

# Contents

Contributors xv ■ Preface xxi

## Part I: Definition and Assessment of Physical Activity and Obesity. . . . . 1

### 1 Introduction 2

*Claude Bouchard and Peter T. Katzmarzyk*

|                                                                |   |
|----------------------------------------------------------------|---|
| A General Model . . . . .                                      | 2 |
| Gene-Physical Activity Interaction Effects . . . . .           | 3 |
| Progress Over the Past Decade . . . . .                        | 4 |
| Important Differences Between Overweight and Obesity . . . . . | 4 |
| A Major Challenge . . . . .                                    | 5 |
| Content of the Book . . . . .                                  | 6 |

### 2 The Physical Activity and Exercise Continuum 7

*Darren Warburton*

|                                                                 |    |
|-----------------------------------------------------------------|----|
| Definition of Health, Physical Activity, and Exercise . . . . . | 7  |
| The Continuum of Physical Activity Behavior . . . . .           | 8  |
| Estimates and Indices of Physical Activity . . . . .            | 9  |
| Summary . . . . .                                               | 12 |

### 3 Assessing the Level of Sedentarism 13

*Mark S. Tremblay*

|                                                       |    |
|-------------------------------------------------------|----|
| Relationship Between Sedentarism and Health . . . . . | 13 |
| Behavior Compensation . . . . .                       | 14 |
| Methods to Assess Sedentarism . . . . .               | 14 |
| Examples of Sedentarism Assessment . . . . .          | 16 |
| Implications . . . . .                                | 17 |
| Summary . . . . .                                     | 17 |

### 4 Assessing the Level of Physical Activity in Adults 18

*Barbara E. Ainsworth*

|                                                 |    |
|-------------------------------------------------|----|
| Movement Construct . . . . .                    | 18 |
| Measuring Physical Activity Behaviors . . . . . | 20 |
| Measuring Energy Expenditure . . . . .          | 21 |
| Summary . . . . .                               | 21 |

### 5 Assessing the Level of Physical Activity in Children 22

*Russell R. Pate*

|                                                            |    |
|------------------------------------------------------------|----|
| Established Measures of Physical Activity . . . . .        | 22 |
| Emerging Methods in Physical Activity Assessment . . . . . | 24 |
| Conclusion . . . . .                                       | 24 |

### 6 Evaluation of the Overweight Patient 26

*George A. Bray*

|                                                               |    |
|---------------------------------------------------------------|----|
| Evaluation . . . . .                                          | 26 |
| A Clinical Perspective on Setting Weight Loss Goals . . . . . | 26 |
| Clinical Evaluation of the Overweight Patient . . . . .       | 27 |
| Clinical History . . . . .                                    | 27 |
| Family History . . . . .                                      | 27 |
| Physical Examination . . . . .                                | 27 |
| Laboratory Evaluation . . . . .                               | 29 |

### 7 Assessment of Obesity in Children 30

*John H. Himes*

|                                        |    |
|----------------------------------------|----|
| Definitions and Nomenclature . . . . . | 30 |
| Clinical Applications . . . . .        | 31 |
| Public Health Applications . . . . .   | 31 |
| Research Applications . . . . .        | 31 |
| Conclusions . . . . .                  | 33 |

### 8 Limitations of Self-Report in Physical Activity and Obesity Research 34

*Richard P. Troiano*

|                                                                            |    |
|----------------------------------------------------------------------------|----|
| Methods of Reported Weight Status . . . . .                                | 34 |
| Methods of Reported Physical Activity . . . . .                            | 34 |
| Evaluating Agreement Between Self-Reports and Objective Measures . . . . . | 35 |
| Beyond Bias . . . . .                                                      | 36 |
| Implications of Reporting Error . . . . .                                  | 37 |



## Part II: Prevalence and Cost Issues . . . . .39

### 9 Global Prevalence of Adult Physical Inactivity 40

*Wendy J. Brown*

|                                                                         |    |
|-------------------------------------------------------------------------|----|
| Comparisons From National Population Surveillance Instruments . . . . . | 40 |
| "International" Surveys for Measuring Physical (In)Activity . . . . .   | 41 |
| International Comparisons in Europe . . . . .                           | 41 |
| Global Physical Activity . . . . .                                      | 42 |
| Minority Populations . . . . .                                          | 43 |
| Conclusions . . . . .                                                   | 43 |

### 10 The Prevalence of Children's Physical Activity 44

*Chris Riddoch*

|                                                       |    |
|-------------------------------------------------------|----|
| Accelerometer Measures of Physical Activity . . . . . | 44 |
| Levels of Physical Activity . . . . .                 | 45 |
| Future Directions . . . . .                           | 47 |
| Conclusions . . . . .                                 | 47 |

### 11 Global Prevalence of Adult Obesity 48

*W. Philip T. James*

|                                           |    |
|-------------------------------------------|----|
| Secular Increases in Obesity . . . . .    | 48 |
| Overall Global Prevalences . . . . .      | 50 |
| Regional Differences . . . . .            | 50 |
| Sex Differences . . . . .                 | 50 |
| Age, Period, and Cohort Effects . . . . . | 51 |
| Socioeconomic Differences . . . . .       | 52 |

### 12 The Economic Cost of Obesity 53

*Peter T. Katzmarzyk*

|                                      |    |
|--------------------------------------|----|
| Methods to Estimate Costs . . . . .  | 53 |
| Direct Costs of Obesity . . . . .    | 54 |
| Indirect Costs of Obesity . . . . .  | 55 |
| Lifetime Health Care Costs . . . . . | 56 |
| Summary . . . . .                    | 56 |

### 13 Global Prevalence of Childhood Obesity 57

*Tim Lobstein*

|                                                          |    |
|----------------------------------------------------------|----|
| Definitions of Child Overweight and Obesity . . . . .    | 57 |
| Prevalence Levels in Childhood and Adolescence . . . . . | 58 |
| Worldwide Prevalence Levels . . . . .                    | 58 |
| Secular Trends and Demographic Differences . . . . .     | 60 |
| Conclusion . . . . .                                     | 60 |

### 14 The Economic Cost of Physical Inactivity 61

*Ian Janssen*

|                                                          |    |
|----------------------------------------------------------|----|
| Direct Versus Indirect Costs . . . . .                   | 61 |
| Population-Level Versus Individual-Level Costs . . . . . | 62 |
| Currents Costs Versus Lifetime Costs . . . . .           | 63 |
| Conclusions . . . . .                                    | 64 |

### 15 The Cost-Benefit Relationship of Physical Activity Interventions for Obesity 65

*Larissa Roux*

|                                                                      |    |
|----------------------------------------------------------------------|----|
| Cost-Effectiveness Analyses in Obesity . . . . .                     | 65 |
| Determining Cost . . . . .                                           | 66 |
| Putting It Together in the Real World . . . . .                      | 66 |
| Addressing Challenges Through the Project<br>MOVE Approach . . . . . | 67 |
| Future Directions . . . . .                                          | 68 |



**Part III: Determinants of Physical Activity Levels . . . . . 69**

**16 Biological Regulation of Physical Activity Level 70**

*Catherine M. Kotz*

Spontaneous Physical Activity . . . . . 70

Physical Activity Regulation . . . . . 70

Physical Activity and Body Weight . . . . . 71

Potential Mechanisms . . . . . 72

Conclusion . . . . . 72

**17 Genetics and Physical Activity Level 73**

*Tuomo Rankinen*

Evidence From Genetic Epidemiology Studies . . . . . 73

Evidence From Molecular Studies . . . . . 74

Future Directions . . . . . 75

Summary . . . . . 75

**18 Epigenetic or Programming Effects on Physical Activity Level 77**

*Mark H. Vickers*

Evidence From Animal Models and Epidemiology . . . . . 77

Possible Mechanisms . . . . . 79

Epigenetic Basis for Reduced Physical Activity . . . . . 79

Conclusions . . . . . 80

**19 Socioeconomic Position and Physical Activity Levels 81**

*Lise Gauvin*

Conceptualization and Operationalization of SEP . . . . . 81

Socioeconomic Position and Physical Activity Levels . . . . 82

Socioeconomic Position and Physical Activity Interventions . . . . . 83

Conclusion . . . . . 84

**20 U.S. Ethnic Differences in Physical Activity and Sedentary Behavior 85**

*Robert L. Newton, Jr.*

Physical Activity in Adults . . . . . 85

Sedentary Behavior in Adults . . . . . 86

Physical Activity in Children . . . . . 87

Sedentary Behavior in Children . . . . . 87

Conclusions . . . . . 88

**21 Psychological Factors and Physical Activity Level 89**

*Rod K. Dishman*

Moderators and Mediators of Physical Activity . . . . . 89

Measurement of Social-Cognitive Moderators and Mediators . . . . . 90

Measurement of Physical Activity . . . . . 91

Environments and Choice . . . . . 91

Biology and Choice . . . . . 91

Multilevel Models of Physical Activity Change . . . . . 91

Summary . . . . . 92

**22 Effects of the Built Environment on Physical Activity Level 93**

*James F. Sallis*

Need for Transdisciplinary Collaboration . . . . . 93

Built Environments and Physical Activity in Adults . . . . . 94

Built Environments and Physical Activity in Youth . . . . . 95

Causal Role of Built Environments . . . . . 95

Strengths and Weaknesses . . . . . 96

Future Directions . . . . . 96



## 23 Sedentary Time and the Risk of Obesity in Adults 98

*Ross Andersen*

|                                                                              |     |
|------------------------------------------------------------------------------|-----|
| Obesity and Sedentary Versus Active Choices . . . . .                        | 98  |
| Associations of Sedentary and Leisure-Time Activities With Obesity . . . . . | 99  |
| Sedentary Activity and Weight Regain . . . . .                               | 99  |
| Reducing Sedentary Time to Treat Obesity . . . . .                           | 100 |
| Summary . . . . .                                                            | 100 |

## 24 Sedentary Time and the Risk of Obesity in Children 101

*Steven L. Gortmaker*

|                                                                          |     |
|--------------------------------------------------------------------------|-----|
| Television Viewing and Obesity Risk . . . . .                            | 101 |
| Effects of TV Viewing on Energy Expenditure and Dietary Intake . . . . . | 102 |
| Other Sedentary Behaviors and Obesity Risk . . . . .                     | 102 |
| Sedentary Time and Physical Activity Levels . . . . .                    | 102 |
| Summary . . . . .                                                        | 103 |

## 25 Physical Activity Level and the Risk of Obesity in Adults 104

*John M. Jakicic*

|                                                                                 |     |
|---------------------------------------------------------------------------------|-----|
| Cross-Sectional Association Between Body Weight and Physical Activity . . . . . | 104 |
| Physical Activity and Weight Change . . . . .                                   | 105 |
| Cardiorespiratory Fitness and Weight Change . . . . .                           | 105 |
| Sedentary Behavior and Weight Change . . . . .                                  | 105 |
| Summary . . . . .                                                               | 106 |

## 26 Physical Activity Level and the Risk of Obesity in Children 107

*Margarita S. Treuth*

|                                                                   |     |
|-------------------------------------------------------------------|-----|
| Levels of Physical Activity in Children and Adolescents . . . . . | 107 |
| Childhood . . . . .                                               | 108 |
| Adolescence . . . . .                                             | 110 |
| Future Directions . . . . .                                       | 110 |
| Summary . . . . .                                                 | 110 |

## 27 Childhood and Adolescent Physical Activity and Risk of Adult Obesity 111

*Robert M. Malina*

|                                                                      |     |
|----------------------------------------------------------------------|-----|
| Body Mass Index as Influenced by Growth and Maturation . . . . .     | 111 |
| Tracking Body Mass Index and Risk of Overweight or Obesity . . . . . | 112 |

|                                                                                 |     |
|---------------------------------------------------------------------------------|-----|
| Energy Expenditure and Physical Activity in Childhood and Adolescence . . . . . | 112 |
| Tracking Physical Activity . . . . .                                            | 112 |
| Physical Activity and Adiposity During Childhood and Adolescence . . . . .      | 112 |
| Childhood and Adolescent Activity and Adiposity in Adulthood . . . . .          | 112 |
| Transition From Adolescence Into Adulthood . . . . .                            | 113 |
| Conclusion . . . . .                                                            | 113 |

## 28 Childhood Obesity and the Risk of Adult Obesity 114

*François Trudeau*

|                                   |     |
|-----------------------------------|-----|
| Body Mass Index . . . . .         | 114 |
| Effect of Gender . . . . .        | 115 |
| Skinfolds . . . . .               | 116 |
| Waist Circumference . . . . .     | 116 |
| Challenges for Research . . . . . | 116 |
| Conclusion . . . . .              | 116 |

## 29 Physical Activity and Risk of Obesity in Older Adults 117

*Wendy M. Kohrt*

|                                                                                     |     |
|-------------------------------------------------------------------------------------|-----|
| Prevalence of Obesity in Older Adults . . . . .                                     | 117 |
| Prevalence of Physical Activity in Older Adults . . . . .                           | 118 |
| Does Physical Activity Prevent Fat Accumulation With Aging? . . . . .               | 118 |
| Does Physical Activity Reduce Obesity Risk in Older Adults? . . . . .               | 119 |
| Independent Effects of Physical Activity and Obesity on Physical Function . . . . . | 120 |
| Summary . . . . .                                                                   | 120 |

## 30 Physical Fitness and Risk of Obesity 121

*Steven N. Blair*

|                                                           |     |
|-----------------------------------------------------------|-----|
| Methods . . . . .                                         | 122 |
| Fitness and Obesity in Children and Adolescents . . . . . | 122 |
| Fitness and Obesity in Adults . . . . .                   | 124 |
| Conclusion . . . . .                                      | 125 |

## 31 The Interaction of Diet and Physical Activity on Obesity 126

*Tom Baranowski*

|                                                               |     |
|---------------------------------------------------------------|-----|
| The Energy Balance Concept . . . . .                          | 126 |
| Emerging Questions About Diet and Physical Activity . . . . . | 127 |
| Future Directions . . . . .                                   | 128 |
| Conclusion . . . . .                                          | 128 |



## **41** Physical Activity Level and the Hypothalamic-Pituitary-Adrenal Axis 166

*Denis Richard*

|                                                     |     |
|-----------------------------------------------------|-----|
| The HPA Axis and Stress .....                       | 166 |
| The HPA Axis, Exercise, and Exercise Training ..... | 167 |
| The HPA Axis, Energy Homeostasis, and Obesity ..... | 169 |
| Conclusion .....                                    | 169 |

## **42** Physical Activity Level and Skeletal Muscle Biology 170

*David A. Hood*

|                                 |     |
|---------------------------------|-----|
| Myofibrillar Isoforms .....     | 171 |
| Calcium-Handling Kinetics ..... | 172 |
| Energy Provision .....          | 172 |
| Summary .....                   | 173 |

## **43** Postexercise Energy Expenditure 174

*Elisabet Børsheim*

|                                                             |     |
|-------------------------------------------------------------|-----|
| Methodological Considerations .....                         | 174 |
| Aerobic Exercise .....                                      | 175 |
| Supramaximal Exercise .....                                 | 175 |
| Resistance Exercise .....                                   | 175 |
| Mechanisms Underlying EPOC .....                            | 176 |
| Effect of Subject Characteristics .....                     | 176 |
| Effect of Diet Composition .....                            | 177 |
| Implications for Total Energy Expenditure and Obesity ..... | 177 |

## **44** Genetics of Obesity 178

*Ruth J.F. Loos*

|                                                      |     |
|------------------------------------------------------|-----|
| Evidence for a Genetic Contribution to Obesity ..... | 178 |
| Mendelian Disorders and Single-Gene Disorders .....  | 179 |
| Genes for Common Obesity .....                       | 179 |
| Future Directions .....                              | 182 |
| Conclusions .....                                    | 182 |

## **45** Epigenetic Effects on Obesity 183

*Peter W. Nathanielsz*

|                                                                      |     |
|----------------------------------------------------------------------|-----|
| Altered Regulation of Appetite and Physical Activity .....           | 184 |
| General Mechanisms of Epigenetic Modification of Gene Function ..... | 185 |
| Conclusion .....                                                     | 186 |

# **Part VI: Physical Activity, Behavioral, and Environmental Determinants of Obesity ..... 187**

## **46** Physical Activity Level, Sleep, and Obesity 188

*Shawn D. Youngstedt*

|                                                                   |     |
|-------------------------------------------------------------------|-----|
| Epidemiologic Association of Sleep Duration With Obesity .....    | 188 |
| Potential Mechanisms .....                                        | 189 |
| Long Sleep and Obesity .....                                      | 190 |
| Influence of Exercise on Sleep and Implications for Obesity ..... | 190 |
| Future Directions .....                                           | 190 |

## **47** Physical Activity Level and Occupational Work 192

*David R. Bassett, Jr.*

|                                                                        |     |
|------------------------------------------------------------------------|-----|
| Historical Perspective .....                                           | 192 |
| Recent Time Trends in Modern Industrialized Civilizations .....        | 192 |
| Relationships Between Occupational Physical Activity and Obesity ..... | 193 |
| How Jobs Influence Caloric Expenditure .....                           | 193 |
| Worksite Interventions .....                                           | 194 |
| Conclusion .....                                                       | 194 |

## **48** Physical Activity Level and Mode of Transportation 195

*Catrine Tudor-Locke*

|                              |     |
|------------------------------|-----|
| Active Transportation .....  | 196 |
| Passive Transportation ..... | 197 |
| Summary .....                | 197 |