Preface

The three chapters of this book may be read as standalone scientific articles, although they are interconnected.

Chapter I is an introductory part presenting the remarkable diversity in human physique – particularly among athletes, whose bodies often display extreme morphological adaptations and body compositions – as illustrated by the selected images, which vividly show the wide spectrum of human physique, ranging from the slimness characteristic of fashion models to the desired muscular physique of bodybuilders. Certain traits of physique are strong indicators of increased disease risk. Physique plays a central role in medical diagnosis and treatment monitoring, as well as in optimising physical performance in medical, sport, and work settings. Analysing typical examples, this chapter explains the relationship of physique with human performance and health, and outlines the scientific imperative to measure body composition with sufficient validity, accuracy, and reliability in both medicine and sport.

Chapter II presents an original scientific study of the physique of the world's best male and female sport climbers – as an example of a typical weight-sensitive sport. This unique study includes nearly the entire set of male and female semi-finalists in a World Cup event (a 97% participation rate), which represents not just a sample, but the actual status of the world elite. This study is also representative of all other groups of lean individuals, and of all practical and research contexts where valid, accurate, and reliable measurements of body composition are required. For classifying weight in relation to body dimensions, the mass index (MI) was used; it adjusts the body mass index (BMI) to account for the important influence of body shape. For persons with long legs, MI is larger than BMI, and vice versa. However, both MI and BMI are not designed to measure body composition. The extremely low levels of subcutaneous adipose tissue (SAT) were measured using the standardised (brightness-mode) ultrasound method (SUM) – the only method with sufficient accuracy, validity, and reliability to differentiate individuals within such lean populations, and for longitudinal monitoring in any field where detecting minute changes is desired. This example shows that median thickness of subcutaneous adipose tissue is only about one millimetre in the elite male athletes, corresponding to less than 2 kg of SAT (i.e. approximately 3% of body mass); thus, a measurement method capable of achieving accuracy and reliability within the tenths of a millimetre range (corresponding to tenths of a kilogram adipose tissue mass) is imperative. In some cases of female climbers, both alarmingly low SAT values and body weight were observed, prompting a discussion on the need for medical and/or regulatory measures to counter such tendencies in this and other weight-sensitive sports.

Chapter III is a methodological scientific article that defines the accuracy demands for measuring lean individuals and detecting fine-scale changes. It describes both the SUM and the MI, and presents the original, comprehensive data sets (including more than 800 elite athletes) from which reference values for SAT were derived and which served to establish the final form of the MI. In all physically active, and in the lifestyle activity groups (below BMI=25 kgm^{-2}, and younger than 50 years), both female MI and BMI values were significantly lower by typically 2 kgm^{-2}, which raises the question, why such strong evidences found in the groups studied here are not mapped in the current World Health Organisation (WHO) classification of levels of underweight. Furthermore, data show, despite these pronounced differences in MI (and also in BMI), that female athletes exhibited significantly higher SAT values than men, and also differed significantly in their SAT patterning, indicating the differences in their physiological requirements. The chapter includes an Introduction that compares SUM to other methods used for measuring adipose tissue or body fat. Chapter III analyses – based on physical principles of measurement approaches and on scientific publications of various authors – limitations of widely used methods, particularly when applied to lean individuals, or in cases where accurate and reliable measurements of SAT changes are required. The Results section presents the comprehensive

data sets, which are analysed in the Discussion section. The section Methods Part I outlines the SUM approach and the MI definition. Both recently developed methodological improvements are described in depth in the Methods Part 2 section, which is intended for readers who wish to study these advancements in full detail. Descriptive statistics of all groups, and additional information are presented in the Supplementary Materials.

SUM and MI provide capabilities beyond existing techniques and should be considered standard tools wherever subtle differences or changes in SAT and physique matter – whether in elite sport, clinical diagnostics, or physiological research. This book provides the foundation for such a shift, encouraging practitioners and researchers to adopt SUM and MI in response to the measurement demands demonstrated. Their use will substantially improve diagnostic resolution, allow meaningful longitudinal monitoring, and support more evidence-based decisions in both scientific and applied contexts in medicine and sports.