contribution, 403–4
 genetic epidemiology, 403–12
 global epidemiology, 355–83
 incidence
 in Japan, 171
 in Latin America, 147–50
 in Middle East, 122
 in various countries, 122, 147–50,
 171, 184, 356–64
 mortality, 607–10
 trends, 604–5
 prevalence, in Japan, 171–2
 prevention of
 primary prevention, 413, 420–1
 secondary prevention, 421–2
 tertiary prevention, 422–5
 risk factors, 611–12
 risk prediction
 estimation of β -cell function and,
 405–6, 419–20
 family history and, 405, 414
 hypothetical example, 408–10
 islet-cell autoantibodies and, 405,
 415–18
 markers for, 405–6, 414–20
 methodological considerations,
 406–8
 susceptibility genotypes and, 405,
 414–15
see also childhood-onset type 1
 diabetes
- type 2 diabetes, 16, 17, 20–1
 candidate genes, 99–101, 106, 108
 causes of death, 613, 615
 children and adolescents, 339–53
 in Asia, 218, 342
 in Europe, 115–16, 342–3
 factors affecting development,
 344–9
 in Japan, 173, 183, 340–1

- prevalence and incidence of
 diabetes, 116, 173, 183, 339–43
 profile, 343–4
 detection of people at high risk, 442–3
 diabetic ketoacidosis with, 295,
 306–7, 580, 582
 genetic epidemiology, 95–110
 genetic prediction of, 103–4, 395
 incidence, among children and
 adolescents, 116, 173, 183, 341,
 342
 inheritance of, 96
 lifestyle intervention to prevent
 applicability to entire population,
 441
 clinical trial evidence of effect,
 440–1
 costs associated with, 441–2
 long-term effectiveness, 439–40
 trials, 71, 81, 91–2, 194, 195, 288,
 289, 436–9
 mortality, trends, 605–7
 non-pharmacologic prevention of,
 435–47
 pathogenesis
 African Americans, 295, 303–4
 Asian North Americans, 330–2
 potential mechanisms, 456, 457,
 459, 460, 463, 464
 pharmacological prevention of,
 449–74
 prevalence, 96
 African Americans, 296–7
 Asian North Americans, 323–7
 in Europe, 111–16
 in Latin America, 150–7
 in Middle East, 123–5
 primary prevention of, 435–47
 cost-effectiveness, 637
 risk assessment form, 442, 443
 risk factors, 97, 98, 435, 436, 449,
 616–18
 African Americans, 297–300
 Chinese people, 186–8
 Hispanic North Americans, 285–8
 Native Americans, 259–61
 North Americans, 247
 type A insulin resistance, 16, 22
 type B insulin resistance, 23
- Uganda, 64, 134
 UK
 Africans, diabetes prevalence, 140
 Afro-Caribbeans, metabolic syndrome
 among, 47
 costs of diabetes, 630, 633
 diabetes prevalence, 114
 incidence of type 1 diabetes, 359, 361,
 363
 metabolic syndrome in, 42, 44, 45, 47
 obesity prevalence, 58
 UKPDS (United Kingdom Prospective
 Diabetes Study), 2, 436, 616–17,
 641
 cardiovascular disease, 520, 522, 523,
 527
 cost-effectiveness analysis using data,
 636–7
 diabetic nephropathy, 504, 506
 diabetic neuropathy, 568
 diabetic retinopathy, 478, 480, 481
 hypoglycemia risk, 589, 593
 peripheral arterial disease, 545, 548
 undiagnosed diabetes prevalence,
 American adults, 244
 Chinese people, 180, 181
 Pacific Islanders, 228–33, 236
 United Arab Emirates, IFG prevalence,
 123, 124
 University Group Diabetes Program
 (UGDP), 520
 Upper Xingu Indians (Brazil), 154
 urbanization, 213
 diabetes prevalence affected by
 in Africa, 139
 in South East Asia, 214
 India, 213–14
 urinary albumin excretion, elevated
 levels, 499–500
 children and adolescents, 344
 and insulin resistance, 503
 Native Americans, 263, 264
 Pacific Islanders, 237
 urine, glucose measurement methods,
 26–7
 Uruguay
 death rates due to diabetes, 158
 incidence of type 1 diabetes, 150, 360
 type 2 diabetes in, 157
 US Diabetes Prevention Program, 67, 81,
 261, 437, 438–9, 440, 441, 525,
 637
 US Surgeon General, recommendation
 on physical activity, 81
 USA
 complications due to diabetes, 248,
 248, 249
 costs of diabetes, 630, 633
 out-of-pocket medical expenses,
 634
 diabetes prevalence, 125, 242, 243,
 244, 245
 children and adolescents, 339–40,
 342
 future projections, 283
 diabetes prevention programs, 67, 81,
 261, 437, 438–9, 440, 441, 525
 glucose-lowering agents, 450, 451,
 454
 Hispanics, 287, 288
 Native Americans, 261
 health expenditure for diabetes, 630,
 632
 health insurance, 633
 incidence of diabetes, 247
 incidence of type 1 diabetes, 357,
 359–60
 Medicare data, 242, 247, 250
 Asian North Americans, 323–4,
 325, 327, 333
 Hispanic North Americans, 277,
 278, 281
 metabolic syndrome in, 42, 43, 45
 mortality rates, 250, 284
 number of people with diabetes, 66,
 242, 243, 282–3
 obesity prevalence, 58, 243
 productivity losses, 633, 637
 type 2 diabetes prevalence, 125
see also African Americans; Asian
 North Americans; Hispanic North
 Americans; Native Americans
- vaccinations, type 1 diabetes risk
 affected by, 368
 Vacor (rat poison), 16, 22
 Vanuatu (Pacific Islands), 233, 235
 vascular disease
 microalbuminuria/microalbuminuria
 and, 503
see also cardiovascular disease
 vascular factors, diabetic neuropathy
 affected by, 569
 vegetarians, 89
 Venezuela
 death rates due to diabetes, 158
 incidence of type 1 diabetes, 150, 357,
 360
 type 2 diabetes in, 157
 venous thromboembolic disease, 557–9
 incidence rate, 558
 risk factors, 557, 558
see also deep venous thrombosis;
 pulmonary embolism
 Veterans Affairs (VA) studies, 506, 524,
 556, 659
 Vietnam
 diabetes prevalence, 61, 208
 metabolic syndrome in, 46
 viral infections, type 1 diabetes triggered
 by, 362, 366–7, 404
 Virgin Islands, 164, 165, 360
 visceral fat, 32, 37
 in Asian North Americans, 328
 in Chinese people, 185
 Visual Impairment Project (Australia),
 477, 486
 vitamin D, 91, 368–9, 404, 420
 vitamin E, 369
- waist circumference, as measure of
 central obesity, 38, 57, 142–3
 African Americans, 299
 Asian North Americans, 328
 cut-off values for Asians, 37, 38, 185,
 215
 waist:hip ratio (WHR), as measure of
 central obesity, 35, 36, 57, 142
 in Afro-Caribbeans, 299
 in Asian North Americans, 331
 Wales *see* UK
 Wallis Islands, 229, 234
 weight loss, effect on diabetes risk, 62,
 67–8, 80, 128, 250, 440, 456
 weight-loss agents, 67, 456–8
 Western Pacific region
 diabetes prevalence, 113