Prediction of lean body mass from height and weight

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SYNOPSIS Lean body mass, calculated from the measurement of total body water using antipyrine space, was estimated in 29 males and 27 females. It was found that the lean body mass could be predicted from the height and weight, and formulae for both males and females have been produced with multiple correlation coefficients (r) of 0.96 and 0.83 respectively.

In 1956 Allen, Peng, Chen, Huang, Chang, and Fang showed that the circulating total blood volume was closely related to a combination of body weight and cube of height. In 1962 Nadler, Hidalgo, and Bloch improved on this formula by adding a computer correction factor. Since the red cell volume is directly related to the lean body mass or fat-free body weight (Muldowney, 1957), and since the red cell volume derived from the height-cubed body weight formula of Nadler, Hidalgo, and Bloch correlates closely with the red cell volume derived from the lean body mass relationship (Hume and Goldberg, 1964), it seemed likely that the lean body mass could be predicted from height and weight. In 1965, Steinkamp, Cohen, Goffey, McKey, Bron, Siri, Sargent, and Isaacs showed from an extensive study of the problem that fat weight could be accurately predicted from body parameters other than height and weight. This paper presents evidence which confirms the practicability of predicting lean body mass from height and weight.

METHODS

CLINICAL CASES Fifty-six subjects were studied (29 males and 27 females). They comprised four main clinical groups: those with no apparent disorder, those suffering

from polycythaemia vera, those with chronic bronchitis, and those suffering from obesity (Table I). Many of the subjects had formed part of a previous study on the polycythaemic states (Hume and Goldberg, 1964). None had clinical evidence of fluid retention or malnutrition, conditions known to influence the relationship between total body weight and total body water. The ages of the males ranged from 40 years to 77 years with a mean of 61 years. The ages of the females ranged from 37 years to 80 years with a mean of 60.0 years.

HEIGHT AND WEIGHT (Tables II and III) The standing height in centimetres was measured without shoes.

TABLE II

RESULTS IN MALES

Case No.	Age (yr.)	Height (cm.)	Total Body Weight (kg.)	Lean Body Mass ¹ (kg.)
1	50	182.9	82.4	59.8
2	55	176.5	66.3	56.8
3	77	167.6	66.0	52.5
4	54	162.6	59.9	43.0
5	77	173.0	75.1	53.6
6	54	172.7	73.1	53.7
7	58	168.3	58.3	48.3
8	69	171.5	81.9	55.0
9	76	168.9	113.5	63.0
10	65	173.4	132.8	72.5
11	61	167.6	107.1	60.0
12	40	178.4	81.0	53.0
13	56	172.7	87.6	58.4
14	49	177.8	68.3	50.0
15	63	160.0	77.1	52.0
16	73	163.8	75.1	56.0
17	59	151.1	63.1	43.0
18	68	162.6	80.0	52.0
19	64	163.8	83.0	52.0
20	42	168.9	60.8	50.4
21	57	177.8	70.9	56.0
22	70	157.5	56.3	39.1
23	46	187.9	75.6	54.8
24	72	167.6	77.4	49.3
25	69	171.5	75.0	48.5
26	66	188.0	80.5	66.8
27	54	175.3	80.0	56.7
28	57	157.5	45.4	41.0
29	69	152.4	42.9	36.0

¹Lean body mass derived from measurement of total body water

TABLE I

GENERAL DESCRIPTION OF SUBJECTS STUDIED

Group	Males		Females	
	No. of Subjects	Mean Age (yr.)	No. of Subjects	Mean Age (yr.)
Normal	8	61	11	63
Chronic bronchitis	9	62	2	49
Polycythaemia vera	9	59	8	64
Obesity	3	67	6	53
Total	29	61.0	27	60.0

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TABLE IV

TABLE OF PREDICTED LEAN BODY MASS IN MEN

Weight (kg.)	Height (cm.)							
	150	155	160	165	170	175	180	185
45	36.12	37.82	39.52	41.21	42.91	44.61	46.30	48.00
50	37.76	39.46	41.16	42.85	44.55	46.25	47.94	49.64
55	39.40	41.10	42.80	44.49	46.19	47.89	49.58	51.28
60	41.05	42.75	44.45	46.14	47.84	49.54	51.23	52.93
65	42.69	44.39	46.09	47.78	49.48	51.18	52.87	54.57
70	44.33	46.03	47.73	49.42	51.12	52.82	54.51	56.21
75	45.97	47.67	49.37	51.06	52.76	54.46	56.15	57.85
80	47.61	49.31	51.01	52.70	54.40	56.10	57.79	59.49
85	49.25	50.95	52.65	54.34	56.04	57.74	59.43	61.13
90	50.89	52.59	54.29	55.98	57.68	59.38	61.07	62.77
95	52.53	54.23	55.93	57.62	59.32	61.02	62.71	64.41
100	54.17	56.17	57.57	59.26	60.96	62.66	64.35	66.05
105	55.81	57.81	59.21	60.90	62.60	64.30	65.99	67.69
110	57.45	59.45	60.85	62.54	64.24	65.94	67.63	69.33
115	59.09	61.09	62.49	64.18	65.88	67.58	69.27	70.97
120	60.73	62.73	64.13	65.82	67.52	69.22	70.91	72.61
125	62.37	64.37	65.77	67.46	69.16	70.86	72.55	74.25
130	64.01	66.01	67.41	69.10	70.80	72.50	74.19	75.89
135	65.65	67.65	69.05	70.74	72.44	74.14	75.83	77.53
140	67.29	69.29	70.69	72.38	74.08	75.78	77.47	79.17

$$(L.B.M. = 0.32810 W + 0.33929 H - 29.5336)$$

TABLE V

TABLE OF PREDICTED LEAN BODY MASS IN WOMEN

Weight (kg.)	Height (cm.)							
	145	150	155	160	165	170	175	180
35	27.69	29.78	31.87	33.96	36.05	38.14	40.23	42.32
40	29.17	31.26	33.35	35.44	37.53	39.62	41.71	43.80
45	30.65	32.74	34.83	36.92	39.01	41.10	43.19	45.28
50	32.12	34.21	36.30	38.39	40.48	42.57	44.66	46.75
55	33.60	35.69	37.78	39.87	41.96	44.05	46.14	48.23
60	35.08	37.17	39.26	41.35	43.44	45.53	47.62	49.71
65	36.56	38.65	40.74	42.83	44.92	47.01	49.10	51.19
70	38.04	40.13	42.22	44.31	46.40	48.49	50.58	52.67
75	39.52	41.61	43.70	45.79	47.88	49.97	52.06	54.15
80	41.00	43.09	45.18	47.27	49.36	51.45	53.54	55.63
85	42.47	44.56	46.65	48.74	50.83	52.92	55.01	57.10
90	43.95	46.04	48.13	50.22	52.31	54.40	56.49	58.58
95	45.43	47.52	49.61	51.70	53.79	55.88	57.97	60.06
100	46.91	49.00	51.09	53.18	55.27	57.36	59.45	61.54
105	48.39	50.48	52.57	54.66	56.75	58.84	60.93	63.02
110	49.87	51.96	54.05	56.14	58.23	60.32	62.41	64.50
115	51.34	53.43	55.52	57.61	59.70	61.79	63.88	65.97
120	52.82	54.91	57.00	59.09	61.18	63.27	65.36	67.45
125	54.30	56.39	58.48	60.57	62.66	64.75	66.84	68.93
130	55.78	57.87	59.96	62.05	64.14	66.23	68.32	70.41

$$(L.B.M. = 0.29569 W + 0.41813 H - 43.2933)$$

effect in relation to total body water although it does have in those below 30. Since the youngest woman studied in this series was 37, it is suggested that the formula is probably only applicable to those over the age of 30 years.

Although many of the subjects studied were selected because of particular clinical problems (Table I), nevertheless they were unselected with regard to height and, with the exception of nine obese patients, to weight. They may therefore in all probability be regarded as a random sample of a hospital population and it is suggested that the formulae are applicable to hospital patients. It is recognized that this recommendation is contrary to the opinion of Edwards and Whyte (1962), who concluded from their own observations and after reviewing the literature, that there was no method for estimating at all accurately the fat mass (calculated from total body water) from simple accessible bodily measurements. But, in the construction of their formulae, they failed to differentiate between the sexes. This may well have been important since not only is age a factor but total body water related to body weight is different between the sexes (Moore *et al.*, 1963).

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