Limitations of the "Normal" Body Weight as a Criterion of Normality[1]

Josef Brožek and Ancel Keys

The Laboratory of Physiological Hygiene, University of Minnesota, Minneapolis

In attempting to characterize the physical or nutritional status of an individual, the gross body weight is widely used as the first criterion. "Standard" tables are available that purport to give the "normal" body weight for the individual's sex, height, and age. Most, if not all, of the tables for adults cited in American textbooks—frequently without indicating the original source of information and lacking consistency in the recommended adjustment for clothing—go back to the Medico-actuarial Mortality Investigation of 1912. These tables indicate that body weight continues to increase, on the average, even after the growth in height is completed. This trend is incorporated in the standards.

In the course of studies on ageing, carried out since 1947 at the Laboratory of Physiological Hygiene, with special emphasis on the cardiovascular system and its disturbances, we became acutely aware of the misleading nature of the height-age-weight standards. In terms of quantitative morphology a middle-aged man, retaining his relative position in the distribution of weight for men of a given height, differs markedly from his physical status in his early twenties.

TABLE 1

QUANTITATIVE CHARACTERISTICS OF FATNESS IN YOUNGER AND OLDER MEN WITH NORMAL RELATIVE BODY WEIGHT

	Younger men (N = 37)	Older men (N = 66)
Age range, years	19–25	45–55
Mean age, years	22.1	49.1
Range of relative body weight, actual, as percentage of standard weight	95.0–104.9	95.0–104.9
Mean relative body weight	100.2	100.0
Skinfolds, in mm		
Abdomen	13.7	25.3
Chest	11.4	25.4
Back	11.7	20.3
Arm	10.4	14.3
Thigh	8.1	10.2
Specific gravity*	1.079	1.056
Body fat, as percentage of body weight	9.8	21.0

* Corrected for residual air in the lungs.

Table 1 presents data on two groups of men, 19–25 and 45–55 years of age, respectively. Both groups were drawn from larger samples, restricting the selection to those individuals whose actual body weight was within ± 5% of their standard weight. The mean values of the relative body weight in the two groups are very close (100.2 and 100.0, respectively). Nevertheless, the amount of body fat, determined both in terms of the thickness of the skinfolds (*1*) and estimated on the basis of specific gravity (*2*, *3*), is strikingly larger in the older men. Although both groups are "normal" in respect to their body weight, they differ markedly in terms of the composition of the body.

The concept of "normal" body weight, defined actuarially, tends to obscure the profound changes taking place in the process of ageing. The latter involves not only an additive accumulation of body fat but also, very likely, replacement of some of the muscle (and other "active tissues") by fatty tissues.

It is a current practice to express the rates of physiological processes, such as the basal metabolic rate, and to prescribe pharmacological dosages in reference to the total body weight or to the body surface, the latter being estimated in turn from body weight and height. In view of the variations in the composition of the body at the same weight and the differences in the metabolic properties of muscles and the depot fat, it appears that the expression "per kg of body weight" may lead to erroneous conclusions. The vexing problems of physiologically sound reference points for the basal metabolic rate were discussed in some detail in connection with studies on prolonged starvation and nutritional rehabilitation (*4*).

[1] The data reported in this paper were obtained in the course of research aided by the Research Grants Division, U. S. Public Health Service.

References

1. BROŽEK, J., and KEYS, A. *Brit. J. Nutrition* (in press).
2. BROŽEK, J., HENSCHEL, A., and KEYS, A. *J. Appl. Physiol.*, **2**, 240 (1949).
3. RATHBUN, E. N., and PACE, N. *J. Biol. Chem.*, **158**, 667 (1945).
4. KEYS, A., *et al. The Biology of Human Starvation.* Minneapolis: Univ. Minnesota Press (1950).

Hypotension in the Rat Following Limitation of Potassium Intake[1]

S. Charles Freed and Meyer Friedman[2]

The Mount Zion Hospital, Harold Brunn Institute for Cardiovascular Research, San Francisco, California

There is an increasing amount of evidence that an adequate intake of potassium is necessary for the anatomical integrity of the myocardium and kidneys (*1*, *2*). Data on the functional aspects of this relationship are scanty, however. The following experiments suggest that potassium deficiency has a profound effect on circulatory dynamics as reflected in blood pressure changes.

Four groups of Long-Evans rats (age, 45 days) were treated as follows: Group I (12 rats) received a synthetic diet in 1 g of which there was 0.1 mg of potassium. Group II (8 rats) received the same diet, but were permitted to drink a 1% solution of potassium chloride. Group III (10 rats) received a restricted amount of Purina Chow laboratory ration in an amount that allowed

[1] Preliminary report.

[2] The authors wish to express their thanks to Elizabeth Wright for her technical assistance.

the animals to grow at approximately the same rate as the rats in Group I. Those in Group IV (10 rats) were maintained on Purina Chow *ad lib.* Blood pressure readings were determined on the rats under light ether anesthesia by the microphonic method of Friedman and Freed (*3*). Readings were taken at the beginning of the study and once weekly for 9 weeks.

The rats in Group I exhibited a pronounced degree of generalized flaccidity of the skeletal musculature. Growth was restricted, their weight increasing from an initial average of 116 g to an average of 152 g after 9 weeks. Otherwise, they appeared in good physical condition. The animals in Group II, receiving supplemental potassium, were in excellent health. Their weight increased from an average of 115 g to 234 g. Those in Group III maintained approximately the same weights as Group I. The rats of Group IV grew from an average of 111 g to 346 g.

Our findings revealed that the rats maintained on the potassium-free diet (Group I) exhibited a steady decline

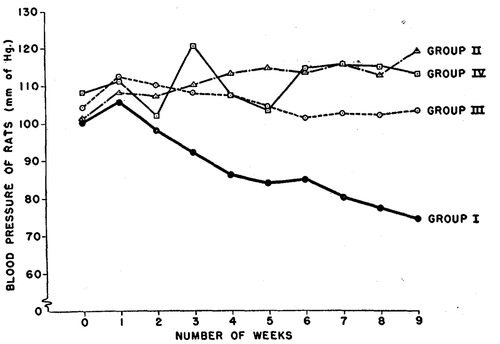

FIG. 1.

in blood pressure (Fig. 1) after the second week, from an average initial reading of 100 mm of Hg (range, 92–116 mm). At the end of the fourth week the blood pressures averaged 86 mm of Hg (range, 80–102 mm). At the end of 9 weeks the average pressure was 74 mm of Hg (range, 68–86 mm). Animals in the control groups, II, III, and IV, showed no marked deviation from normal in their pressures.

Our results indicate that rats on a diet deficient in potassium develop a profound hypotension. Other rats on an identical diet but supplied with potassium, maintain a normal blood pressure. A third group of animals on a standard diet, but partially starved to grow as slowly as those in Group I, also had a normal pressure. It would appear, therefore, that the hypotension observed was due to a specific deficiency in potassium. The possible mechanisms for this action are now under investigation.

References

1. SCHRADER, G. A., PRICHETT, C. O., and SALMON, W. D. *J. Nutrition,* **14**, 85 (1937).
2. FOLLIS, JR., R. H., ORENT-KEILES, E., and MCCOLLUM, E. V. *Am. J. Path.,* **18**, 29 (1942).
3. FRIEDMAN, M., and FREED, S. C. *Proc. Soc. Exper. Biol. Med.,* **70**, 670 (1949).

C-M Medium: A Mounting Medium for Small Insects, Mites, and Other Whole Mounts

Edgar W. Clark[1] and Frank Morishita[2]

Division of Entomology and Parasitology, University of California, Berkeley

Past experience in mounting mites has shown that the existing media are not completely adequate in many respects. A mounting medium was therefore sought that would permit ease and speed in mounting and yet have a refractive index that would give better definition of the morphological and gross histological structures. Experimentation was carried out using methocellulose, and the following formula was evolved:

Methocellulose[3]	5 g
Carbowax 4,000[4]	2 "
Diethylene glycol	1 ml
95% Ethyl alcohol	25 "
Lactic acid	100 "
Distilled water	75 "

The methocellulose and alcohol are mixed, added to the remainder of the formula, and filtered through glass wool. The medium is then placed in an oven at 40°–45° C for 3–5 days, or until it has reached the desired consistency. If it becomes too thick the viscosity may be reduced by warming gently or by thinning with 95% ethyl alcohol or water.

Specimens cannot be transferred directly from glycerine, strong acids, or bases such as KOH clearing solution. It was found, however, that specimens cleared in KOH could be mounted safely if they were first rinsed in acid-alcohol.

Acarina, larval cestodes, nematodes, and insects (larvae and adults) have been mounted with excellent results. The best procedure for mounting mites was to clear thoroughly in lactophenol before mounting. At times a slight shrinkage occurs, but this can be reflected by warming the lactophenol solution and the mites slightly. Mosquito larvae mounted well by passing through cellusolve into the medium. Some of the more delicate specimens needed no special clearing procedure but were placed directly into the medium, thereby allowing the lactic acid in the medium to clear the specimen.

Some of the favorable characteristics of the C-M medium are as follows:

1. It has an excellent refractive index for arthropod tissues, namely, 1.428.
2. It is not visibly affected by light (does not turn yellow as does balsam).
3. It is heat-stable at average temperatures (slides were held at 55° C for 6 months without visible change).

[1] Now at Department of Zoology, University of California at Los Angeles.

[2] The authors are grateful to Roderick Craig for his advice and many helpful suggestions.

[3] Methocel, furnished by Veronal Chemical Company.

[4] Supplied by Carbide & Carbon Chemicals Corporation.