A COMPARISON OF THE DU BOIS AND THE HARRIS AND BENEDICT NORMAL STANDARDS FOR THE ESTIMATION OF THE BASAL METABOLIC RATE.

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(Received for publication, October 21, 1922.)

One of the most important contributions to the science of medicine within recent years was the establishment by Lusk and Du Bois and their associates of a normal standard of heat production of sufficient accuracy to allow the general introduction of indirect calorimetry into clinical medicine.[1] The historical details, which need not be repeated here, of the development of Rubner's law of body surface into an accurate standard for the determination of the basal metabolic rate have been extensively covered in the various articles of Lusk and Du Bois and of Harris and Benedict; the former emphasize its consistencies and general applicability and the latter emphasize the point "that the metabolism or heat output of the human body even at rest does not depend on Newton's law of cooling and, therefore, is not proportional to the body surface." Murlin has recently demonstrated some of the fallacies in the position maintained by Benedict and his associates both by mathematical and by teleological arguments.

Because of their reluctance to accept the body surface law as a basis for the establishment of normal standards for heat production Harris and Benedict, in an exhaustive mathematical consideration of the subject, developed a series of biometric correlation formulas, based on stature, body weight, sex, and age (the same factors as used by Du Bois) by which "results as good as, or better than, those obtainable from the constant of basal metab-

[1] For bibliography on this subject see the following paper (Boothby, W. M., and Sandiford, I., *J. Biol. Chem.*, 1922, liv, 783).

olism per square meter of body surface can be obtained by biometric formulas involving no assumption concerning derivation of surface area but based on direct physical measurements." Shortly after the appearance of the Harris and Benedict standards we tabulated 404 determinations of the basal metabolic rate expressed in percentages above and below normal, using both the standards of Du Bois and of Harris and Benedict. The average rates of all the cases show that those obtained by the Harris and Benedict method are 6.5 points higher than the rates obtained by the Du Bois method. The striking parallelism between the results obtained by the two methods is shown in Table I in which it is seen that 195 of the 404 determinations are within ± 2.5 of

TABLE I.

Comparison of Metabolic Rates Obtained by the Harris and Benedict Method with Those Obtained by the Du Bois Method.

Difference between the Harris and Benedict rates from Du Bois' rates as standard.	No. of determinations for each range.
−10 to − 6	3
− 5 to − 1	20
0 to + 3	88
+ 4 to + 9	195*
+10 to +14	69
+15 to +19	24
+20 to +25	5
Average of 404 determinations +6.5	

* Within ± 2.5 of the average deviation.

the average variation. Because of the demonstrated agreement between the two methods in such a large proportion of subjects we concluded that there was a fundamental similarity between the two methods, but reserved our final opinion until after an analysis of the discrepancies.

Means and Woodwell have recently made a similar, but somewhat more extensive analysis and have likewise shown that the Harris and Benedict standards give basal metabolic rates on an average 6 per cent higher than the Du Bois standards. They point out that these differences might be abolished by an empirical reduction in the Du Bois standards, but refrain from doing so and recommend that the use of the Du Bois method be continued, unchanged.

Unfortunately, and without the authorization or knowledge of Du Bois, Sanborn, in his compilation of "basal metabolism" has presented a table containing the Du Bois normal standards with 1.8 calories arbitrarily deducted. Although it is possible that in the future the present Du Bois standards may be modified, yet in order to avoid confusion it is highly desirable that they be altered as infrequently as possible.

As we have pointed out an analysis of the Du Bois and of the Harris and Benedict standards by Boothby and Sandiford and by Means and Woodwell showed for the majority of determinations a remarkable parallelism between the two methods; however, in our series materially discordant results were obtained in approximately one-fifth of the subjects. The present paper is a more extended analysis of the two standards with an attempt to learn the cause of these larger discrepancies.

Harris and Benedict claim that their standards are in no way based on Rubner's law of surface area. While this is true as far as the original construction of their formulas is concerned, yet the startling fact remains, as the curves in Chart 1 of Du Bois' paper on the basal metabolism in fever indicate, that the surface area can be calculated within certain range by their formulas with practically the same accuracy as by the formulas of Du Bois and Du Bois. The basal heat production for males as predicted by Harris and Benedict is

$$h = 66.4730 + 13.7516w + 5.0033s - 6.7550a \qquad (1)$$

where h = basal heat production for 24 hours, w = weight in kilos, s = height in centimeters, and a = age in years. This formula can be transposed into one which will predict surface area by substituting constants as follows:

$$S.A. = \frac{66.4730 + 13.7516w + 5.0033s - K_1}{K_2} \qquad (2)$$

where K_1 = 141.86 which is 6.7550 (the Harris and Benedict age factor for males) $\times$ 21 years and K_2 = 948 which is Du Bois' normal calories per hour for each square meter for males 21 years old multiplied by 24 hours (39.5 $\times$ 24), and $S.A.$ = surface area in square meters. This formula can be simplified by factoring and dropping insignificant figures to

$$S.A. = \frac{2.75w + s - 15.1}{190} \qquad (3)$$

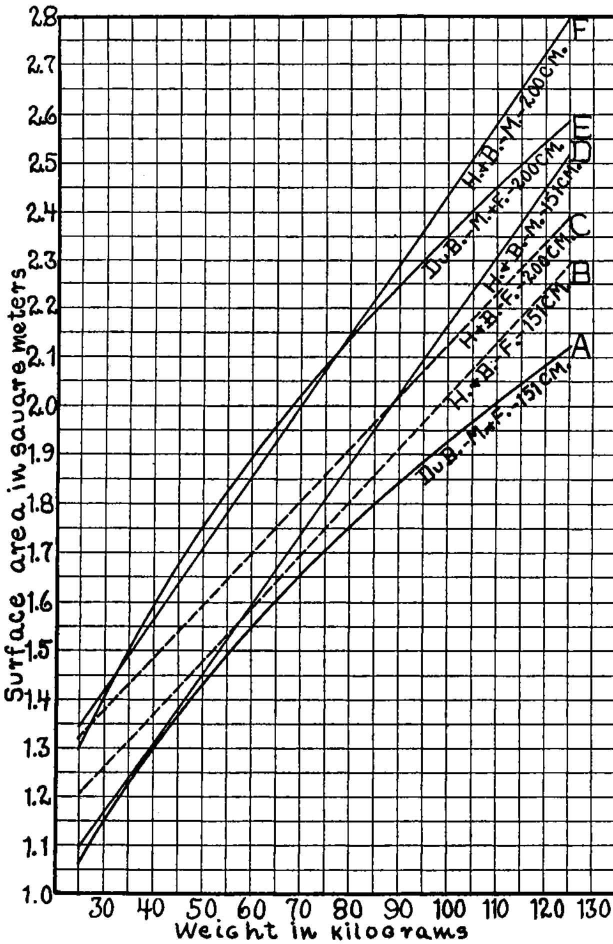

CHART 1. Surface areas for increasing weights at constant heights. Curves A, B, and D represent the surface area at a constant height of 151 cm. plotted for increasing weights; Curves C, E, and F are similar for a constant height of 200 cm. Curves A and E are the surface areas calculated by the Du Bois height-weight formula and are the same for men and women ($S.\ A. = 0.007184 \times w^{0.425} \times s^{0.725}$). Curves D and F are the surface areas calculated by the formula $\left(S.A. = \frac{2.75\,w + s - 15.1}{190}\right)$ derived from the Harris and Benedict heat prediction formula for men. Curves B and C are the surface areas calculated by the formula $\left(S.A. = \frac{5.17\,w + s + 301}{480}\right)$, derived from the Harris and Benedict heat prediction formula for women. Similar curves plotted for intermediate heights are not indicated because it is evident that they would show correspondingly smaller variations in the surface area as calculated by the three formulas.

Similarly for females:

$$h = 655.0955 + 9.5634w + 1.8496s - 4.6756a \tag{4}$$

and by substitution of constants

$$S.A. = \frac{655.0955 + 9.5634w + 1.8496s - K_3}{K_4} \tag{5}$$

where $K_3 = 98.19$ which is 4.6756 (the Harris and Benedict age factor for females) $\times$ 21 years and $K_4 = 888$ which is 37.0 calories per square meter (the Du Bois standard for females 21 years old) $\times$ 24 hours. By factoring and dropping insignificant figures this formula may be simplified to:

$$S.A. = \frac{5.17w + s + 301}{480} \tag{6}$$

Formulas 3 and 6 are comparable to the height-weight formula for surface area of Du Bois and Du Bois.

$$S.A. = 0.007184 \times w^{0.425} \times s^{0.725} \tag{7}$$

In order to test the accuracy of these formulas we have utilized the group of subjects studied by Benedict in the development of his photographic method and also the group whose surface areas were accurately measured by means of molds by Du Bois. In Table II are assembled the surface areas for these subjects calculated by (1) the formulas derived from the Harris and Benedict formulas for the prediction of total calories in men and women (Formulas 3 and 6); (2) the Du Bois linear formula; (3) the Du Bois height-weight formula; (4) Benedict's photographic method; and (5) the actual measurement by molds. An examination of Table II shows such slight differences in normal adults between the surface areas as calculated by the various methods that it is doubtful as to which formula is the most accurate. The practical conclusion which is revealed in Table II is that the surface area formulas derived from the Harris and Benedict correlation formulas for the prediction of basal heat production are possibly nearly as good for the estimation of the surface area within the average ranges of adult height and weight as is the Du Bois height-weight formula. The surface area for infants, however, cannot be predicted by the derived Harris and Benedict formula for females, as illustrated by Anna M.; also it cannot be extended to short subjects like Benny L. There also is a considerable discrepancy in Subject 19 who is likewise rather short.

TABLE II.

Comparison of the Surface Areas Calculated by Various Methods.

1		2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Subject.	No.	Age.	Sex.	Weight.	Height.	Harris-Benedict. Formula 3 for males.	Harris-Benedict. Formula 6 for females.	Du Bois linear.	Du Bois height-weight.	Photographic.	Measured.	$\frac{5-7}{7}$	$\frac{5-8}{8}$	$\frac{5-9}{9}$	$\frac{9-7}{7}$	$\frac{8-9}{9}$	$\frac{8-7}{7}$	$\frac{6-9}{9}$	$\frac{6-7}{7}$	$\frac{6-8}{8}$	$\frac{5-10}{10}$	$\frac{6-10}{10}$	$\frac{7-10}{10}$	$\frac{8-10}{10}$
		yrs.		*kg.*	*cm.*	*sq. m.*	*sq. m.*	*sq. m.*	*sq. m.*	*sq. m.*	*sq. m.*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Males.	1	30		144.6	166.2	2.89	2.53	2.69	2.40	2.69		+7	+20	+7	0	−11	−11	−6	−6	+5				
	2	45		87.1	182.2	2.14	1.94	2.10	2.08	2.12		+2	+3	+1	+1	−2	−1	−8	−8	−7				
	3	39		84.8	166.3	2.03	1.89	2.04	1.92	2.00		−1	+6	+2	−2	−4	−6	−6	−7	−2				
	4	23		70.4	170.8	1.85	1.74	1.91	1.81	1.91		−3	+2	−3	0	−5	−5	−9	−9	−4				
	5	21		69.0	185.4	1.90	1.76	1.95	1.91	1.93		−3	−1	−2	−1	−1	−2	−9	−10	−8				
	6	48		60.4	179.7	1.75	1.65	1.74	1.75	1.72		+1	0	+2	−1	+2	+1	−4	−5	−6				
	7	23		59.8	172.9	1.70	1.63	1.74	1.70	1.80		−2	0	−6	+3	−6	−2	−9	−6	−4				
	8	36		59.1	176.1	1.71	1.63	1.71	1.72	1.70		0	−1	+1	−1	+1	+1	−4	−5	−5				
	9	27		57.5	173.5	1.67	1.61	1.73	1.68	1.71		−4	−1	−2	−1	−2	−3	−6	−7	−4				
	10	26		57.1	174.3	1.67	1.60	1.67	1.68	1.67		0	−1	0	0	+1	+1	−4	−4	−4				
	11	24		53.6	167.5	1.59	1.55	1.59	1.59	1.65		0	0	−4	+4	−4	0	−6	−3	−3				
	12	55		49.5	166.4	1.52	1.51	1.63	1.53	1.61		−7	−1	−6	−1	−5	−6	−6	−7	−1				
	13	37		48.0	164.8	1.49	1.49	1.47	1.50	1.54		+1	−1	−3	+5	−3	+2	−3	+1	−1				
	14	24		32.9	148.1	1.18	1.29	1.19	1.19	1.20		−1	−1	−2	+1	−1	0	+8	+8	+8				

Females.	15	50		99.1	144.7	2.12	2.00	2.09	1.86	2.11		+1	+14	+1	+1	−12	−11	−5	−4	+8				
	16	10.5		86.5	144.3	1.93	1.86	2.00	1.75	1.92		−4	+10	+1	−4	−9	−13	−3	−7	+6				
	17	24		56.6	159.6	1.59	1.57	1.65	1.57	1.61		−4	+1	−1	−2	−3	−5	−3	−5	0				
	18	56		49.1	156.6	1.46	1.48	1.53	1.46	1.50		−5	0	−3	−2	−3	−5	−1	−3	+1				
	19	6.5		44.3	126.8	1.23	1.37	1.29	1.21	1.30		−5	+2	−5	+1	−7	−6	+5	+6	+13				
	20	35		37.1	151.7	1.26	1.34	1.31	1.27	1.32		−4	−1	−5	+1	−4	−3	+2	+2	+6				
Average deviation for males and females												2.8	3.3	2.9	1.6	4.3	4.2	5.4	5.7	4.8				
" " " "												2.3	2.7	2.9	1.5	3.4	2.9	6.3	6.1	4.4				
" " " females												3.8	4.7	2.7	1.8	6.3	7.2	3.2	4.5	5.7				
Benny L.	21	36	M.	24.2	110.3	0.85	1.12	0.85	0.84		0.85	0	+1				−1		(+32)*	(+33)*	0	(+32)*	0	−1
Morris S.	22	21	"	64.0	164.3	1.72	1.66	1.69	1.69		1.67	+2	+2				0		−2	−2	+3	−1	+1	+1
R.H.H.	23	22	"	64.1	178.0	1.79	1.69	1.77	1.79		1.84	+1	0				+1		−5	−6	−3	−8	−4	−3
E.F.D.B.	24	32	"	74.1	179.2	1.94	1.80	1.88	1.92		1.90	+3	+1				+2		−4	−6	+2	−5	−1	+1
Gerald S.	25	18	"	45.2	171.8	1.48	1.47	1.49	1.50		1.49	−1	−1				+1		−1	−2	−1	−1	0	+1
Fab. R.S.	26	13	"	32.7	141.5	1.14	1.28	1.15	1.15		1.19†	−1	−1				0		+11	+11	−4	+8	−3	−3
R. H. S.	27	22	"	63.0	184.2	1.81	1.69	1.80	1.82		1.80	+1	−1				+1		−6	−7	+1	−6	0	+1
Mrs. McK.	28		F.	93.0	149.7	2.06	1.94	1.90	1.85		1.86	+8	+11				−3		+2	+5	+11	+4	+2	−1
Anna M.	29	1.8	"	6.27	73.2	0.40	0.85	0.36	0.34		0.37	+11	+17				−6		(+136)*	(+150)*	+8	(+130)*	−3	−8
Emma W.	30	26	"	57.6	164.8	1.63	1.59	1.60	1.61		1.65	+2	+1				+1		−1	−1	−1	−4	−3	−2
Average deviation for males and females												3.0	3.6				1.6		4.0	5.0	3.4	4.6	1.7	2.2
" " " "												1.3	1.0				0.9		4.8	5.7	2.0	4.8	1.3	1.6
" " " females												7.0	9.7				3.3		1.5	3.0	6.7	4.0	2.7	3.7

* Figures in parentheses excluded from average.

† Adhesive plaster method = 3.3 per cent too high.

Subjects 1 to 20 are those published by Benedict in the *American Journal of Physiology*, 1916, xli, 289, Table 1.

Subjects 21 to 30 are those published by Du Bois and Du Bois in the *Archives of Internal Medicine*, 1916, xvii, 867, Table 3; *Archives of Internal Medicine*, 1915, xv, 876, Table 4; Sawyer, Stone, and Du Bois, *Archives of Internal Medicine*, 1916, xvii, 862, Table 4.

The following statement of Benedict concerning the surface areas obtained by the photographic and by the Du Bois linear methods appears to us fully as applicable to a comparison between the surface areas obtained by the Du Bois height-weight formula and those calculated for normal adults by the formulas derived from the Harris and Benedict correlation formulas: "Comparisons between the photographed areas and the body surface as computed from the Du Bois linear formula show, even with the most diverse configurations of body, a constancy rarely observed in anatomical measurements or in computed ratios based upon such measurements."

A comparison similar to that for subjects shown in Table II may be made of the surface areas calculated by the Du Bois height-weight formula and by the formulas derived from Harris and Benedict's heat prediction formulas throughout the entire range of Harris and Benedict's tables. In Chart 1 are plotted curves for surface areas as calculated by the two methods for the extreme heights of 151 and 200 cm. between the ranges of 25 and 124 kilos for men and women. In Chart 2 are plotted the percentage variations of the Benedict curves from the Du Bois curves shown in Chart 1. From these curves it is evident that the greatest possible discrepancy between the two methods amounts to 19 per cent if restricted to the limits given in the Harris and Benedict tables, and occurs in men who are very fat and extremely short for their weight. Near this extreme range, however, there is a discrepancy of -11 per cent between the area calculated by the Du Bois height-weight formula from that by the Du Bois linear, while there is only a $+7$ per cent discrepancy between the area calculated by the Benedict formula for males from that by the Du Bois linear as illustrated by Subject 1 in Table II. If it is assumed that the linear formula and the photographic method are the most accurate methods, then the surface area obtained from Harris and Benedict's formula for men may, at these extreme ranges, predict the surface area with nearly the same accuracy as the Du Bois height-weight formula. Harris and Benedict, however, warn against the application of their formulas beyond the ranges given in their table, thus creating the suspicion that likewise the extreme ranges utilized are also open to question. The direction and position of their curves for women in relation

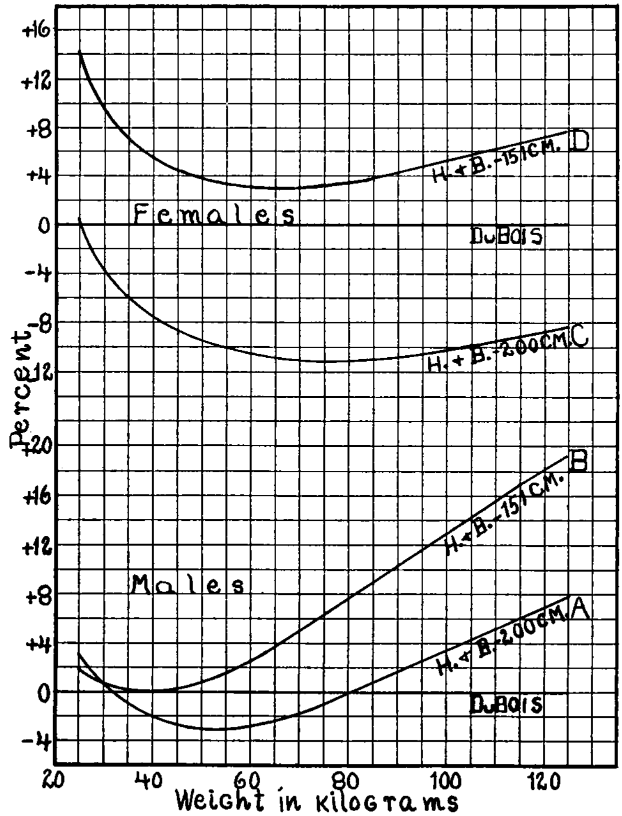

CHART 2. Percentage variation of the surface areas as calculated by the derived Harris and Benedict formulas from that calculated by the Du Bois height-weight formula. Curves A and B represent the percentage variation of the surface area as calculated by the Harris and Benedict formulas for men from that calculated by the Du Bois formula as shown in Chart 1. Curve A is for a constant height of 200 cm. and Curve B is for a constant height of 151 cm. Similarly for women, Curve D represents the percentage variation of Curve B from Curve A of Chart 1 (height 151 cm.) and Curve C the percentage variation of Curve C from Curve E of Chart 1 (height 200 cm.). These curves illustrate the extreme limits of the percentage variation of the surface area as calculated by the formulas derived from the Harris and Benedict heat prediction formulas (for any height or weight included in their tables) from the surface area as calculated by the height-weight formula of Du Bois and Du Bois.

to their curves for men indicate why prolongation, especially of the formula for women, leads to improbable values for the surface area. It seems likely that that formula is best within limits which also allows with equal accuracy an extension beyond those limits. Chart 1 also reveals the peculiar fact that according to Harris and Benedict the value of the height-weight factor is for a woman 151 cm. in height and 25 kilos in weight, 9 per cent larger, while for a woman 200 cm. in height and 25 kilos in weight this is 2 per cent smaller than for a man of similar size; likewise for a woman 151 cm. in height and 124 kilos in weight, this height-weight factor is 9 per cent smaller, and for a woman of 200 cm. and 124 kilos in weight it is 17 per cent smaller than for a man of similar size. Harris and Benedict have as yet offered neither a reasonable explanation, nor sufficient experimental proof, to justify the embodiment of such a peculiar variation of the effect of height-weight on the heat production between men and women as to incorporate the same into a formula for the prediction of standards of heat production.

From these curves it is evident, however, that usually nearly the same values for variation in height and weight are utilized in the prediction of heat production in subjects of average adult size, both by the heat formulas of Harris and Benedict and the formulas of Du Bois and Du Bois, regardless of the theoretic considerations of surface area underlying the derivation of the formulas. Certain discrepancies in the relationship between the Harris and Benedict formulas for men and women as mentioned, however, indicate that the height-weight formula of Du Bois is of more general applicability.

On the other hand, an analysis of the predicted total calories for the effect of age reveals marked discrepancies in the value allotted to the age factor by Du Bois and by Harris and Benedict. By basing his comparisons for age on calories for each square meter of body surface Du Bois makes the same percentage decrease in heat production in a small or a large subject for increasing age; Harris and Benedict on the other hand subtract exactly the same number of calories for a given increase in age, regardless of the size of the subject. For example, as illustrated by Chart 3, the Du Bois method predicts a 10 per cent reduction in the basal heat production for a man 70 years of age, of any size, as compared with a man of a similar height and weight at the age of 20 years; Harris and Benedict on the contrary predict that a large subject (124 kilos, 200 cm.) will have a heat production 12.5 per

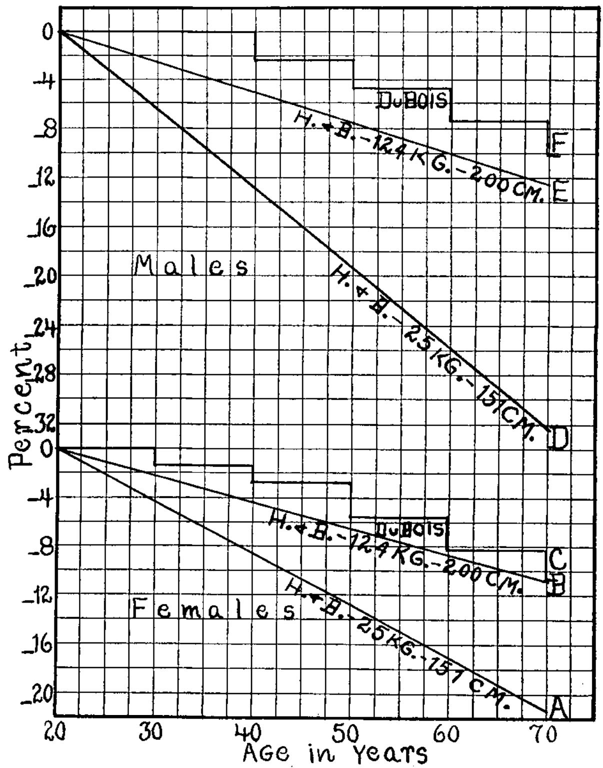

CHART 3. The percentage decrease in the heat production for increasing age. Curve A for women and Curve D for men show the percentage decrease in heat production for small subjects with heights of 151 cm. and weights of 25 kilos, as predicted by Harris and Benedict; Curve B for women and Curve E for men are the percentage decreases according to Harris and Benedict in the heat production for advancing age, as predicted for large subjects with a height of 200 cm. and a weight of 124 kilos. Curve C for women and Curve F for men illustrate the percentage decrease in heat production for increasing age, as predicted by the Du Bois normal standards. It is to be noted that according to Du Bois the size of the subject does not alter the percentage decrease of the heat production for advancing age, while according to Harris and Benedict a much greater percentage decrease occurs in small than in large subjects.

cent less, and a small subject (25 kilos, 151 cm.) will have a heat production 32 per cent less at 70 years of age as compared with similar subjects 20 years of age. It does not appear to be in accordance with the facts, nor does it seem logical to assume, that a small man will show more than twice the percentage decrease in heat production for advancing age than a large man. The formula for women shows this same peculiarity (Chart 3) but to a lesser degree. We believe that the Du Bois age factor is more in accordance with the data at present available than that of Harris and Benedict.

In his normal standards Du Bois makes the same percentage difference in heat production for sex at any constant age, regardless of the size of the subject, because he bases his comparisons on calories for each square meter of body surface. In contrast, Harris and Benedict predict on the one hand a markedly lower heat production for large women than for similar sized men, but on the other hand they make the astounding prediction, which is contrary to their general conclusion, that the heat production of small women is greater than that of similar sized men. This peculiarity of their prediction formulas is illustrated in Chart 4, in which it is shown that, at the age of 21 years, a small woman (25 kilos, and 151 cm.) will have a heat production 5 per cent greater, and at the age of 70, a heat production 22 per cent greater than that of a man of similar height and weight at those respective ages. The assumption of such a reversed effect of sex on the heat production in small as opposed to large subjects does not appear to us to be sufficiently established by the data at present available to justify its incorporation into a prediction formula, particularly since theoretically it seems much more likely that both age and sex affect the heat production of large and small subjects in the same direction and probably also in approximately the same degree.

The larger discrepancies between the basal metabolic rate, as predicted from the formulas of Harris and Benedict and from those of Du Bois, result usually from a summation of the small discrepancies found for height and weight and the larger ones for age and sex; in some instances there is entire agreement as to the value of the different groups of factors, while in others the discrepancies approximately balance one another, thus accounting for the parallelism between the basal metabolic rate calculated by the Du Bois and by the Harris and Benedict standards, as found by Boothby and Sandiford and by Means and Woodwell.

Constants for age and sex must always be used in the prediction of the basal metabolic rate, either by proper standards for varying

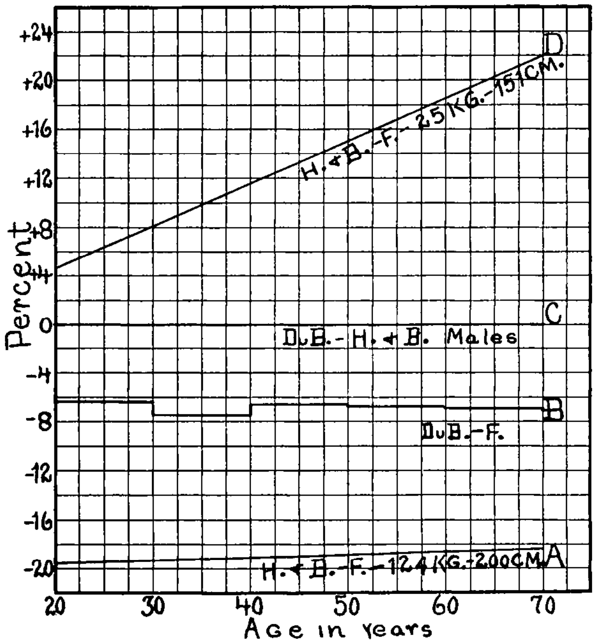

CHART 4. Effect of sex on the heat production. Curve A represents the percentage variation of the basal heat production of a large woman (200 cm. and 124 kilos) from a similar sized man between the ages of 20 and 70 years, as predicted by Harris and Benedict. Curve B is the prediction of Du Bois and is the same for all women, regardless of their size. Curve C is the percentage base line. Curve D is the prediction of Harris and Benedict for a small woman (151 cm. and 25 kilos) as compared to a similar sized man.

age and sex as done by Du Bois, or by the introduction of the constants directly into the formula as done by Harris and Benedict. Certain critics of the Du Bois surface area normal standard method neglect to emphasize the Du Bois standards for age and sex and refer simply to surface area, and they so state their arguments that to the superficial reader it may appear that Du Bois does not utilize the age and sex factors in the prediction of the normal basal metabolism. Such an implication is as unwarranted as it would be to refrain from using appropriately the four tables of Harris and Benedict one of which is for height and age in men, another for height and age in women, while the third and fourth are for the weight of men and women, respectively.

We, as well as all other recent writers, agree with Benedict that the rate of heat production is neither controlled by the area of the body surface, nor at the present stage of the evolution of man caused by the influence of cooling on the body; we also agree that in all probability the heat production is proportional to the active protoplasmic mass of the body for any given age and sex. However, as the protoplasmic mass of the body must be related to the total body nitrogen and since Moulton has shown that the surface area of beef cattle is a power function of the total body nitrogen, the formula being $S = N^{\frac{2}{3}}$, there is direct experimental evidence to the effect that the protoplasmic mass is proportional to the surface area. Furthermore, the constants of the height and weight as used by Harris and Benedict and by Du Bois and Du Bois, although derived by entirely different methods and from diametrically opposite theoretic considerations, lead to an estimation of the surface area in the average adult subject with practically equal accuracy. This remarkable fact seems to us, when taken in conjunction with the average demonstrated parallelism in the basal metabolic rate as calculated by the two methods, to be additional evidence that the surface area is the most exact method at present available for estimating the active protoplasmic mass and in consequence the best method, in conjunction with appropriate standards of age and sex, for predicting the basal heat production.

CONCLUSIONS.

1. It is shown that there is remarkable agreement between the surface area calculated by the Du Bois surface area formulas and the formulas derived from Harris and Benedict's biometric correlation formulas for the prediction of the basal heat production.

2. Since the factors for height and weight, as used by Harris and Benedict in their formulas for predicting the basal heat production, admit of the calculation of the surface area of subjects who have been measured by casts or Benedict's photographic method with approximately the same variation as that between the Du Bois height-weight formula and the Du Bois linear formula, the contention of Lusk and Du Bois is strengthened that the basal heat production, for a given age and sex, is proportional to the surface area.

3. As a marked difference exists between the Du Bois and the Harris and Benedict factors for age and sex, the major discrepancies between the basal metabolic rate as calculated from the two standards are due to the difference in values attributed thereto, especially when those of the latter are superimposed on the small differences obtained from the slightly different height-weight factors of the two methods.

4. Harris and Benedict, in their correlation formula, assume that a small subject will show more than twice the percentage decrease in heat production for advancing age than a large subject, while Du Bois assumes that age affects alike both small and large people.

5. Harris and Benedict assume a reversed action for sex, depending on the size of the subject, by predicting first that large men have a greater heat production than similar sized women and second that small women have a greater heat production than small men.

6. Until Harris and Benedict prove that the effect of age and of sex is different in large and small men and women, and that small women have a greater heat production than small men, it is best to adopt the factors of Du Bois which are in better accordance with the evidence at present available, namely that age and sex produce at least approximately the same percentage alteration in different subjects, regardless of their size.

7. The Du Bois formula for the determination of the surface area and the Du Bois normal standards of heat production for each square meter of body surface for age and sex are considered by us the best method at present available for predicting the normal heat production.