

OBESITY

Epidemiology,
Pathophysiology, and Prevention

Second Edition

Edited by
Debasis Bagchi and Harry G. Preuss



CRC Press

Taylor & Francis Group

Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

© 2013 by Taylor & Francis Group, LLC
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works
Version Date: 20120328

International Standard Book Number-13: 978-1-4398-5426-6 (eBook - PDF)

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Visit the Taylor & Francis Web site at
<http://www.taylorandfrancis.com>

and the CRC Press Web site at
<http://www.crcpress.com>

*Dedicated to my beloved father, the late Tarak Chandra Bagchi, MSc, AIC,
and my beloved father-in-law, the late Nakuleshwar Bardhan, BA.*

Debasis Bagchi

*Dedicated to my teachers, especially the late Rachel B. Lott (third grade),
the late MSG Thomas Hannon (CCD), and the late Dr. Robert F. Pitts
(postdoctoral training). They along with many others prepared me for my career.*

Harry G. Preuss

Contents

Preface.....	xiii
Editors.....	xv
Contributors	xvii

PART I Introduction

Chapter 1 Epidemiology of Obesity.....	3
<i>Giovanna Turconi and Hellas Cena</i>	
Chapter 2 Epidemiology of Type 2 Diabetes and Obesity.....	33
<i>Kevin Corley, Monina S. Cabrera, Jean Claude Desmangles, Cristina Fernandez, and Archana Chatterjee</i>	

PART II Pathophysiology of Obesity

Chapter 3 Global View on the Development of Noncommunicable Diseases.....	45
<i>Karl-Heinz Wagner and Helmut Brath</i>	
Chapter 4 Evidence for Refined Food Addiction.....	53
<i>J.R. Iffland, Harry G. Preuss, Marianne T. Marcus, K.M. Rourke, W.C. Taylor, and Marty Lerner</i>	
Chapter 5 Disruption of Development by Environmental Estrogens.....	73
<i>Frederick S. vom Saal, Benjamin L. Coe, Brittany M. Angle, and Julia A. Taylor</i>	
Chapter 6 Cigarette Smoking, Inflammation, and Obesity.....	85
<i>Saibal K. Biswas, Ian L. Megson, Catherine A. Shaw, and Irfan Rahman</i>	
Chapter 7 Role of Neurotransmitters in Obesity Regulation.....	113
<i>Sunny E. Ohia, Catherine A. Opere, Madhura Kulkarni, and Ya Fatou Njie-Mbye</i>	
Chapter 8 Neurobiology of Obesity	125
<i>Nina Eikelis</i>	

Chapter 9	Leptin as a Vasoactive Adipokine.....	137
	<i>Anne Bouloumié, Cyrile Anne Curat, Alexandra Miranville, Karine Lolmède, and Coralie Sengenès</i>	
Chapter 10	Leptin-Induced Inflammation	149
	<i>Na-Young Song and Young-Joon Surh</i>	
Chapter 11	Overview of Ghrelin, Appetite, and Energy Balance	161
	<i>Rafael Fernández-Fernández and Manuel Tena-Sempere</i>	
Chapter 12	Molecular Genetics of Obesity Syndrome	171
	<i>Rama S. Dwivedi, Maria R. Wing, and Dominic S. Raj</i>	
Chapter 13	Sleep and Obesity	179
	<i>Michelle A. Miller and Francesco P. Cappuccio</i>	
 <i>PART III Obesity and Degenerative Diseases</i> 		
Chapter 14	Oxidative Stress Status in Humans with Metabolic Syndrome	193
	<i>C.-Y. Oliver Chen and Jeffrey B. Blumberg</i>	
Chapter 15	Obesity and Type 2 Diabetes.....	211
	<i>Subhashini Yaturu and Sushil K. Jain</i>	
Chapter 16	Inflammation	239
	<i>Sashwati Roy and Chandan K. Sen</i>	
Chapter 17	Angiogenesis-Targeted Redox-Based Therapeutics	253
	<i>Shampa Chatterjee, Debasis Bagchi, Manashi Bagchi, and Chandan K. Sen</i>	
Chapter 18	Obese and Overweight	263
	<i>George B. Corcoran</i>	
Chapter 19	Genomic Imprinting Disorders in Obesity.....	275
	<i>Merlin G. Butler</i>	

PART IV Novel Concept in Obesity Drug Development

- Chapter 20** Adipose Drug Targets for Obesity Treatment 291
Olivier Boss, Lorenz Lehr, and Jean-Paul Giacobino
- Chapter 21** History and Regulation of Prescription and Over-the-Counter Weight Loss Drugs..... 313
Susan M. Schwartz and David M. Savastano

PART V Safety of Obesity Drugs

- Chapter 22** Safety of Obesity Drugs 327
Alok K. Gupta and Frank L. Greenway
- Chapter 23** Historical Perspective, Efficacy of Current Drugs, and Future Directions
 in the Management of Obesity 349
Birgit Khandalavala and Archana Chatterjee

PART VI Natural, Nutritional, and Physical Approaches of Weight Management

- Chapter 24** Essential Role of Exercise and Physical Activity in Weight Management 365
Dawn Blatt and Cheri L. Gostic
- Chapter 25** Role of Exercise in Diet and Weight Loss..... 381
William J. Kraemer, Courtenay Dunn-Lewis, and Hui-Ying Luk
- Chapter 26** Role of Exercise in Weight Management and Other Health Benefits 409
Harry G. Preuss, Debasis Bagchi, and Gilbert R. Kaats
- Chapter 27** Overview of Nutritional and Dietary Approaches for Weight Control 417
Sanjiv Agarwal
- Chapter 28** Gender Effects on Adiposity 423
Sanja Cvitkusic, David J. Baer, and Gabriel Keith Harris

Chapter 29 Beyond Obesity Prevention	431
<i>Kurt W. Saupe and Jacob D. Mulligan</i>	
Chapter 30 Carbohydrate Digestion Inhibitors	443
<i>Jay K. Udani and Marilyn L. Barrett</i>	
Chapter 31 Vegetarian Diets in the Prevention and Treatment of Obesity	457
<i>Kathryn T. Knecht, Hayden T. Cale, Hien T. Bui, Don K. Tran, and Joan Sabate</i>	
Chapter 32 Atkins Paradigm.....	477
<i>Ariel Robarge and Bernard W. Downs</i>	
Chapter 33 Nature vs. Nurture.....	485
<i>Dilip Ghosh</i>	
Chapter 34 Glycemic Index	495
<i>David J.A. Jenkins, Krobua Srichaikul, Arash Mirrahimi, Livia S.A. Augustin, Laura Chiavaroli, John L. Sievenpiper, and Cyril W.C. Kendall</i>	
Chapter 35 Chromium (III) in Promoting Weight Loss and Lean Body Mass	501
<i>Debasis Bagchi, Manashi Bagchi, Shirley Zafra-Stone, and Harry G. Preuss</i>	
Chapter 36 Overview on (–)-Hydroxycitric Acid in Weight Management	511
<i>Debasis Bagchi, Shirley Zafra-Stone, Manashi Bagchi, and Harry G. Preuss</i>	
Chapter 37 Review of the Safety and Efficacy of Bitter Orange (<i>Citrus aurantium</i>) and Its Primary Protoalkaloid, <i>p</i> -Synephrine, in Weight Management.....	535
<i>Sidney J. Stohs and Mohd Shara</i>	
Chapter 38 Antiobesity Effects of Conjugated Linoleic Acid	555
<i>Richard Zwe-Ling Kong</i>	
Chapter 39 Role of Tea in Weight Management	577
<i>Chithan Kandaswami</i>	
Chapter 40 Laboratory and Clinical Studies of Chitosan.....	593
<i>Harry G. Preuss, Debasis Bagchi, and Gilbert R. Kaats</i>	

Chapter 41	Role of Curcumin, the Golden Spice, in Obesity and Associated Chronic Diseases.....	603
	<i>Sahdeo Prasad, Sridevi Patchva, and Bharat B. Aggarwal</i>	
Chapter 42	Role of <i>Caralluma fimbriata</i> in Weight Management	619
	<i>Ramasamy V. Venkatesh and Ramaswamy Rajendran</i>	
Chapter 43	Glucomannan in Weight Loss	627
	<i>Barbara Swanson and Joyce K. Keithley</i>	
Chapter 44	Role of Medium-Chain Triglycerides in Weight Management.....	637
	<i>Mary G. Enig and Beverly B. Teter</i>	
Chapter 45	Antiobesity by Marine Lipids	651
	<i>Kazuo Miyashita and Masashi Hosokawa</i>	
Chapter 46	Dairy Foods, Calcium, and Weight Management.....	667
	<i>Antje Bruckbauer and Michael B. Zemel</i>	
Chapter 47	Lessons from the Use of Ephedra Products as a Dietary Supplement.....	691
	<i>Madhusudan G. Soni, Kantha Shelke, Rakesh Amin, and Ashish Talati</i>	
Chapter 48	<i>Coleus forskohlii</i> Extract in the Management of Obesity	703
	<i>Muhammed Majeed</i>	
Chapter 49	Curcumin.....	729
	<i>Adeeb Shehzad and Young Sup Lee</i>	
Chapter 50	Review of the Safety and Efficacy of Banaba (<i>Lagerstroemia speciosa</i> L.) and Its Major Constituents, Corosolic Acid and Ellagitannins, in the Management of Metabolic Syndrome	743
	<i>Sidney J. Stohs, Howard Miller, and Gilbert R. Kaats</i>	
Chapter 51	Appetite, Body Weight, Health Implications of a Low-Glycemic-Load Diet.....	757
	<i>Stacey J. Bell</i>	

Chapter 52	Herbals and Dietary Nutrients Associated with Weight Loss.....	777
	<i>Akhtar Afshan Ali, Sherry M. Lewis, Xi Yang, William Frederick Salminen, and Julian E. Leakey</i>	
Chapter 53	Calcium and Obesity	801
	<i>Robert P. Heaney</i>	
Chapter 54	Dietary Supplementation in Weight Loss.....	811
	<i>Betty Wedman-St. Louis</i>	
Chapter 55	Beyond Glycemic Index and Glycemic Load.....	819
	<i>Corinne Bush and Dana Reed</i>	
Chapter 56	Challenges to the Conduct and Interpretation of Weight Loss Research.....	833
	<i>Gilbert R. Kaats and Harry G. Preuss</i>	

PART VII Child Obesity and Prevention

Chapter 57	Obesity and Disordered Eating in Youth	853
	<i>Sarah S. Jaser</i>	
Chapter 58	Childhood Obesity	863
	<i>Sang-Hoon Suh and Yu-Sik Kim</i>	
Chapter 59	Impact of Childhood Obesity on Musculoskeletal Growth, Development, and Disease.....	889
	<i>Lisa M. Esposito, Paul W. Esposito, and Archana Chatterjee</i>	
Chapter 60	New Directions in Childhood Obesity	903
	<i>Fernando Zapata, Ruben E. Quiros-Tejeira, Cristina Fernandez, Karla Lester, Archana Chatterjee, and Sandra G. Hassink</i>	
Chapter 61	Thinking Outside the Box.....	919
	<i>Shirley Gonzalez and Betsy Ramsey</i>	

PART VIII Bariatric Surgery in Weight Management

Chapter 62 Bariatric Surgery and Reversal of Metabolic Disorders 931

Melania Manco

Chapter 63 Bariatric Surgery in Pediatric Weight Management 947

*Anand Dusad, Cristina Fernandez, Geetanjali Rathore, Sumeet K. Mittal,
and Archana Chatterjee*

Preface

The spread of obesity has been declared a worldwide epidemic by the World Health Organization (WHO). In fact, a new term, globesity, has been coined to describe the recent upsurge of overweight and obesity throughout the world's population. How severe is the problem? According to WHO, worldwide obesity has more than doubled since 1980. In 2008, 1.5 billion adults, 20 years and older, were overweight [1]. Of these, more than 200 million men and 300 million women were obese. Sixty-five percent of the world's population live in countries where overweight and obesity kills more people than underweight [1]. Furthermore, nearly 43 million children under the age of five were overweight in 2010 [1].

To make matters worse, overweight and obesity in children are significant public health problems in the United States. It has been estimated that between 16% and 33% of children and adolescents are obese [2]. The number of adolescents who are overweight has tripled since 1980, and the prevalence of obesity among younger children has more than doubled [2]. According to the 1999–2002 National Health and Nutrition Examination Survey (NHANES), 16% of children aged between 6 and 19 years are overweight. Not only have the rates of overweight in children increased, but also the heaviest children in a recent NHANES were markedly heavier than those in previous surveys [2]. In addition to type 2 diabetes, obesity has also been linked to other broad-spectrum, degenerative diseases, including other metabolic disorders and certain forms of cancer. It has been reported that 80% of type 2 diabetes, 70% of cardiovascular diseases, and 42% of breast and colon cancers are related to obesity [3]. Obesity is the major factor behind 30% of gallbladder perturbations, leading to surgery, and 26% of incidences of high blood pressure.

This unfortunate outcome has generated an unlimited array of weight loss strategies. Products and programs that induce rapid weight loss and disturb metabolic homeostasis dominate the focus of marketers and consumers alike; however, rapid weight loss is potentially unhealthy and frequently induces undesirable rebound weight gain consequences. In addition, many antiobesity pharmaceuticals are accompanied by adverse reactions, making the cure worse than the disorder itself; thus, it is very important to develop a strategic therapeutic intervention using safe, novel, and natural supplements supported by credible research. This book, intended for practicing medical professionals, clinical nutritionists, dietitians, and researchers, addresses many issues relevant to obesity: the molecular mechanism and pathophysiology leading to obesity and metabolic disorders, the safety of obesity drugs, drug development strategies, the influences of physical activity and nutrition, and the benefits of research-supported nutraceutical supplements.

The 63 chapters in this book have been written by experts in their respective fields and have been divided into 8 parts. Part I provides a general introduction. Chapter 1, written by a world-renowned nutritionist and a health professional, provides an overview on the epidemiology of obesity. Chapter 2 explains the relationship between obesity and type 2 diabetes. Part II deals with the pathophysiology of obesity. Chapter 3 by Professor Karl-Heinz Wagner and Helmut Brath demonstrates the global view on noncommunicable diseases and where we all are going. This part demonstrates the evidence for refined food addiction; correlates obesity with environmental estrogens and endocrine disruption, cigarette smoking, and inflammatory responses; and elaborates the roles of neurotransmitters, neurobiology, leptin, ghrelin (the hunger hormone), DNA methylation, and sleep. Part III correlates obesity with diverse degenerative diseases, including metabolic syndrome, type 2 diabetes, and diverse inflammatory responses such as wound healing and angiogenesis. Professor George Corcoran, immediate past president of the Society of Toxicology, discusses the role of drug and chemical toxicities in overweight and obesity

in Chapter 18. Finally, Professor Merlin Butler emphasizes the genomic imprinting disorders in obesity in Chapter 19.

Part IV starts with Dr. Olivier Boss et al.'s chapter covering new concepts in obesity drug development. This is followed by Dr. Susan Schwartz and Dr. David Savastano's chapter on the history and regulation of prescription and over-the-counter weight loss drugs. The world-renowned Pennington Biomedical Research Center scientists Dr. Alok Gupta and Dr. Frank Greenway discuss the safety of obesity drugs in Part V. This part is further expanded to discuss the historical perspective of obesity drugs, efficacy of current obesity drugs, and future directions. Part VI consists of 33 chapters on natural, nutritional, and physical approaches of weight management. The roles of exercise and physical activity in weight management and weight loss, the usefulness of pedometers, the nutritional and dietary approaches for weight control, gender effects of adiposity, and antiaging effects of caloric restrictions are thoroughly demonstrated by experts in the field. This part also covers carbohydrate blocks; vegetarian, plant-based, and Atkins diets; the concept of the glycemic index; as well as the roles of chromium (III), (–)-hydroxycitric acid, bitter orange (*Citrus aurantium* and *p-synephrine*), conjugated linoleic acid, curcumin, tea, chitosan, *Caralluma fimbriata*, glucomannan, medium chain triglycerides, marine lipids, calcium and dairy products, the banned weight loss ingredient ephedra, *Coleus forskohlii* extract, and *Lagerstroemia speciosa* (coroslic acid) in weight management. There are also two interesting chapters, including a review on weight loss and a chapter providing the reflections of a practicing dietician regarding weight loss supplements. Part VII deals with child obesity—a most challenging issue in the new millennium. Five chapters highlight the intricate aspects of this problem and possible strategies for prevention. Part VIII discusses bariatric surgery and how this may help in weight management and in reversing metabolic disorders.

Finally, we extend our special thanks and gratitude to all the authors for their invaluable contributions and to Randy Brehm and Jill Jurgensen for their continued support.

REFERENCES

1. Obesity and overweight, Fact Sheet No 311, Updated March 2011, <http://www.who.int/mediacentre/factsheets/fs311/en/> (dated October 12, 2011).
2. Childhood obesity statistics and trends, <http://www.stop-childhood-obesity.com/childhood-obesity-statistics.html> (dated October 12, 2011).
3. Obesity statistics: Weight statistics—Adults, children, obesity-related diseases, 2006, <http://www.annecollins.com/obesity/statistics-obesity.htm> (dated October 12, 2011).

Debasis Bagchi, PhD, MACN, CNS, MAChE
College of Pharmacy, University of Houston
Houston, Texas

Harry G. Preuss, MD, MACN, CNS
Georgetown University Medical Center
Washington, District of Columbia

Editors

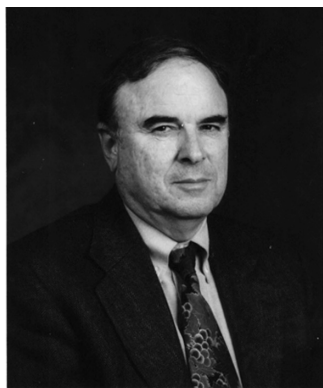


Debasis Bagchi, PhD, MACN, CNS, MAICHe, received his PhD in medicinal chemistry in 1982. He is a professor in the Department of Pharmacological and Pharmaceutical Sciences at the University of Houston, Houston, Texas. Dr. Bagchi is also the director of Innovation & Clinical Affairs at Iovate Health Research Sciences Inc., Oakville, Ontario, Canada. He is the immediate past president of the American College of Nutrition (ACN), Clearwater, Florida, and immediate past chairman of the Nutraceuticals and Functional Foods Division at the Institute of Food Technologists, Chicago, Illinois. Dr. Bagchi is the vice-chair of the International Society of

Nutraceuticals and Functional Foods (ISNFF). He also serves as a distinguished advisor at the Japanese Institute for Health Food Standards, Tokyo, Japan. Dr. Bagchi received the Master of American College of Nutrition Award in October 2010. His research interests include free radicals, human diseases, carcinogenesis, pathophysiology, mechanistic aspects of cytoprotection by antioxidants, and regulatory pathways in obesity, diabetes, and gene expression.

Dr. Bagchi has authored 12 books and 278 papers in peer-reviewed journals and has 15 patents to his credit. He has delivered invited lectures at various national and international scientific conferences and has organized workshops and group discussion sessions. He is a fellow of the ACN and the Nutrition Research Academy and a member of the Society of Toxicology, the New York Academy of Sciences, and the TCE Stakeholder Committee of the Wright Patterson Air Force Base, Ohio. Dr. Bagchi is a member of the Study Section and Peer Review Committee of the National Institutes of Health, Bethesda, Maryland, the associate editor of the *Journal of Functional Foods* and the *Journal of the American College of Nutrition*, and also serves as an editorial board member of numerous peer-reviewed journals, including *Antioxidants and Redox Signaling*, *Cancer Letters*, *Toxicology Mechanisms and Methods*, and other scientific and medical journals. He is also a consulting editor of CRC Press/Taylor & Francis.

Dr. Bagchi received funding from various institutions and agencies, including the U.S. Air Force Office of Scientific Research, Nebraska State Department of Health, Biomedical Research Support Grant from the National Institutes of Health (NIH), National Cancer Institute (NCI), Health Future Foundation, the Procter & Gamble Company, and Abbott Laboratories.



Harry G. Preuss, MD, MACN, CNS, received his BA and MD from Cornell University, Ithaca, New York, and Cornell University Medical Center, New York City, New York, respectively; trained for three years in internal medicine at Vanderbilt University Medical Center Nashville, Tennessee, under Dr. David E. Rogers; studied for two years as a fellow in renal physiology at Cornell University Medical Center under Dr. Robert F. Pitts; and spent two years in clinical and research training in nephrology at Georgetown University Medical Center Washington, DC, under Dr. George E. Schreiner. During his training years, he was a special research fellow of the NIH. After working for five years as an assistant and associate (tenured) professor of medicine at the University of Pittsburgh Medical Center, where he became an established investigator of the American Heart Association, Dr. Preuss

returned to Georgetown University Medical Center and is now a tenured professor in four departments—biochemistry, physiology, medicine, and pathology. He subsequently performed a six-month sabbatical in molecular biology at the NIH in the laboratories of Dr. Maurice Burg.

Dr. Preuss' bibliography includes more than 220 peer-reviewed medical research papers, 190 general medical contributions (chapters, reviews, etc.), 7 patents, and more than 250 abstracts. He has written, edited, or coedited nine books and three symposia published in well-established journals. He has recently published two books: one coauthored for the lay public entitled *The Natural Fat Loss Pharmacy* (Broadway Books/Rodale Press), which has sold over 120,000 copies, and a second coedited for the academic community entitled *Obesity: Epidemiology, Pathophysiology, and Prevention* (CRC Press), which received outstanding reviews from the *New England Journal of Medicine* and the *Journal of American Medical Association*. In 1976, Dr. Preuss was elected as a member to the American Society for Clinical Investigations, a prestigious research group. He is currently an advisory editor for six journals. His previous government appointments included four years on the advisory council for the National Institute on Aging, two years on the advisory council of the director of the NIH (NIA representative), and two years on the advisory council for the Office of Alternative Medicine of the NIH. He has been a member of many other peer research review committees for the NIH and American Heart Association and was a member of the National Cholesterol Education Program of the NHLBI (NIH).

Dr. Preuss was elected the ninth Master of the ACN. He is a former chairman of two ACN councils—the Cardiovascular and Aging Council and the Council on Dietary Supplements, Nutraceuticals, and Functional Foods. After a brief stint on the board of directors of the ACN, Dr. Preuss spent three years as secretary–treasurer and three consecutive years as vice president, president-elect, and, finally, as president in 1998. In 2008 and 2011, he was reelected president of the ACN—the only person to hold this office more than once. Dr. Preuss is a member of the board of directors for the Alliance for Natural Health (ANH-USA) and has also served as their treasurer. He wrote the nutrition section for the *Encyclopedia Americana* and is the past president of the Certification Board for Nutrition Specialists (CBNS) that gives the CNS certification. He was chairman of the Institutional Review Board (IRB) at Georgetown University, which reviews all clinical protocols at Georgetown University Medical Center, for over 20 years. He is the recipient of the William B. Peck, James Lind, and Bieber Awards for his research and activities in the medical and nutrition field. His current research, both laboratory and clinical, centers on the use of dietary supplements and nutraceuticals to favorably influence or even prevent a variety of medical perturbations, especially those related to obesity, insulin resistance, and cardiovascular disorders. Lately, he has also researched the ability of many essential oils and fats to overcome various infections, including those resistant to antibiotics. He recently won, through a vote of his peers, the coveted Charles E. Ragus Award of the ACN for publishing the best research paper in their journal for the year 2006 and the ACN Award for 2010 given to an outstanding senior investigator in nutrition.

Contributors

Sanjiv Agarwal, PhD, FACN

Campbell Soup Company
Camden, New Jersey

Bharat B. Aggarwal, PhD

Department of Experimental Therapeutics
MD Anderson Cancer Center
The University of Texas
Houston, Texas

Akhtar Afshan Ali, PhD

Division of Systems Biology
Center of Excellence for Hepatotoxicity
National Center for Toxicological Research
U.S. Food and Drug Administration
Jefferson, Arkansas

Rakesh Amin, JD, LLM

AminTalati, LLC
Chicago, Illinois

Brittany M. Angle, BS

Division of Biological Sciences
University of Missouri-Columbia
Columbia, Missouri

Livia S.A. Augustin, PhD

Clinical Nutrition and Risk Factor
Modification Center
St. Michael's Hospital
and
Faculty of Medicine
Department of Nutritional Sciences
University of Toronto
Toronto, Ontario, Canada

David J. Baer, MS, PhD

Diet and Human Performance Laboratory
Beltsville Human Nutrition Research Center
and
Food Components and Health Laboratory
United States Department of Agriculture
Beltsville, Maryland

Debasis Bagchi, PhD, MACN, CNS, MAIChE

Department of Pharmacological
and Pharmaceutical Sciences
College of Pharmacy
University of Houston
Houston, Texas

and

Iovate Health Sciences International, Inc.
Oakville, Ontario, Canada

Manashi Bagchi, PhD

Nutri Today LLC
Boston, Massachusetts

Marilyn L. Barrett, PhD

Pharmacognosy Consulting Services
Mill Valley, California

Stacey J. Bell, DSc, RD

Consultant
Boston, Massachusetts

Saibal K. Biswas, PhD

Department of Biochemistry
Dr. Ambedkar College
Nagpur, India

Dawn Blatt, PT, DPT, MS

Division of Rehabilitation Sciences
School of Health Technology and Management
Stony Brook University
Stony Brook, New York

**Jeffrey B. Blumberg, PhD, FASN,
FACN, CNS**

Antioxidants Research Laboratory
Jean Mayer USDA Human Nutrition Research
Center on Aging
Tufts University
Boston, Massachusetts

Olivier Boss, PhD

Energesis Pharmaceuticals, Inc.
Cambridge, Massachusetts

Anne Bouloumié, PhD

Institut National de la Santé et de la Recherche
Médicale
Toulouse, France

Helmut Brath, MD

Diabetes Outpatient Clinic
Vienna, Austria

Antje Bruckbauer, MD, PhD

NuMeta Sciences, Inc.
Knoxville, Tennessee

Hien T. Bui, PharmD

Department of Pharmaceutical Sciences
School of Pharmacy
Loma Linda University
Loma Linda, California

Corinne Bush, MS, CNS

Far Hills Wellness Center
Bedminster, New Jersey

Merlin G. Butler, MD, PhD, FFACMG

Department of Psychiatry and Behavioral
Sciences and Pediatrics
Kansas University Medical Center
Kansas City, Kansas

Monina S. Cabrera, MD

Children's Hospital and Medical Center
University of Nebraska Medical Center
Omaha, Nebraska

Hayden T. Cale, BS

Department of Chemistry and Biochemistry
La Sierra University
Riverside, California

**Francesco P. Cappuccio, FRCP, FFPH,
FAHA**

Division of Metabolic and Vascular Health
Warwick Medical School
University of Warwick
Coventry, United Kingdom

Hellas Cena, MD

Department of Public Health,
Neuroscience, Experimental and
Forensic Medicine
Section of Human Nutrition
School of Medicine
University of Pavia
Pavia, Italy

Archana Chatterjee, MD, PhD

Division of Pediatric Infectious Diseases
School of Medicine
Creighton University
Omaha, Nebraska

Shampa Chatterjee, PhD

Institute for Environmental Medicine
University of Pennsylvania Medical Center
Philadelphia, Pennsylvania

C.-Y. Oliver Chen, PhD

Antioxidants Research Laboratory
Jean Mayer USDA Human Nutrition
Research Center on Aging
Tufts University
Boston, Massachusetts

Laura Chiavaroli, MSc

Risk Factor Modification Center
and
Li Ka Shing Institute
St. Michael's Hospital
and
Faculty of Medicine
Department of Nutritional Sciences
University of Toronto
Toronto, Ontario, Canada

Benjamin L. Coe, MS

Division of Biological Sciences
University of Missouri-Columbia
Columbia, Missouri

George B. Corcoran, PhD, ATS

Department of Pharmaceutical Sciences
Eugene Applebaum College of Pharmacy
and Health Sciences
Wayne State University
Detroit, Michigan

Kevin Corley, MD

Children's Hospital and Medical Center
University of Nebraska Medical Center
Omaha, Nebraska

Cyrile Anne Curat, PhD

Institut National de la Santé et de la Recherche
Médicale
Toulouse, France

Sanja Cvitkusic, BS

Department of Food, Bioprocessing
and Nutrition Science
North Carolina State University
Raleigh, North Carolina

Jean Claude Desmangles, MD, FAAP

Children's Hospital and Medical Center
University of Nebraska Medical Center
Omaha, Nebraska

Bernard W. Downs, BSc

LifeGen Research
Lederach, Pennsylvania

Courtenay Dunn-Lewis, MA

Human Performance Laboratory
Department of Kinesiology
University of Connecticut
Storrs, Connecticut

Anand Dusad, MD

College of Pharmacy
University of Nebraska Medical Center
and
Veterans Affairs Medical Center
Omaha, Nebraska

Rama S. Dwivedi, PhD

Division of Cardiovascular and Renal
Products
U.S. Food and Drug Administration
Silver Spring, Maryland

Nina Eikelis, PhD

Human Neurotransmitters Laboratory
Baker IDI Heart and Diabetes Institute
Melbourne, Victoria, Australia

Mary G. Enig, PhD, FACN, MACN, CNS

Enig Associates, Inc
Silver Spring, Maryland

Lisa M. Esposito, MS, RD, CSSD, LN

Sanford University of South Dakota
Medical Center
Sioux Falls, South Dakota

Paul W. Esposito, MD

University of Nebraska Medical Center
Omaha, Nebraska

Cristina Fernandez, MD

Department of Pediatrics
Creighton University
and
Children's Hospital and Medical Center
University of Nebraska Medical Center
Omaha, Nebraska

Rafael Fernández-Fernández, PhD

Department of Cell Biology, Physiology
and Immunology
University of Córdoba
Córdoba, Spain

Dilip Ghosh, PhD, FACN

Nutriconnect
Sydney, New South Wales, Australia

Jean-Paul Giacobino, PhD

University of Geneva Medical Center
Geneva, Switzerland

Shirley Gonzalez, MD, FAAP

Division of General Pediatrics
St. Elizabeth's Medical Center
Brighton, Massachusetts

and

Tufts University School of Medicine
Boston, Massachusetts

Cheri L. Gostic, PT, DPT, MS

Division of Rehabilitation Sciences
School of Health Technology and Management
Stony Brook University
Stony Brook, New York

Frank L. Greenway, MD
 Department of Clinical Trials
 Pennington Biomedical Research Center
 Louisiana State University System
 Baton Rouge, Louisiana

Alok K. Gupta, MD, FAAFP, FASH
 Pennington Biomedical Research Center
 Louisiana State University System
 Baton Rouge, Louisiana

Gabriel Keith Harris, MS, PhD
 Department of Food, Bioprocessing
 and Nutrition Science
 North Carolina State University
 Raleigh, North Carolina

Sandra G. Hassink, MD
 Thomas Jefferson University
 Philadelphia, Pennsylvania
 and

Department of Pediatrics
 Alfred I. DuPont Hospital for Children
 Wilmington, Delaware

Robert P. Heaney, MD
 Creighton University
 Omaha, Nebraska

Masashi Hosokawa, PhD
 Hokkaido University
 Hokkaido, Japan

J.R. Iffland, PhD
 Refined Food Addiction Research
 Foundation
 Houston, Texas

Sushil K. Jain, PhD
 Department of Pediatrics
 Health Sciences Center
 Louisiana State University
 Shreveport, Louisiana

Sarah S. Jaser, PhD
 School of Nursing
 Yale University
 New Haven, Connecticut

David J.A. Jenkins, MD, PhD, DSc
 Risk Factor Modification Center
 and
 Li Ka Shing Institute
 St. Michael's Hospital
 and
 Faculty of Medicine
 Department of Nutritional Sciences
 University of Toronto
 Toronto, Ontario, Canada

Gilbert R. Kaats, PhD, FACN
 Integrative Health Technologies, Inc.
 Health and Research Center
 San Antonio, Texas

Chithan Kandaswami, PhD, FACN, CNS
 Castle Hills Health
 Saskatoon, Saskatchewan, Canada

Joyce K. Keithley, DNSc, RN, FAAN
 College of Nursing
 Rush University
 Chicago, Illinois

Cyril W.C. Kendall, PhD
 Clinical Nutrition and Risk Factor
 Modification Center
 St. Michael's Hospital
 and
 Faculty of Medicine
 Department of Nutritional Sciences
 University of Toronto
 Toronto, Ontario, Canada
 and

College of Pharmacy and Nutrition
 University of Saskatchewan
 Saskatoon, Saskatchewan, Canada

Birgit Khandalavala, MD
 Department of Family Medicine
 School of Medicine
 Creighton University
 Omaha, Nebraska

Yu-Sik Kim, MS
 Department of Medical Science
 College of Medicine
 Yonsei University
 Seoul, Korea

Kathryn T. Knecht, PhD

Department of Pharmaceutical Sciences
School of Pharmacy
Loma Linda University
Loma Linda, California

Richard Zwe-Ling Kong, PhD

Department of Food Science
National Taiwan Ocean University
Keelung, Taiwan

**William J. Kraemer, PhD, FACSM, FNCSA,
FISSN, FACN**

Human Performance Laboratory
Department of Kinesiology
University of Connecticut
Storrs, Connecticut

Madhura Kulkarni, MPharm

Department of Pharmaceutical Sciences
College of Pharmacy and Health Sciences
Texas Southern University
Houston, Texas

Julian E. Leakey, PhD, DABT

Office of Scientific Coordination
National Center for Toxicological Research
Jefferson, Arkansas

Young Sup Lee, PhD

School of Life Sciences
College of Natural Sciences
Kyungpook National University
Daegu, Korea

Lorenz Lehr, PhD

Department of Cell Physiology and Metabolism
University of Geneva Medical School
Geneva, Switzerland

Marty Lerner, PhD

Milestone Treatment Center
Dallas, Texas

Karla Lester, MD

Community Pediatrician
Lincoln, Nebraska

Sherry M. Lewis, PhD

Office of Scientific Coordination
National Center for Toxicological Research
Jefferson, Arkansas

Karine Lolmède, PhD

Institut National de la Santé et de la Recherche
Médicale
Toulouse, France

Hui-Ying Luk, MS

Human Performance Laboratory
Department of Kinesiology
University of Connecticut
Storrs, Connecticut

Muhammed Majeed, PhD

Sabinsa Corporation
East Windsor, New Jersey

Melania Manco, MD, PhD, FACN

Liver Unit
Bambino Gesù Pediatric Hospital and
Research Institute
Rome, Italy

Marianne T. Marcus, EdD, RN, FAAN

Department of Nursing Systems
School of Nursing
University of Texas Health Science Center
Houston, Texas

Ian L. Megson, PhD

Department of Diabetes and Cardiovascular
Science
Centre for Health Science
University of the Highlands and Islands
Inverness, United Kingdom

Howard Miller, MS

Nutratch Inc.
West Caldwell, New Jersey

**Michelle A. Miller, PhD, MAcadMED,
FFPH**

Division of Metabolic and Vascular Health
Warwick Medical School
University of Warwick
Coventry, United Kingdom

Alexandra Miranville, PhD

Institut National de la Santé et de la Recherche
Médicale
Toulouse, France

Arash Mirrahimi, MSc

Risk Factor Modification Center
and
Li Ka Shing Institute
St. Michael's Hospital
and
Faculty of Medicine
Department of Nutritional Sciences
University of Toronto
Toronto, Ontario, Canada

Sumeet K. Mittal, MD

School of Medicine
Creighton University
Omaha, Nebraska

Kazuo Miyashita, PhD

Hokkaido University
Hokkaido, Japan

Jacob D. Mulligan, PhD

Department of Medicine
The University of Wisconsin-Madison
Madison, Wisconsin

Ya Fatou Njie-Mbye, PhD

Department of Pharmaceutical Sciences
College of Pharmacy and Health Sciences
Texas Southern University
Houston, Texas

Sunny E. Ohia, PhD

Department of Pharmaceutical Sciences
College of Pharmacy and Health Sciences
Texas Southern University
Houston, Texas

Catherine A. Opere, PhD

Department of Pharmacy Sciences
School of Pharmacy and Health Professions
Creighton University
Omaha, Nebraska

Sridevi Patchva, PhD

Department of Experimental Therapeutics
MD Anderson Cancer Center
The University of Texas
Houston, Texas

Sahdeo Prasad, PhD

Department of Experimental Therapeutics
MD Anderson Cancer Center
The University of Texas
Houston, Texas

Harry G. Preuss, MD, MACN, CNS

Georgetown University Medical Center
Washington, District of Columbia

Ruben E. Quiros-Tejeira, MD

Pediatric Gastroenterology, Hepatology
& Nutrition Clinic
and
Pediatric Liver and Intestinal Transplantation
Center
and
Division of Pediatrics and Surgery
University of Nebraska Medical Center
Omaha, Nebraska

Irfan Rahman, PhD

Department of Environmental Medicine
University of Rochester Medical Center
Rochester, New York

Dominic S. Raj, MD

Division of Renal Diseases and
Hypertension
Department of Medicine
The George Washington University
Washington, District of Columbia

Ramaswamy Rajendran, MSc

Green Chem Herbal Extracts & Formulations
Bangalore, India

Betsy Ramsey, MS, RD, CDE, LDN

George L. Tully III, MD Diabetes Care Center
St. Elizabeth's Medical Center
Brighton, Massachusetts

Geetanjali Rathore, MD

Department of Pediatrics
and
Children's Hospital and Medical Center
University of Nebraska Medical Center
Omaha, Nebraska

Dana Reed, MS, CNS, CDN

Reed Nutrition
New York, New York

Ariel Robarge, RD

Department of Nutrition
Nutritious Lifestyles, Inc.
Orlando, Florida

K.M. Rourke, PhD

Refined Food Addiction Research
Foundation
Houston, Texas

Sashwati Roy, PhD

Department of Surgery
Comprehensive Wound Center
Davis Heart and Lung Research Institute
Wexner Medical Center at the Ohio State
University
Columbus, Ohio

Joan Sabate, MD, PhD

Department of Nutrition
and
Department of Epidemiology
School of Public Health
Loma Linda University
Loma Linda, California

William Frederick Salminen, PhD, DABT

Division of Systems Biology
Food and Drug Administration
Center of Excellence for Hepatotoxicity
National Center for Toxicological Research
Jefferson, Arkansas

Kurt W. Saupe, PhD

Department of Medicine
The University of Wisconsin-Madison
Madison, Wisconsin

David M. Savastano, PhD

GlaxoSmithKline Consumer Healthcare
Parsippany, New Jersey

Susan M. Schwartz, PhD

GlaxoSmithKline Consumer Healthcare
Parsippany, New Jersey

Chandan K. Sen, PhD

Department of Surgery
Davis Heart and Lung Research Institute
Wexner Medical Center at The Ohio State
University
Columbus, Ohio

Coralie Sengenès, PhD

Institut National de la Santé et de la Recherche
Médicale
Toulouse, France

Mohd Shara, PhD, PharmD, FACN

Faculty of Pharmacy
Jordan University of Science and
Technology
Irbid, Jordan

Catherine A. Shaw, PhD

Centre for Cardiovascular Science
Queen's Medical Research Institute
University of Edinburgh
Edinburgh, United Kingdom

Adeeb Shehzad, PhD

Laboratory of Cellular Biochemistry
School of Life Sciences
College of Natural Sciences
Kyungpook National University
Daegu, South Korea

Kantha Shelke, PhD

Corvus Blue LLC
Chicago, Illinois

John L. Sievenpiper, MD, PhD

Department of Pathology and Molecular
Medicine
McMaster University
Hamilton, Ontario, Canada

Na-Young Song, PhD

Tumor Microenvironment Global Core
Research Center
College of Pharmacy
Seoul National University
Seoul, South Korea

Madhusudan G. Soni, PhD, FACN, FATS

Soni & Associates Inc.
Vero Beach, Florida

Krobua Srichaikul, MSc

Risk Factor Modification Center
and

Li Ka Shing Institute
St. Michael's Hospital
and

Department of Nutritional Sciences
Comprehensive Wound Center
University of Toronto
Toronto, Ontario, Canada

and

Medical School
University of Ottawa
Ottawa, Ontario, Canada

**Sidney J. Stohs, PhD, FACN, CNS, ATS,
FASAHP**

Creighton University Medical Center
Omaha, Nebraska

Sang-Hoon Suh, PhD

Department of Physical Education
Yonsei University
and

Korea Institute of Sport Science
Seoul, Korea

Young-Joon Surh, PhD

Tumor Microenvironment Global Core
Research Center
College of Pharmacy
Seoul National University
Seoul, Korea

Barbara Swanson, PhD, RN, ACRN

College of Nursing
Rush University
Chicago, Illinois

Ashish Talati, JD, MS

AminTalati, LLC
Chicago, Illinois

Julia A. Taylor, PhD

Division of Biological Sciences
University of Missouri-Columbia
Columbia, Missouri

W.C. Taylor, PhD

School of Public Health
The University of Texas
Houston, Texas

Manuel Tena-Sempere, MD, PhD

Department of Cell Biology, Physiology
and Immunology
University of Córdoba
and

Centro de Investigación Biomédica en Red de
Fisiopatología de la Obesidad y Nutrición
Instituto de Salud Carlos III
Córdoba, Spain

Beverly B. Teter, MACN, CNS

Department of Animal and Avian Sciences
University of Maryland
College Park, Maryland

Don K. Tran, PharmD

Department of Pharmaceutical Sciences
School of Pharmacy
Loma Linda University
Loma Linda, California

Giovanna Turconi, PhD

Department of Public Health, Neuroscience,
Experimental and Forensic Medicine
Section of Human Nutrition
School of Medicine
University of Pavia
Pavia, Italy

Jay K. Udani, MD

Medicus Research LLC
Northridge, California

and

Northridge Hospital Integrative Medicine
Program
Los Angeles, California

Ramasamy V. Venkatesh, BSc, PGDIT

Gencor Pacific Limited
Discovery Bay, Hong Kong

Frederick S. vom Saal, PhD

Division of Biological Sciences
University of Missouri-Columbia
Columbia, Missouri

Karl-Heinz Wagner, PhD

Department of Nutritional Sciences
University of Vienna
Vienna, Austria

Betty Wedman-St. Louis, PhD, RD, LD

Private Practice
Disc & Spine Center
Pinellas Park, Florida

and

Department of Health Sciences
South University
Tampa, Florida

Maria R. Wing, PhD

Division of Renal Diseases and
Hypertension
Department of Medicine
School of Medicine and Health Sciences
The George Washington University
Washington, District of Columbia

Xi Yang, PhD

Division of Systems Biology
Food and Drug Administration
Center of Excellence for Hepatotoxicity
National Center for Toxicological Research
Jefferson, Arkansas

Subhashini Yaturu, MD, FACE

Endocrinology Section
Stratton VA Medical Center
and

Department of Medicine
Albany Medical College
Albany, New York

Shirley Zafra-Stone, BS

Products Solution Research Inc.
Davis, California

Fernando Zapata, MD

Division of Pediatric Gastroenterology
and
Children's Hospital and Medical Center
University of Nebraska Medical Center
Omaha, Nebraska

Michael B. Zemel, PhD

Department of Nutrition
The University of Tennessee, Knoxville
and
NuMeta Sciences, Inc.
Knoxville, Tennessee

Part I

Introduction

1 Epidemiology of Obesity

Current Status

Giovanna Turconi, PhD and Hellas Cena, MD

CONTENTS

Introduction.....	3
Prevalence of Obesity in the Adult Population	7
Europe	7
United States	7
Latin America and Caribbean.....	18
Africa.....	19
Japan, China, and Western Pacific Countries	19
Prevalence of Obesity in Children and Adolescents	20
Europe	20
United States	20
Australia, China, Asian/Pacific Islanders, and New Delhi	26
Health Consequences of Obesity and Morbidity	26
Benefits of Weight Loss	27
Economic Costs of Obesity.....	27
Need for Action.....	28
Acknowledgment	30
References.....	30

INTRODUCTION

Obesity is a complex, multifactorial chronic disease involving environmental (social and cultural), genetic, physiologic, metabolic, behavioral, and psychological components.

It has been increasing at an alarming rate throughout the world over the past two decades to the extent that it is now a pandemic, affecting millions of people globally, and it is the second leading cause of preventable death in the United States [1].

The 2010 International Obesity Task Force (IOTF) analysis [2] estimates that approximately 1.0 billion adults are currently overweight (body mass index [BMI] 25–29.9 kg/m²) and a further 475 million are obese. When Asian-specific cutoff points for the definition of obesity (BMI > 28 kg/m²) are taken into account, the number of adults considered obese globally is over 600 million. The IOTF estimates that up to 200 million school-age children are either overweight or obese, 40–50 million of which are classified as obese. In the European Union—27 member states—approximately 60% of adults and over 20% of school-age children are overweight or obese. This equates to around 260 million adults and over 12 million children being either overweight or obese.

Obesity is defined as a condition of excess body fat, and it is associated with a large number of debilitating and life-threatening disorders, such as a major increase in associated cardiovascular, metabolic, and other noncommunicable diseases [3]. It also contributes to increased mortality rates from all causes, including cardiovascular diseases (CVD) and cancer.

The obesity prevalence rate increase is evident in Westernized countries, where obesity has been present for decades, but today, it is also particularly noticeable in less developed countries that previously have not experienced problems with overweight and obesity. For example, the prevalence of obesity has increased by about 10%–40% in the majority of European countries in the last decade, and it currently affects nearly one-third of the adult American population, as well as more than half of the adult population living in urban areas of Western Samoa in the Pacific [4].

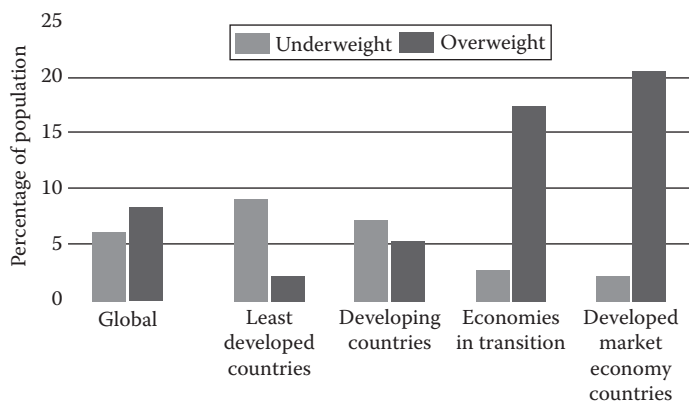
Between 1980 and 2004, the prevalence of obesity in the United States increased from 15% to 33% among adults and the prevalence of overweight in children increased from more than 6% to 19% [5]. Obesity is a complex condition, and prevention and treatment are difficult.

Obesity in the developing world reflects the profound changes in society over the past 20–30 years that have created an environment that promotes a sedentary lifestyle and the consumption of a high-fat, energy-dense diet, collectively known as the “nutrition transition.” As poor countries become more prosperous, they acquire some of the benefits along with some of the problems of industrialized nations, including obesity (Figure 1.1) [6].

Because the direct measurement of body fat is difficult, the BMI, a simple weight-to-height ratio (kg/m^2), is typically used to classify overweight and obese adults. Consistent with this, the WHO has published international standards for classifying overweight and obesity in adults (Table 1.1). Obesity is defined as a BMI $\geq 30 \text{ kg}/\text{m}^2$ but can be further subdivided on the basis of the severity of the obesity [1].

The interpretation of BMI in terms of body fatness and in comparison with weight standards (or definitions of obesity) varies by sex, age, and other factors [7]. Only if the same body weight standards are considered to be appropriate for both men and women does a given value of BMI have the same meaning in terms of relative weight. A given value of BMI may be numerically the same for men and women and for people of different ages, but may not represent the same percentage of body fat, the same degree of risk or, even necessarily, the same degree of overweight relative to a weight standard [5].

Although the BMI provides a simple, convenient measurement of obesity, a more important aspect of obesity is the regional distribution of excess body fat. Visceral or intra-abdominal obesity, in contrast to subcutaneous or lower body obesity, carries the greatest risk of a number of chronic-degenerative diseases, including CVD and noninsulin-dependent diabetes mellitus (NIDDM). The importance of central obesity is clear in populations (e.g., Asian) who tend to have relatively low BMI values but high



As countries develop, they face many of the problems common in industrialized nations. Obesity is one of the most worrisome.

Source: WHO, 2000.

FIGURE 1.1 From least to most developed countries: overweight is on the rise. (From FAO, *The developing world's new burden: Obesity, food and agricultural organization*, United Nations, Geneva, Switzerland, 2002, <http://www.fao.org/FOCUS/E/obesity/obes2.htm>, accessed on October 12, 2011.)

TABLE 1.1
WHO Standard Classification of Obesity

	BMI (kg/m ²)	Risk of Comorbidities
Normal range	18.5–24.9	Average
Overweight	25.0–29.9	Mildly increased
Obesity class I	30.0–34.9	Moderate
Obesity class II	35.0–39.9	Severe
Obesity class III	≥40	Very severe

Source: WHO, Obesity: Preventing and managing the global epidemic, Report of a WHO consultation on obesity, Technical Report Series, No. 894, World Health Organization, Geneva, Switzerland, 2000, p. 256.

levels of abdominal fat and are particularly prone to NIDDM, hypertension, and CVD. Methods for evaluating abdominal fat include measuring waist circumference. Changes in waist circumference reflect changes in risk for CVD and other chronic diseases. As with the BMI, cutoff values have been set to identify increased risk, but for waist circumference, these must be sex and population specific (Table 1.2) [1].

In children, “overweight, obesity, and at risk for overweight” are the terminologies for different levels of weight or BMI [8]. For adults, the currently used definitions of overweight and obesity are related to functional outcomes of mortality and morbidity and are based on fixed values of BMI, not varying by age or sex; in children, there are no risk-based fixed values of BMI used to determine overweight because it is unclear what risk-related criteria should be used.

A variety of reference data sets for BMI in childhood exist. One reference set of BMI values that has been widely used consists of sex-specific smoothed 85th and 95th percentiles for single year of age from 6 to 19 years based on data from the first NHANES I, 1971–1974, in the United States [9]. In 1995, a WHO Expert Committee recommended the use of these reference values [10].

TABLE 1.2
Sex-Specific Waist Circumferences for “Increased Risk” and “Substantially Increased Risk” of Metabolic Complications Associated with Obesity in Caucasians

	Risk of Obesity-Associated Metabolic Complications	
	Increased	Substantially Increased
Men	≥94 cm	≥102 cm
Women	≥80 cm	≥88 cm

Source: WHO, Obesity: Preventing and managing the global epidemic, Report of a WHO consultation on obesity, Technical Report Series, No. 894, World Health Organization, Geneva, Switzerland, 2000, p. 256.

Note: The figures are population specific, and the relative risk also depends on the levels of obesity (BMI) and other risk factors for CVD and NIDDM.

In 2000, Cole et al. [11] published a set of smoothed sex-specific BMI cutoff values based on six nationally representative data sets from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States. These values, often referred to as the IOTF cutoff values, represent cutoff points chosen as the percentiles that matched the adult cutoffs of BMI 25 and 30 at age 18 years. The IOTF cutoffs were not intended as clinical definitions and were not aimed at replacing the national reference data, but rather to provide a common set of definitions that researchers and policy makers in different countries could use for descriptive and comparative purposes internationally. The IOTF's

TABLE 1.3
All-Cause and Disease-Specific Cause
of Death from Several Epidemiological
Studies in Relation to BMI

Study and BMI Criteria (kg/m ²)	All-Cause Mortality ^a	
	Male	Female
<i>Nurses Health Study (age 30–55 years, with 16 years' follow-up)</i>		
19.0–21.9	—	2.46
22.0–24.9	—	2.46
25.0–26.9	—	2.61
27–28.9	—	3.35
29–31.9	—	3.90
>32	—	4.64
<i>British Regional Heart Study⁸ (age 40–59 years, with 13.8 years' follow-up)</i>		
20–21.9	12.6	—
22–23.9	11.5	—
24–25.9	11.8	—
26–27.9	11.8	—
28–29.9	13.3	—
>30	16.8	—
<i>Gothenburg Birth Cohort⁹ (age 47–55 years, with 19.7 years' follow-up)</i>		
20.0–22.5	15.5	—
22.5–25.0	13.9	—
25.0–27.5	14.3	—
27.5–30	16.6	—
>30	21.1	—
<i>Cancer Prevention Study II (age 65–74 years)¹⁰</i>		
22.0–23.4	8.54	4.98
23.5–24.9	8.98	5.95
25.0–26.4	9.41	5.98
26.5–27.9	10.38	6.36
28.0–29.9	12.70	7.96
30.0–31.9	13.70	8.36
32.0–34.9	17.98	11.11
>35.0	27.67	12.99

Source: Caterson, I.D. et al., *Circulation*, 110, e476, 2004.

^a Deaths/thousand patient-years.

international standard for analyzing childhood overweight and obesity data has been widely adopted, and it enables more realistic comparisons to be made between data from different countries.

However, we must still recognize that overweight and obesity are part of a continuum and that health risks increase with increasing weight in the individual.

It has been estimated that the costs of obesity account for up to 8% of the total health-care costs in Western countries, and they represent an enormous burden with regard to individual illness, disability, and early mortality as well as in terms of the costs to employers, tax payers, and society.

The mortality associated with excess weight increases as the degree of obesity and overweight increases. One study estimated that between 280,000 and 325,000 deaths annually in the United States could be attributed to overweight and obesity [12]. More than 80% of these deaths occur among people with a BMI > 30kg/m². The increase in deaths due to obesity has been documented in a number of studies from around the world (Table 1.3) [13–17].

PREVALENCE OF OBESITY IN THE ADULT POPULATION

It should be noted that it is often difficult to make a direct comparison of the prevalence of obesity between countries due to the inconsistent classifications used for obesity. This problem may be overcome with the adoption in future surveys of the WHO standardized classification for obesity.

From available data, the worldwide prevalence of obesity has been found to range from less than 5% in rural China, Japan, and some African countries to levels as high as 55% of the adult population in urban Samoa. Table 1.4 shows the prevalence estimates of overweight and obesity within the world in 2002 and projections for 2005 and 2010, by sex, in the adults aged 15 and over provided by the WHO in 2005 [18].

Obesity levels also vary depending on ethnic origin. In the United States, particularly among women, large differences exist in the prevalence of obesity among populations of different ethnic origins within the same country.

EUROPE

Obesity is relatively common in Europe, especially among women and in Southern and Eastern European countries. A marked trend toward increasing levels of adult overweight and obesity can be found throughout Europe, although prevalence rates differ. Data from WHO (2005) [18] suggest that the range of obesity prevalence in European countries in 2002 is 2.5%–26.2% for men and up to 33% for women. When judged on obesity alone, at least 21 European countries have female obesity rates above 20%, including Malta and Turkey (>30%).

The prevalence of obesity has increased by about 10%–40% in most of the European countries in the last decade. In France, obesity rose from 8.0% to 11.3% and from 8.4% to 11.4% in women and men, respectively, in self-reported survey conducted between 1997 and 2003. In the Netherlands, obesity rose gradually from 6.2% to 9.3% and from 4.9% to 8.5% in women and men, respectively, from the late 1970s to the mid-1990s. The most dramatic increase was recorded in the United Kingdom, where the obesity rate rose from 13.2% to 22.2% in men and from 16.4% to 23.0% in women respectively in just 10 years, up to 2003, this compared with an obesity rate of 6%–7% in 1980 [19].

Figure 1.2 shows the prevalence of adult obesity in Europe provided by the IOTF 2003 [20].

UNITED STATES

National survey data from the United States show that the prevalence of overweight and obesity among adults remained relatively constant over the 20 year period from 1960 to 1980. It began to increase around the mid-1980s, and the past 25 years have witnessed a dramatic increase. In 1985, only a few states participated in and provided obesity data to the Behavioral Risk Factor Surveillance System (BRFSS) of the Centers for Disease Control and Prevention (CDC). In 1991, four states reported obesity prevalence rates of 15%–19%, and no states had rates at or above 20%. In 2004, 7 states had

TABLE 1.4

Prevalence Estimates of Overweight and Obesity for 2002, and Projections for 2005 and 2010, by Sex, Adults Aged 15 and over, around the World

	Prevalence of Overweight Male			Prevalence of Overweight Female			Prevalence of Obesity Male %			Prevalence of Obesity Female %		
	2002	2005	2010	2002	2005	2010	2002	2005	2010	2002	2005	2010
<i>WHO African region</i>												
Angola	19.9	21.3	23.8	31.4	33.6	37.2	1.6	1.9	2.4	5.9	6.9	8.7
Benin	15.8	17.9	21.9	32.8	39.1	43.8	0.7	1.0	1.5	6.2	9.3	12.1
Botswana	35.5	37.8	41.6	46.9	49.4	53.5	4.6	5.4	6.9	12.9	14.6	17.7
Burkina Faso	10.6	12.1	15.1	15.8	16.0	19.4	0.3	0.4	0.6	1.1	1.1	1.7
Burundi	7.0	7.8	9.1	16.3	18.1	21.1	0.1	0.1	0.2	1.2	1.5	2.2
Cameroon	35.7	38.7	43.9	38.3	41.1	45.8	6.3	7.5	10.1	9.2	10.8	13.8
Cape Verde	30.5	32.4	35.6	41.8	44.1	48.0	4.0	4.6	5.8	11.0	12.5	15.1
Central African Republic	6.7	7.2	8.0	17.7	18.5	20.0	0.1	0.1	0.1	1.1	1.3	1.5
Chad	10.4	12.0	15.0	17.1	19.2	22.9	0.3	0.4	0.6	1.3	1.7	2.6
Comoros	17.7	20.0	24.3	33.1	35.9	40.7	0.9	1.2	1.9	5.8	7.1	9.6
Congo, Democratic Republic of	4.3	4.8	5.7	11.9	13.3	15.8	0.0	0.0	0.1	0.6	0.8	1.1
Congo, Republic of	12.0	12.7	13.8	24.2	25.2	26.8	0.4	0.4	0.5	2.7	3.0	3.5
Côte d'Ivoire	10.9	11.6	12.7	32.5	34.2	36.0	0.2	0.2	0.3	4.8	5.4	6.2
Djibouti	17.6	18.9	21.2	28.8	31.0	34.5	1.2	1.4	1.8	5.0	5.8	7.4
Equatorial Guinea	35.4	37.5	41.0	46.1	48.5	52.3	5.6	6.4	7.9	13.8	15.4	18.4
Eritrea	2.9	3.1	3.5	5.9	5.7	6.3	0.0	0.0	0.0	0.1	0.1	0.1
Ethiopia	7.4	7.8	8.6	3.1	3.3	3.7	0.1	0.2	0.2	0.0	0.0	0.0
Gabon	22.7	25.4	30.2	45.0	47.7	52.2	1.8	2.3	3.4	13.5	15.5	19.2
Gambia	9.0	10.3	12.8	20.5	22.8	27.0	0.2	0.3	0.5	1.9	2.5	3.6
Ghana	27.3	30.3	35.6	26.2	28.1	32.5	2.6	3.3	4.8	3.5	4.2	5.9
Guinea	14.5	16.5	20.3	27.8	30.4	34.9	0.6	0.8	1.3	4.2	5.2	7.1
Guinea-Bissau	10.5	11.4	12.9	20.3	22.1	25.1	0.4	0.5	0.6	2.4	2.8	3.7
Kenya	6.5	6.9	7.7	21.3	21.7	23.3	0.1	0.1	0.1	1.8	1.9	2.2
Lesotho	26.3	27.5	29.5	68.7	69.5	70.8	1.7	1.9	2.3	33.2	34.3	36.1
Liberia	27.8	29.6	32.7	39.2	41.6	45.4	3.3	3.8	4.8	9.6	11.0	13.4

Madagascar	12.9	14.5	17.5	18.1	20.2	24.1	0.7	1.0	1.5	1.5	1.9	2.9	
Malawi	14.3	15.1	16.4	21.6	23.5	25.2	0.6	0.7	0.8	1.6	2.0	2.4	
Mali	12.8	14.6	18.1	26.1	33.6	38.4	0.4	0.6	1.0	3.4	6.2	8.4	
Mauritania	27.5	30.4	35.4	52.2	54.6	58.6	2.9	3.7	5.3	20.6	22.9	26.9	
Mozambique	8.7	9.3	10.3	24.3	25.3	26.9	0.1	0.2	0.2	2.7	3.0	3.4	
Namibia	11.6	12.3	13.5	31.5	32.6	34.4	0.2	0.3	0.4	4.9	5.3	6.1	
Niger	12.1	13.9	17.2	19.6	21.3	25.1	0.4	0.6	0.9	1.9	2.3	3.4	
Nigeria	19.6	21.9	26.0	29.6	32.2	36.8	1.6	2.0	3.0	4.9	6.0	8.1	
Rwanda	6.8	7.3	8.1	19.2	20.1	21.7	0.1	0.1	0.1	1.2	1.3	1.6	
Sao Tome and Principe	14.4	15.5	17.5	25.2	27.2	30.5	0.8	0.9	1.2	3.7	4.4	5.7	
Senegal	14.4	16.1	19.2	34.1	36.7	41.0	1.0	1.3	2.0	7.8	9.2	11.8	
Seychelles	55.1	58.5	63.8	68.6	70.7	73.8	14.2	16.7	21.3	35.8	38.6	43.2	
Sierra Leone	20.2	22.4	26.3	41.6	44.5	49.1	1.9	2.4	3.5	10.9	12.7	16.0	
Somalia	9.8	10.6	12.1	19.3	21.1	24.0	0.3	0.4	0.6	2.1	2.6	3.4	
South Africa	38.2	39.3	41.3	66.4	67.2	68.5	6.2	6.7	7.6	34.3	35.2	36.8	
Sudan	16.0	17.2	19.3	27.0	29.1	32.5	1.0	1.2	1.5	4.3	5.1	6.5	
Swaziland	33.6	35.8	39.5	45.2	47.8	51.9	4.0	4.7	6.1	11.8	13.5	16.5	
Tanzania, United Republic of	14.7	15.4	16.8	26.0	27.0	28.7	0.6	0.7	0.8	2.8	3.1	3.6	
Togo	15.0	17.1	20.9	28.3	30.9	35.5	0.6	0.9	1.4	4.3	5.3	7.3	
Uganda	6.9	7.4	8.2	20.1	22.2	23.9	0.1	0.1	0.1	1.3	1.6	1.9	
Zambia	7.0	7.5	8.3	20.2	18.6	20.0	0.1	0.1	0.1	1.6	1.3	1.5	
Zimbabwe	14.5	15.3	16.7	47.2	48.9	50.6	0.5	0.6	0.8	14.1	15.3	16.7	
<i>WHO Eastern Mediterranean and Middle East region</i>													
Afghanistan	11.2	12.7	15.6	15.6	17.4	20.8	0.3	0.5	0.7	1.1	1.4	2.1	
Algeria	32.1	34.1	37.4	43.2	45.6	49.4	4.5	5.2	6.4	11.9	13.4	16.2	
Armenia	53.9	53.9	53.9	52.8	52.8	52.8	12.1	12.1	12.1	19.8	19.8	19.8	
Bahrain	60.9	60.9	60.9	66.0	67.3	69.5	21.2	21.2	21.2	33.5	35.2	37.9	
Brunei Darussalam	55.3	56.4	58.1	61.9	63.2	65.2	14.4	15.2	16.6	25.9	27.4	29.7	
Egypt	64.5	64.5	64.5	69.7	74.2	76.0	22.0	22.0	22.0	39.3	45.5	48.0	
Iran, Islamic Republic of	47.3	48.5	48.5	55.7	57.8	60.2	9.4	10.0	10.0	25.0	27.0	29.5	
Iraq	38.7	40.1	42.4	49.0	50.8	53.6	6.6	7.2	8.3	15.5	16.8	19.1	
Jordan	57.5	57.5	57.5	67.3	63.4	65.4	19.6	19.6	19.6	40.2	35.6	37.9	
Kuwait	69.5	69.5	69.5	76.6	79.0	80.4	29.6	29.6	29.6	49.2	52.9	55.2	
Lebanon	51.7	51.7	51.7	52.9	54.3	56.7	14.9	14.9	14.9	23.9	25.2	27.4	

(continued)

TABLE 1.4 (continued)

Prevalence Estimates of Overweight and Obesity for 2002, and Projections for 2005 and 2010, by Sex, Adults Aged 15 and over, around the World

	Prevalence of Overweight Male			Prevalence of Overweight Female			Prevalence of Obesity Male %			Prevalence of Obesity Female %		
	2002	2005	2010	2002	2005	2010	2002	2005	2010	2002	2005	2010
Libyan Arab Jamahiriya	47.6	48.8	50.8	56.0	57.5	59.8	10.7	11.4	12.7	21.1	22.5	24.9
Morocco	31.1	31.1	31.1	53.0	54.7	57.5	3.7	3.7	3.7	19.0	20.5	23.1
Oman	43.4	43.4	43.4	46.0	47.8	50.8	7.7	7.7	7.7	13.5	14.8	17.0
Pakistan	16.7	18.8	22.8	23.2	25.5	29.5	0.8	1.0	1.6	2.9	3.6	5.0
Qatar	56.9	57.9	59.5	62.9	64.1	65.9	16.6	17.4	18.7	27.9	29.3	31.6
Saudi Arabia	62.4	63.1	63.1	63.0	63.8	65.9	22.3	23.0	23.0	32.8	33.8	36.4
Syrian Arab Republic	47.2	48.4	50.4	55.7	57.2	59.6	10.5	11.2	12.4	20.8	22.2	24.6
Tunisia	42.8	42.8	42.8	57.9	59.2	61.4	7.7	7.7	7.7	28.8	30.2	32.6
United Arab Emirates	66.9	66.9	66.9	68.4	69.6	71.6	24.5	24.5	24.5	37.9	39.4	42.0
Yemen	24.6	24.6	24.6	27.8	29.4	32.2	2.0	2.0	2.0	4.4	5.1	6.2
<i>WHO European region</i>												
Albania	57.2	57.2	57.2	52.5	52.5	52.5	18.6	18.6	18.6	23.8	23.8	23.8
Andorra	59.8	60.9	62.5	65.5	66.8	68.7	14.9	15.8	17.1	27.3	28.8	31.2
Austria	59.0	61.0	62.9	53.4	53.2	55.2	19.5	21.3	23.1	20.4	20.3	21.8
Azerbaijan	57.4	57.4	57.4	56.8	56.8	56.8	15.4	15.4	15.4	24.9	24.9	24.9
Belarus	63.7	63.7	63.7	69.9	69.9	69.9	16.2	16.2	16.2	32.2	32.2	32.2
Belgium	49.0	51.9	54.1	40.7	40.7	42.9	11.4	13.3	14.8	9.5	9.5	10.7
Bosnia and Herzegovina	56.6	56.6	56.6	51.0	51.0	51.0	13.8	13.8	13.8	21.5	21.5	21.5
Bulgaria	62.8	62.8	62.8	45.5	45.5	45.5	17.0	17.0	17.0	19.0	19.0	19.0
Croatia	60.0	61.3	63.5	45.3	46.4	48.3	17.1	18.2	20.1	15.4	16.2	17.6
Cyprus	50.4	51.7	53.9	59.0	60.6	63.0	9.4	10.1	11.4	20.7	22.2	24.7
Czech Republic	56.7	58.1	60.1	47.0	47.8	49.3	17.4	18.5	20.2	20.0	20.7	22.1
Denmark	50.7	52.5	55.0	37.5	39.1	41.4	9.6	10.6	12.0	6.4	7.1	8.3
Estonia	50.7	50.7	50.7	33.8	33.8	33.8	8.6	8.6	8.6	8.4	8.4	8.4
Finland	63.8	64.9	67.1	52.0	52.4	54.5	18.0	18.9	20.9	17.5	17.8	19.4

France	44.1	45.6	48.0	33.4	34.7	36.9	7.2	7.8	9.0	6.1	6.6	7.6
Georgia	37.4	38.9	41.5	48.9	50.8	53.8	4.7	5.2	6.1	13.4	14.7	17.1
Germany	63.7	65.1	67.2	53.6	55.1	57.1	19.7	20.9	22.9	19.2	20.4	22.1
Greece	74.6	75.7	77.5	60.1	61.3	63.2	26.2	27.7	30.3	23.4	24.5	26.4
Hungary	55.9	55.9	55.9	47.4	47.4	47.4	15.8	15.8	15.8	16.1	16.1	16.1
Iceland	57.7	59.0	61.2	60.5	61.7	63.7	15.7	16.7	18.5	22.0	23.2	25.3
Ireland	50.0	51.5	53.9	40.3	41.7	43.9	9.5	10.3	11.7	8.4	9.1	10.4
Israel	55.9	57.2	59.4	56.3	57.5	59.3	15.2	16.2	17.9	23.3	24.3	25.9
Italy	51.9	52.7	55.0	37.8	38.3	40.0	12.2	12.9	14.4	12.2	12.6	13.7
Kazakhstan	43.9	43.9	43.9	41.9	38.9	38.9	7.9	7.9	7.9	13.1	11.0	11.0
Kyrgyzstan	34.5	34.5	34.5	43.9	43.9	43.9	5.0	5.0	5.0	14.2	14.2	14.2
Latvia	49.9	49.9	49.9	44.7	44.7	44.7	9.7	9.7	9.7	15.0	15.0	15.0
Lithuania	62.3	62.3	62.3	43.9	43.9	43.9	16.8	16.8	16.8	13.9	13.9	13.9
Luxembourg	53.0	54.4	56.9	52.6	54.0	56.2	11.2	12.1	13.6	15.0	16.0	17.8
Macedonia, FYR	37.1	37.1	37.1	57.4	57.4	57.4	5.9	5.9	5.9	24.3	24.3	24.3
Malta	70.2	71.4	73.3	65.1	66.1	67.6	24.6	25.9	28.1	33.8	34.8	36.5
Moldova, Republic of	33.3	34.8	37.5	45.4	47.4	50.7	3.5	4.0	4.8	11.2	12.5	14.8
Monaco	58.0	59.1	60.9	64.3	65.6	67.6	13.7	14.5	15.9	26.0	27.5	29.9
Netherlands	46.7	48.0	50.2	42.6	44.0	46.1	9.6	10.4	11.7	10.7	11.5	12.9
Norway	53.3	54.8	57.2	42.0	43.4	45.8	10.4	11.3	12.8	8.6	9.3	10.7
Poland	50.7	50.7	50.7	44.3	44.3	44.3	12.9	12.9	12.9	18.0	18.0	18.0
Portugal	55.5	58.5	60.9	47.6	49.2	51.2	13.1	13.7	15.5	14.6	16.1	17.7
Romania	37.7	37.7	37.7	40.6	40.6	40.6	5.5	5.5	5.5	12.0	12.0	12.0
Russian Federation	46.5	46.5	46.5	51.7	51.7	51.7	9.6	9.6	9.6	23.6	23.6	23.6
San Marino	57.6	58.8	60.5	64.1	65.4	67.4	13.5	14.3	15.7	25.7	27.2	29.7
Serbia and Montenegro	61.2	61.2	61.2	48.5	48.5	48.5	17.7	17.7	17.7	20.6	20.6	20.6
Slovakia	50.7	52.0	54.0	59.1	60.6	62.9	10.1	10.8	12.0	21.3	22.8	25.3
Slovenia	54.8	56.0	57.9	62.1	63.5	65.7	11.8	12.5	13.9	23.7	25.2	27.6
Spain	55.7	55.8	57.9	45.7	47.7	49.8	15.6	15.6	17.3	14.5	15.8	17.3
Sweden	51.7	54.5	57.0	43.3	44.9	47.2	10.1	11.8	13.3	10.0	10.9	12.4
Switzerland	52.4	54.1	56.5	53.8	56.7	58.9	11.4	12.4	13.9	16.4	18.7	20.6
Tajikistan	29.2	30.8	33.5	41.8	43.9	47.4	2.5	2.9	3.6	9.2	10.4	12.6
Turkey	47.9	47.9	47.9	65.4	65.7	65.7	10.8	10.8	10.8	32.1	32.5	32.5

(continued)

TABLE 1.4 (continued)

Prevalence Estimates of Overweight and Obesity for 2002, and Projections for 2005 and 2010, by Sex, Adults Aged 15 and over, around the World

	Prevalence of Overweight Male			Prevalence of Overweight Female			Prevalence of Obesity Male %			Prevalence of Obesity Female %		
	2002	2005	2010	2002	2005	2010	2002	2005	2010	2002	2005	2010
Turkmenistan	48.1	48.1	48.1	45.5	45.5	45.5	9.3	9.3	9.3	15.0	15.0	15.0
Ukraine	41.2	41.2	41.2	48.5	48.5	48.5	7.4	7.4	7.4	19.4	19.4	19.4
United Kingdom	62.5	65.7	67.8	58.8	61.9	63.8	18.7	21.6	23.7	21.3	24.2	26.3
Uzbekistan	42.0	42.0	42.0	44.3	49.9	49.9	7.1	7.1	7.1	13.5	17.6	17.6
<i>WHO North American region</i>												
Antigua and Barbuda	50.0	51.2	53.2	58.3	59.8	62.1	10.4	11.2	12.4	21.5	22.9	25.3
Bahamas	55.9	57.0	58.7	62.5	63.8	65.9	13.9	14.7	16.0	25.6	27.1	29.5
Barbados	55.5	59.2	65.1	77.8	80.1	83.3	14.1	16.8	22.0	46.7	50.8	57.2
Belize	43.3	44.7	47.0	53.3	54.9	57.6	7.3	7.9	9.0	17.2	18.6	21.0
Canada	64.5	65.1	66.9	55.9	57.1	59.5	23.1	23.7	25.5	22.2	23.2	25.7
Dominica	61.5	65.1	70.8	74.4	77.1	80.8	16.9	20.0	25.8	41.8	46.0	52.6
Grenada	47.4	48.7	50.8	56.4	58.0	60.4	9.1	9.8	11.0	19.8	21.2	23.6
Guyana	40.6	42.1	44.4	51.2	52.9	55.8	6.3	6.8	7.9	15.6	17.0	19.4
Haiti	13.0	15.1	19.0	39.8	50.6	57.7	0.5	0.7	1.3	8.2	15.0	21.1
Jamaica	36.0	40.0	46.8	71.8	74.7	79.0	3.8	5.1	7.7	36.4	41.0	48.3
Mexico	64.6	68.4	73.6	65.6	67.9	73.0	20.3	24.0	30.1	31.6	34.3	41.0
Saint Kitts and Nevis	50.7	52.0	53.9	58.9	60.3	62.6	10.8	11.6	12.8	22.0	23.4	25.8
Saint Lucia	41.3	45.5	52.5	65.7	69.1	74.1	5.0	6.6	9.8	30.5	34.7	41.7
Saint Vincent and the Grenadines	44.3	45.6	47.9	54.0	55.7	58.3	7.7	8.4	9.5	17.8	19.2	21.6
Trinidad and Tobago	54.8	58.9	65.2	74.4	77.0	80.8	11.3	14.0	19.1	41.9	46.1	52.7
United States of America	72.2	75.6	80.5	69.8	72.6	76.7	32.0	36.5	44.2	37.8	41.8	48.3
<i>WHO South and Central American region</i>												
Argentina	70.1	73.1	77.7	62.1	65.7	71.2	28.0	31.4	37.4	27.1	31.0	37.8
Bolivia	52.5	56.3	62.4	64.4	68.0	73.2	12.2	14.7	19.4	28.8	33.1	40.2
Brazil	43.4	47.4	54.0	49.2	53.5	60.3	6.9	8.7	12.4	15.0	18.3	24.5
Chile	58.9	62.6	68.4	64.4	68.0	73.3	16.1	19.0	24.3	27.2	31.6	39.1

Colombia	52.7	56.5	62.6	55.1	54.6	61.1	12.4	14.9	19.6	20.3	19.9	26.1
Costa Rica	49.8	53.9	60.1	56.2	57.8	63.8	10.6	13.0	17.5	22.7	24.2	30.5
Cuba	55.2	59.2	65.4	57.0	61.1	67.2	12.3	14.9	20.1	20.7	24.6	31.5
Dominican Republic	42.5	46.6	53.4	62.8	66.4	71.7	6.0	7.7	11.2	27.8	31.8	38.7
Ecuador	40.2	41.7	44.0	50.9	52.6	55.5	6.1	6.7	7.7	15.4	16.7	19.1
El Salvador	42.1	43.5	45.8	52.3	54.0	56.8	6.8	7.4	8.5	16.5	17.8	20.2
Guatemala	53.2	56.9	62.9	61.1	65.4	70.9	13.1	15.7	20.5	25.0	29.7	36.8
Honduras	36.2	37.6	40.1	47.5	49.4	52.5	4.7	5.2	6.2	13.1	14.4	16.7
Nicaragua	48.9	52.9	59.4	62.9	68.1	73.1	9.3	11.5	15.9	28.3	34.3	41.1
Panama	45.2	46.5	48.7	54.7	56.3	58.9	8.1	8.8	9.9	18.3	19.8	22.2
Paraguay	40.9	42.3	44.7	51.4	53.2	56.0	6.4	7.0	8.0	15.8	17.2	19.6
Peru	50.8	54.6	60.9	62.7	64.7	70.1	10.8	13.2	17.7	28.9	31.1	37.7
Suriname	41.0	42.4	44.8	51.5	53.2	56.1	6.4	7.0	8.1	15.8	17.2	19.6
Uruguay	60.0	63.6	69.3	54.1	58.1	64.4	17.1	20.1	25.7	19.6	23.3	29.8
Venezuela	65.6	69.1	74.4	57.5	61.4	67.3	19.7	23.2	29.5	22.4	26.2	33.0
<i>WHO Southeast Asian region</i>												
Bangladesh	5.9	6.7	8.4	4.3	5.4	6.7	0.1	0.1	0.2	0.1	0.2	0.2
Bhutan	34.0	35.3	37.7	44.7	46.5	49.6	5.3	5.8	6.7	13.1	14.3	16.5
India	15.0	16.8	20.1	13.7	15.2	18.1	0.9	1.1	1.7	1.1	1.4	2.0
Maldives	29.7	32.3	36.6	45.7	47.6	50.8	4.7	5.7	7.7	20.2	22.0	25.0
Mauritius	35.6	39.0	44.8	49.5	52.3	56.8	4.5	5.6	8.0	16.1	18.3	22.3
Nepal	7.7	8.8	11.0	8.0	8.0	9.9	0.1	0.2	0.3	0.2	0.2	0.3
Sri Lanka	8.8	8.9	9.1	5.0	5.9	7.9	0.2	0.2	0.2	0.1	0.1	0.2
<i>WHO Western Pacific region</i>												
Australia	69.7	72.1	75.7	60.2	62.7	66.5	21.2	23.8	28.4	22.5	24.9	29.1
Cambodia	9.6	13.3	21.4	7.1	9.3	13.8	0.1	0.2	0.5	0.1	0.1	0.4
China	27.5	33.1	45.0	22.7	24.7	32.0	1.0	1.6	4.1	1.5	1.9	3.6
Cook Islands	92.0	92.6	93.4	88.5	89.2	90.3	67.9	69.5	72.1	69.0	70.8	73.4
Fiji	42.7	43.9	47.5	63.4	65.6	69.5	7.8	8.7	10.7	29.8	32.5	37.1
Indonesia	9.6	9.7	9.9	20.3	22.7	27.1	0.2	0.2	0.2	2.0	2.6	3.9
Japan	25.3	27.0	29.8	18.6	18.1	16.2	1.5	1.8	2.3	1.5	1.5	1.1
Kiribati	71.4	73.2	76.1	71.9	73.9	77.1	27.6	29.8	33.6	37.9	41.0	46.1
Korea, Democratic People's Republic of	31.0	32.7	35.5	44.0	46.2	49.7	2.4	2.7	3.4	9.5	10.7	12.9
Korea, Republic of	32.8	40.2	51.5	38.2	43.8	51.0	2.3	4.1	8.3	7.2	10.1	14.6

(continued)

TABLE 1.4 (continued)

Prevalence Estimates of Overweight and Obesity for 2002, and Projections for 2005 and 2010, by Sex, Adults Aged 15 and over, around the World

	Prevalence of Overweight Male			Prevalence of Overweight Female			Prevalence of Obesity Male %			Prevalence of Obesity Female %		
	2002	2005	2010	2002	2005	2010	2002	2005	2010	2002	2005	2010
Lao People's Democratic Republic	30.4	32.1	34.9	43.5	45.6	49.2	2.3	2.6	3.3	9.2	10.4	12.6
Malaysia	22.5	22.7	23.0	34.2	37.2	42.2	1.6	1.6	1.7	6.8	8.2	11.0
Marshall Islands	39.1	40.6	43.0	50.0	51.8	54.7	5.7	6.3	7.3	14.8	16.1	18.5
Micronesia, Federated States of	91.5	92.1	93.1	89.5	90.1	91.1	64.3	66.2	69.1	71.3	72.9	75.3
Mongolia	46.0	53.0	64.1	65.8	69.3	74.4	5.2	7.9	14.5	24.6	29.0	36.6
Myanmar	27.8	29.4	32.3	41.1	43.3	47.0	1.8	2.1	2.7	8.0	9.1	11.3
Nauru	96.3	96.5	96.9	92.0	92.4	93.0	82.3	83.2	84.6	77.7	78.8	80.5
New Zealand	65.2	68.7	73.9	64.0	68.2	74.2	19.7	23.0	28.9	26.7	31.5	39.9
Niue	76.9	78.5	80.9	83.8	85.0	86.7	34.4	36.8	40.7	58.6	61.0	64.7
Palau	72.7	74.5	77.2	81.0	82.4	84.5	29.0	31.2	35.0	52.2	55.0	59.4
Papua New Guinea	29.2	31.5	35.3	26.1	29.0	34.0	2.0	2.5	3.4	3.2	4.2	6.1
Philippines	21.7	21.9	22.2	25.4	28.5	33.6	1.1	1.1	1.1	2.8	3.7	5.5
Samoa	77.2	78.7	81.1	80.7	82.1	84.1	36.2	38.4	42.2	55.0	57.3	60.9
Singapore	23.6	23.8	24.1	20.7	22.0	26.7	1.3	1.3	1.4	1.6	1.8	2.9
Solomon Islands	36.8	38.2	40.7	48.0	49.9	52.9	4.9	5.4	6.4	13.4	14.7	17.1
Thailand	27.7	27.9	28.3	32.5	35.2	39.9	2.5	2.5	2.6	7.0	8.4	11.1
Timor-Leste, Democratic Republic of	35.9	37.2	39.5	46.4	48.2	51.1	6.0	6.5	7.5	14.2	15.4	17.7
Tonga	89.5	90.3	91.4	90.9	91.4	92.1	58.7	60.7	64.0	74.8	76.1	78.1
Tuvalu	51.2	52.5	54.4	59.2	60.7	62.9	11.1	11.9	13.1	22.3	23.8	26.2
Vanuatu	54.0	56.3	60.2	60.1	62.9	67.2	11.9	13.4	16.2	23.4	26.3	31.4
Vietnam	2.7	4.1	7.5	7.0	8.7	12.2	0.0	0.0	0.0	0.2	0.3	0.7

Source: British Health Foundation Statistics website, Prevalence estimates of overweight and obesity for 2002, and projections for 2005 and 2010, by sex, adults aged 15 and over, the world. From The SuRF Report 2, Surveillance of chronic risk factors: Country-level data and comparable estimates, pp. 66–72, 73–79, 2005 WHO, Geneva, Switzerland, January 29, 2009, <http://www.heartstats.org> and <https://apps.who.int/infobase/publicfiles/SuRF2.pdf>

Notes: Values are age standardized to the WHO Standard Population. Overweight is defined as BMI \geq 25 kg/m². Obese is defined as BMI \geq 30 kg/m². Estimates for 2005 and 2010 are projections only.

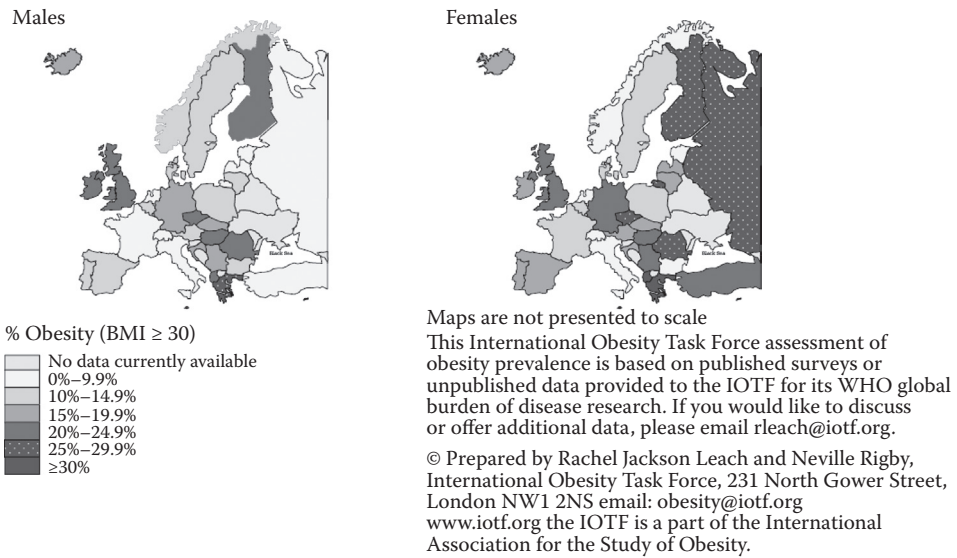


FIGURE 1.2 Prevalence of adult obesity in Europe (BMI ≥ 30 kg/m²). (From Rigby, N. and James, P., Waiting for a green light for health? Europe at the crossroads for diet and disease, IOTF Position Paper, International Obesity Task Force, London, U.K., 2003, <http://www.iotf.org/media/euobesity2.pdf>, accessed on November 24, 2011.)

obesity prevalence rates of 15%–19%, 33 states had rates of 20%–24%, and 9 states had rates higher than 25% (no data for one state). A IOTF report [19] shows that obesity stands at 28% in men and 34% in women, although this rate rises to as high as 50% among black women and includes a very significant component of morbid obesity. The data shown in Figure 1.3 [21] were collected through the CDC’s BRFSS. Each year, state health departments use standard procedures to collect data through a series of monthly telephone interviews with U.S. adults.

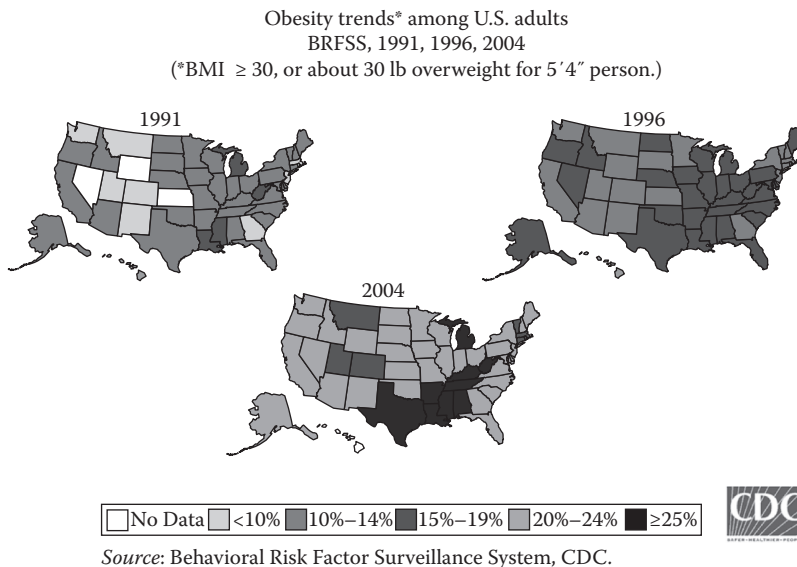


FIGURE 1.3 Trends in U.S. adults obesity from 1991 to 2004. (From CDC, Overweight and Obesity: Obesity Trends: U.S. Obesity trends 1985–2004, Centers for Disease Control and Prevention, Washington, DC, 2005, <http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/index.htm>).

TABLE 1.5
Age-Adjusted Prevalence of Overweight, Obesity, and Extreme Obesity among U.S. Adults Aged 20–74

Sample Size and Weight Status	NHANES I 1960–1962	NHANES I 1971–1974	NHANES II 1976–1980	NHANES III 1988–1994	NHANES 1999–2000	NHANES 2001–2002	NHANES 2003–2004	NHANES 2005–2006	NHANES 2007–2008
Sample (n)	6,126	12,911	11,765	14,468	3,603	3,916	3,756	3,835	4,881
Overweight ($25 \leq \text{BMI} < 30$)	31.5	32.3	32.1	32.7	33.6	34.4	33.4	32.2	33.6
Obese ($\text{BMI} \geq 30$)	13.4	14.5	15.0	23.2	30.9	31.3	32.9	35.1	34.3
Extremely obese ($\text{BMI} \geq 40$)	0.9	1.3	1.4	3.0	5.0	5.4	5.1	6.2	6.0

Source: Ogden, C.L. and Carroll, M.D., Prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1976–1980 through 2007–2008, http://www.cdc.gov/nchs/data/hestat/obesity_adult_07_08/obesity_adult_07_08.hm, (accessed on November 24, 2011).

Notes: NHES is National Health Examination Survey, NHANES is National Health and Nutrition Examination Survey, and BMI is body mass index. Age adjusted by the direct method to the year 2000 U.S. Census Bureau estimates using the age groups 20–39, 40–59, and 60–74 years. NHES included adults aged 18–79, and NHANES I and II did not include individuals over age 74, so trend estimates are based on ages 20–74. Pregnant females were excluded from the analysis.

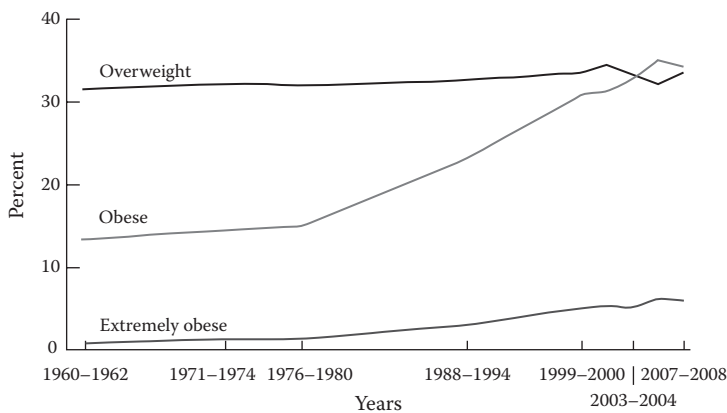
Prevalence estimates generated for the maps may vary slightly from those generated for the states by the BRFSS, as slightly different analytic methods are used.

Results from the 2007–2008 National Health and Nutrition Examination Survey (NHANES), using measured heights and weights, indicate that an estimated 34.2% of U.S. adults aged 20 years and over are overweight, 33.8% are obese, and 5.7% are extremely obese [22].

The NHANES 2007–2008 data for adults aged 20 years and over suggest an increase in obesity between the late 1980s and today in the United States, with the estimated age-adjusted prevalence moving upward from a previous level of 23% in NHANES III (1988–1994) to approximately 34% in 2007–2008 [22]. Among women, however, there was no significant change between 1999–2000 and 2007–2008. Among men, there was a significant linear increase between 1999–2000 and 2007–2008, but no change between 2003–2004 and 2007–2008. It is possible to examine trends since 1960 among adults aged 20–74. These estimates are shown in Table 1.5 and Figure 1.4 [22]. Although the prevalence of obesity more than doubled between 1976–1980 and 2007–2008, the prevalence of overweight remained stable during the same period.

A recent study [23] that analyzes BMI values among U.S. adults in 1999–2000 and 2007–2008 shows that, for both men and women, the estimated median BMI (50th percentile) tended to be slightly higher in 2007–2008 than in 1999–2000 within all age groups; however, some of the differences were extremely small. In 1999–2000, the median BMI for men aged 20–39 years was 26.0 vs. 26.6 in 2007–2008 and for women 25.6 vs. 26.5; for men aged 40–59 years, 27.4 vs. 28.3 and for women 27.6 vs. 27.7; and finally for men aged 60 years or older, 27.5 vs. 28.3 and for women 27.4 vs. 27.6.

It must be noted that overweight and obesity in the United States occur at higher rates among racial or ethnic minority populations such as African Americans and Hispanic Americans, compared with Caucasian Americans. Asian Americans have a relatively low prevalence for obesity. Women and persons of low socioeconomic status within minority populations appear to be particularly affected by overweight and obesity. Cultural factors that influence dietary and exercise behaviors are reported to play a major role in the development of excess weight in minority groups [24].



Note: Age-adjusted by the direct method to the year 2000 U.S. Census Bureau estimates, using the age groups 20–39, 40–59, and 60–74 years. Pregnant females were excluded. Overweight is defined as a body mass index (BMI) of 25 or greater but less than 30; obesity is a BMI greater than or equal to 30; extreme obesity is a BMI greater than or equal to 40.

Source: CDC/NCHS, National Health Examination Survey cycle I (1960–1962); National Health and Nutrition Examination Survey I (1971–1974), II (1976–1980), and III (1988–1994), 1999–2000, 2001–2002, 2003–2004, 2005–2006, and 2007–2008.

FIGURE 1.4 Trends in overweight, obesity, and extreme obesity among adults aged 20–74 years: the United States 1960–2008. (From Ogden, C.L. and Carroll, M.D., Prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1976–1980 through 2007–2008, http://www.cdc.gov/nchs/data/hestat/obesity_adult_07_08/obesity_adult_07_08.hm, accessed on November 24, 2011.)

TABLE 1.6
Prevalence of Obesity among U.S. Adults Aged 20 and over, by Sex and Race/Ethnicity, for Selected Years 1988–1994 through 2007–2008

Characteristic	NHANES 1988–1994	NHANES 1999–2000	NHANES 2001–2002	NHANES 2003–2004	NHANES 2005–2006	NHANES 2007–2008
Men, all	20.2	27.5	27.8	31.1	33.3	32.2
Men, non-Hispanic white	20.3	27.3	29.1	31.1	33.1	31.9
Men, non-Hispanic black	21.1	28.1	27.9	34.0	37.2	37.3
Men, Mexican American	23.9	28.9	25.9	31.6	27.0	35.9
Women ^a , all	25.4	33.4	33.3	33.2	35.3	35.5
Women ^a , non-Hispanic white	22.9	30.1	31.3	30.2	32.9	33.0
Women ^a , non-Hispanic black	38.2	49.7	48.3	53.9	52.9	49.6
Women ^a , Mexican American	35.3	39.7	37.0	42.3	42.1	45.1

Source: Ogden, C.L. and Carroll, M.D., Prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1976–1980 through 2007–2008, http://www.cdc.gov/nchs/data/hestat/obesity_adult_07_08/obesity_adult_07_08.htm, (accessed on November 24, 2011).

Notes: NHANES is National Health and Nutrition Examination Survey. Age adjusted by the direct method to the year 2000 U.S. Census Bureau estimates using the age groups 20–39, 40–59, and 60 years and over. Obesity is defined as having a BMI greater than or equal to 30.

^a Excludes pregnant females.

The prevalence of overweight and obesity increased over the last years among the various racial and ethnic groups. Table 1.6 [22] shows the estimates in obesity prevalence by race or ethnicity for men and women since NHANES III (1988–1994).

Between 1988–1994 and 2007–2008, the prevalence of obesity among men increased from 20.3% to 31.9% among non-Hispanic white men, from 21.1% to 37.3% among non-Hispanic black men, and from 23.9% to 35.9% among Mexican American men.

Among women in 2007–2008, non-Hispanic black women were significantly more likely to be obese (49.6%) than non-Hispanic white women (33.0%). Similarly, Mexican American women were more likely to be obese (45.1%) than non-Hispanic white women (33.0%). Similar disparities existed in 1988–1994 (22.9% of non-Hispanic white women, 38.3% of non-Hispanic black women, and 35.3% of Mexican American women were obese).

The American Indian population also has high prevalence rates of overweight (where overweight is defined as a BMI of ≥ 27.8 for men and ≥ 27.3 for women). The highest rates for American Indians are 80% for women and 67% for men in Arizona, according to researchers of the 1995 Strong Heart Study.

The prevalence of overweight, obesity, and severe obesity (BMI of 40 or more) has increased for both men and women in the various racial and ethnic groups in the United States over the last decade [24].

LATIN AMERICA AND CARIBBEAN

Evidence of the impact of the nutrition transition is clear in the growing levels of obesity throughout this region. Obesity rates are reported to vary for men from about 7% in El Salvador and Brazil to 28% in Argentina, but among women, rates rise as high as 29% in Bolivia and Peru (Table 1.4).

Obesity is a significant problem in the Caribbean and affects women more than men. Abdominal obesity, using WHO waist circumference limits, ranged from 3% of men in St. Lucia to 8% in Barbados, but among women was found to be as high as 34% in Jamaica, 41% in St. Lucia, and 45% in Barbados [25].

In Brazil, the problem of dietary deficit appears to be rapidly shifting to one of dietary excess [4]. Obesity is rising, especially among lower-income groups.

AFRICA

In contrast to most Western countries, the emphasis in Africa has been on undernutrition and food security rather than overweight and obesity. Regional studies, however, do indicate a growing prevalence of overweight and obesity in certain socioeconomic groups.

Women show prevalence rates of obesity higher than men. In 2002, prevalence value of 33.2% was observed in Lesotho, 35.8% in Seychelles, and 34.3% in South Africa (Table 1.4).

Wide disparities in levels of obesity can be found. In South Africa, where mean BMI values for men and women are 22.9 and 27.1 kg/m², respectively, overweight rate in women is 66.4% and levels of central obesity have been assessed at 42% [26]. The South African Health Review 2000 indicated obesity rates from 8% among black men to 20% among Caucasian men, but among women, the rates ranged from 20% for Indian/Asians women to 30.5% for black women.

From the 1960s until the 1980s, the notion of “healthy” or “benign” obesity was propagated in South Africa. Not surprisingly, this led to ignorance around the problem of obesity, and the treatment of some of the comorbid diseases was neglected. Fortunately, as an increasing number of seminal studies draw us closer to reality, the misperception of benign obesity is being corrected [27].

In North Africa the prevalence of overweight among women is high (Table 1.4). Half of all women are overweight (BMI > 25), with rates of 57.9% in Tunisia and 53.0% in Morocco, and obesity rates (BMI > 30) of 28.8% in Tunisia and 19.0% in Morocco are found, a threefold increase over 20 years [28]. High rates of overweight among women were also observed in Botswana (46.9%), Equatorial Guinea (46.1%), Gabon (45.0%), Lesotho (68.7%), Mauritania (52.2%), and Seychelles (68.6%). In parts of sub-Saharan Africa, obesity often exists alongside undernutrition [29].

JAPAN, CHINA, AND WESTERN PACIFIC COUNTRIES

In Japan, obesity in men has doubled since 1982, whereas its rise in women has been restricted to the younger age group (20–29 years) for which it has increased 1.8 times since 1976 [4]. Using the obesity cutoff at BMI > 25 as standard, adult obesity in Japan would average 25%, rising to 30% in men over 30 years old, and in women over 40 years old, thus representing a three- to fourfold increase over the last 40 years [30].

In the Chinese population [31], it has long been suggested that the BMI-based definition for obesity should be lower than that for European or North American populations [32], where obesity is defined as a BMI of 30 kg/m² or greater. The reason for this [33] is because obesity-associated metabolic complications occur at lower BMIs in Chinese people compared to Europeans/North Americans. Overall, the consensus is that BMI cutoffs for obesity should be lower in China whereby overweight was defined as BMI of 24–27.9 kg/m² and obesity was defined as BMI > 28 kg/m² [34,35].

Obesity is increasing in China and is more common in urban areas and among women. One out of five persons with obesity in the world is Chinese [36].

Between 1992 and 2002, the prevalence of overweight and obesity increased in all genders and age groups and in all geographic areas. The Chinese obesity standard shows an increase from 20.0% to 29.9%. The annual increase rate was highest in men aged 18–44 years and women aged 45–59 years (approximately 1.6% and 1.0% points, respectively). In general, male subjects, urban residents, and high-income groups had a greater increase [37].

Today there are more than 200 million people in China who are overweight or obese. By 2020, it is predicted that there will be more obese population in China than in the United States [38].

Obesity is not new to the Pacific and has long been regarded by Polynesian and Micronesian societies of this region as a symbol of high social status and prosperity. The prevalence has risen dramatically, however, in the last 20 years. The link between obesity and type 2 diabetes is most manifest in this region which has some of the highest levels of adult obesity. Obesity prevalence rates (Table 1.4) of between 55% and 80% can be observed among men and women in some islands