Modern Nutrition *in* Health *and* Disease

Dietotherapy

Edited By

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55 Contributors

80 Illustrations and 127 Tables

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Preface

In the last decade, the science of nutrition has developed rapidly. This book has been undertaken to present the salient advances in nutrition that have a direct bearing on the maintenance of optimum health and the prevention and treatment of disease. The object of the book is to present an authoritative and up-to-date discussion of every aspect of nutrition and provide the practicing physician and the student of medicine with a sound knowledge of both current advances in and the practical application of that science.

The general organization of the book is similar to Wohl's *Dietotherapy*, but each chapter has been reconsidered and most of them have been rewritten, so that approximately 80 per cent of the text consists of new material. The book is divided into three parts: Normal Nutrition, Nutrition in Disease and Nutrition in Periods of Physiologic Stress, and the approach throughout has been from the clinical point of view. There are entirely new chapters on Body Composition, Hormonal Control of Metabolism, the Physiology and Psychology of Hunger, Antimetabolites, Principles of Dietotherapy, Nutrition in Ophthalmology, and Emergency Feeding.

The contributors are authorities in their fields and the material has been integrated so that this book represents a co-operative effort. The editors are most grateful to the contributors for their thoroughness and for their patience.

We wish to acknowledge our indebtedness to those who have carefully read and constructively criticized certain chapters in this volume. Our thanks are due to Mrs. Clara Wein and Mrs. Rita D. Gilbert for their faithfulness in the arduous secretarial work entailed in the preparation of this volume. Finally, we wish to acknowledge our debt to the staff of Lea & Febiger for unfailing courtesy and valuable assistance in bringing the book to press.

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Contents

Part I

NORMAL NUTRITION

Modern Nutrition in Health and Disease

Part I. Normal Nutrition

Chapter 1

Body Weight, Body Composition and Calorie Status

By Ancel Keys

The body is, in the most literal sense, the product of its nutrition. "Man ist was er isst," wrote Goethe. Though the transformations are profound, nutrition begins with the foodstuffs and proceeds to the material end result, the living body. Inquiry is made into the composition of the foods in order to gauge their potential nutritional value. It is equally pertinent to inquire into the transformed end result, the composition of the body. In full detail this would be immensely more difficult than food analysis for nutrients but some gross aspects are accessible and important. Besides the mere mass (or size) of the body, it is possible and useful to differentiate fat, water and "cells" at least.[28,30,31]

The most obvious nutritional defects are those produced by gross calorie imbalance. Human society has always had its cases of obesity and of emaciation, and calorie malnutrition has been, and remains, a major nutritional problem in all countries. Obesity tends to become a problem as soon as the age-old threat of starvation is removed by increases in available food supplies. This is particularly true where the specialization of society puts many people into sedentary occupations; in simpler societies obesity may be rare, even though there be no chronic food shortage. On the other hand, even in the midst of plenty, starvation caused by disease, or economic inequity, is not rare. In the United States every hospital has its share of starvation cases, though they are not so labelled, because many illnesses interfere with the appetite or the assimilation of food.

In extreme examples, obesity and emaciation are readily discerned. More moderate departures from normality present problems of recognition and, even in the extremes, there is the problem of measuring the degree and character of the bodily abnormality and its response to treatment. Elementary considerations demand biochemical and functional definitions and measurements of obesity, fatness, overweight, underweight, leanness and emaciation. Metabolic analysis, of course, cannot even begin properly without consideration of the gross composition, and its changes, of the body.

Until recently, besides the impressionistic methods of gross inspection and digital feel, only gross body weight, sometimes supplemented with a few measurements of external dimensions, had to suffice for studies on living man. Fortunately, new methods are now at hand for analysis of the body mass into metabolically distinct components. These, together with the more widespread application of statistical methods and concepts, are providing us with increasingly useful and precise norms for guidance in calorie nutrition.

The Meaning of Body Weight.—The gross body weight, *per se*, has some direct metabolic significance in that it affects the metabolic cost of physical activity. Most of the energy in physical activity is expended in simply moving the body around. With a fixed amount of activity—number, extent, speed and force of movements—energy expenditure tends to be directly proportional to gross body weight.[12] This not only affects calorie requirements; there is the integral need to provide digestion, respiration and circulation for this metabolism. In the unduly heavy person this could mean a strain on one or more vulnerable organs or functions. Such considerations could explain at least part of the excess mortality rate reported by insurance companies for overweight persons. But this argument amounts to concluding that total energy metabolism is a measure of biological strain conducive to illness and death. It suggests that persons with higher than average energy expenditure have an increased tendency to die early, regardless of the cause—increased body weight or increased amount of activity—of the high energy expenditure. Actually, however, it seems probable that many overweight persons are relatively inactive, physically, and do not have a particularly high total energy expenditure. Moreover, there is no evidence that sedentary persons are healthier and live longer than persons who are relatively active habitually. Only in the presence of abnormality or disease already established might it be suggested that reduction of the metabolic (and hence circulatory, etc.) load to a minimum is desirable.

Gross body weight can contribute directly to injury and death in accidents involving motion of the body. The damaging force in a fall is increased with increasing body weight. Moreover, a heavy body is an impediment in avoiding many accidents because it is harder to move or change its direction of movement rapidly. It is not surprising that the insurance companies find overweight people have an excessive mortality rate from accidents.

Nevertheless, there can be little doubt that the major importance of overweight is its association with obesity. Obesity means excessive fatness and it is essential to adhere to the classical definition if confusion is to be avoided.[28,30] The modern ease and popularity of weighing the body is a mixed blessing. The middle-aged person who is 30, 40, or more pounds heavier than the average for his height is almost inevitably overfat as well. But at lesser departures from the average the relationship between relative body weight and relative obesity is far less reliable, particularly in younger adults.[8] That athletes are often overweight but underfat is well known.[4] Differentiation between gross weight and fatness in men discloses differences in circulatory characteristics pertinent to cardiac

performance and health.[57] In many physiological respects the man who is overweight simply because he is fat is at the opposite pole from the man who is equally overweight because of a large muscle mass in his body. The emotional and psychological differences between these types are no less great and may be of greater social significance.

Besides differentiation between fat and muscle in the gross body weight, variations in the water content of the body must be considered. In ascites 5 to 10 kg. of fluid in the abdominal cavity may be encountered and much larger totals of edema fluid are not rare. One of Simonart's[53] starved patients lost 20 kg. in a week while his nutriture was improving and this is by no means unique. Extreme edema is readily detected but more moderate variations in hydration are not clinically recognizable, short of departures from normality of the order of 5 to 10 per cent of the total body weight as water. In severe undernutrition, edema tends to be clinically recognizable only when the relative excess of extracellular fluid, as estimated by the thiocyanate method, approaches 10 per cent of the total body weight.[32] The variable contribution of water to the total body weight of clinically healthy persons is frequently indicated in the weight fluctuations seen on reducing diets under controlled conditions.[44] Under ordinary circumstances an uncertainty of as much as 10 pounds of body weight (in the ordinary adult) may be attributed to hydration variability.

A final contributor to confusion about the meaning of the total body weight is the bony skeleton. The mineral mass in the skeleton averages something like 6 per cent of the normal body weight of the adult but it may be as low as 4 per cent or as high as 9 per cent.[30] There is no evidence that these variations are in any way related to relative obesity except insofar as they may be erroneously included in the inference of obesity from gross body weight.

Perhaps a more important contribution of the skeleton to the body weight is through its form. Relative body weight and overweight and underweight are commonly computed on the basis of weight for height. But a broad and short skeleton automatically means a large body weight per unit of height and no system has yet been devised to allow for this in a practical manner. The body "frame" types to be discussed below do not provide a practical solution.

Body Weight Standards.—Until now almost all evaluations of calorie status, obesity, emaciation, and gross nutritional health, have been based simply on the gross body weight as related to height. In the United States the standard of reference has long been the tables of average weight for height and age, originally published by the Association of Life Insurance Medical Directors and the Actuarial Society of America in 1912 under the title, "Medico-Actuarial Mortality Investigation" (New York). These tables are still the most complete available and are summarized in Tables 1 and 2.

Elsewhere,[7,28] we have discussed the limitations of these tables which merely give the average values for men and women of specified ages who obtained life insurance policies from 1888 to about 1905, mostly in urban centers on the eastern seaboard. The heights and weights were recorded as for "ordinary clothing"; what this means today is questionable. How-

ever, for men at least, the same values appear to apply approximately to the undressed state, that is, in socks and shorts, because the heel height (about 1 inch) roughly counteracts the clothing weight which was customary half a century ago. For women the application is more difficult because of the variability of heel height and the great reduction in female clothing weight over the intervening years.

More recently, similar tables for persons of different skeletal type have come into use with different body weights for the same height under headings for three types: "light" or "small frame," "medium frame," and "heavy" or "large frame." The medium frame values correspond to the averages in the older tables and the "light" and "heavy frame" weight values are simply some 5 to 8 per cent smaller or larger, respectively. This is in recognition of the obvious fact that appropriate weights for the same height must differ according to the relative skeletal breadth. Unfortunately, however, there is no accepted system for deciding who has a "light frame," and so on, and no actual evaluations of frame size were

TABLE 1.—GRADED AVERAGE WEIGHT IN POUNDS OF MEN OF DIFFERENT STATURES AT VARIOUS AGES*

Height, Inches	*Age, Years*							
	20	*25*	*30*	*35*	*40*	*45*	*50*	*55*
60	117	122	126	128	131	133	134	135
62	122	126	130	132	135	137	138	139
64	128	133	136	138	141	143	144	145
66	136	141	144	146	149	151	152	153
68	144	149	152	155	158	160	161	163
70	152	157	161	165	168	170	171	173
72	161	167	172	176	180	182	183	184
74	171	179	184	189	193	195	197	198
76	181	189	196	201	206	209	211	212

* Davenport, C. B.: Body Build and Its Inheritance. Publication 329, Carnegie Institute of Washington, 1923.

TABLE 2.—GRADED AVERAGE WEIGHT IN POUNDS OF WOMEN OF DIFFERENT STATURES AT VARIOUS AGES*

Height, Inches	*Age, Years*							
	20	*25*	*30*	*35*	*40*	*45*	*50*	*55*
56	106	109	112	115	119	122	125	125
58	110	113	116	119	123	126	129	129
60	114	117	120	123	127	130	133	133
62	119	121	124	127	132	135	138	138
64	125	128	131	134	138	141	144	144
66	132	135	138	142	146	149	152	153
68	140	143	146	150	154	157	161	163
70	147	151	154	157	161	164	169	171
72	156	158	161	163	167	171	176	177

* Davenport, C. B.: Body Build and Its Inheritance. Publication 329, Carnegie Institute of Washington, 1923.