Brit. J. prev. soc. Med. (1954) 8, 99–107

BODY-WEIGHT OF MEN RELATED TO STATURE, AGE, AND SOCIAL STATUS

WEIGHT OF SCOTSMEN MEASURED IN 1941

BY

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Body-weight has been studied in many different ways and for many different purposes. For example, it forms a part of several anthropometric indices whose object is the definition of physical types (*e.g.* Naccarati, 1921; Sheldon, Stevens, and Tucker, 1940); it may be used as a measure of growth, as in the Harvard Growth Study (Shuttleworth, 1937); it is also regarded as a pointer to clinical conditions, and so is observed as a routine in physical examinations. There is good reason for doing this, since insurance records indicate that mortality differs amongst men of different weights (Fisk, 1923), and since there is also evidence that some clinical conditions occur more frequently in men of certain physiques than in others (Draper, 1924). In view of the subject's wide significance, it is not to be wondered at, therefore, that numerous statistics on body-weight have been compiled (Kemsley, 1952).

It should be observed that data about body-weight are regarded as a measure. If, however, a measure is to be treated as a standard, the conditions under which the measure varies should be clearly recognized. Unfortunately, this has rarely been the case in discussions of body-weight. The available series of data are deficient: sometimes because they are inadequate statistically; sometimes because they appear to relate to a whole population when, in fact, they apply only to a particular section; sometimes because data about one population are treated as though applicable to a different one; and almost always because the influence of social and economic factors, which change with the passage of time, is overlooked, so that figures collected, say, 20 or even 40 years ago, continue to be treated as a standard for the present day.

It is the purpose of this paper to reveal the importance of these issues by a detailed analysis of records relating to a single homogeneous population. Because they satisfy the basic requirements of the analysis, and because they were readily available, the figures used are those for Scotsmen contained in the war-time (1939–45) medical records of the Ministry of Labour and National Service.

MATERIAL

The analysis is based on measurements recorded on 3,692 men who were medically examined by the Scottish medical boards of the Ministry of Labour and National Service in 1941. An account of the material used and of the information abstracted from the records has already been published (Clements and Pickett, 1952). In the course of this earlier analysis it became apparent that the National Service records of men refer to a random sample within occupations and age groups, but that the numbers in the groups are not in proportion to their occurrence in civil life. The age range of the records extends only from 18 to 40 years, so that no elderly men are included in the material. Nevertheless the changes in body-weight with age are very similar to the findings of a recent survey (Kemsley, 1952) which includes men in the older age groups, and there can be no doubt that the data have been sufficient to establish the main changes in body-weight with age.

ANTHROPOMETRIC DATA—The subjects were weighed, wearing trousers only, on weighing machines of the "Steelyard" type, reading accurately to 2 oz. The accuracy of the machines was checked periodically. A few records were to fractions of a pound, and in the process of abstracting the data, all records of fractions of ½ lb. or more were taken to the pound above. A frequency distribution of the measurements of weight by intervals of 1 lb. shows no serious bias in recording the weight. Nevertheless, the exact stone and half stone are favoured measurements, and weights recorded to an even number of pounds are more frequent than those recorded to an odd number of pounds.

RESULTS

ANALYSIS OF DATA ON WEIGHT.—The mean weight for the whole sample of 3,692 records is 138·2 ± 0·3 lb. The mean weight of Scotsmen aged 20·5 years is 136·3 lb., and the mean for 9,623 native Scotsmen aged between 20 and 21 weighed in

TABLE I
MEAN WEIGHTS FOR REGIONS BY AGE GROUPS

Region	Age Groups				All Ages
	17–19	20–29	30–39	40–42	
Southern	136·7±1·4 (130)	143·6±1·5 (140)	141·3±1·8 (138)	— (1)	140·6±0·9 (409)
West Central ..	131·3±0·7 (366)	136·2±0·9 (384)	137·2±1·0 (339)	133·6±4·0 (14)	134·8±0·5 (1,103)
East Central	133·3±1·0 (258)	137·4±0·9 (320)	136·2±1·0 (317)	—	135·8±0·6 (895)
Northern	138·1±0·9 (318)	142·3±0·9 (337)	143·1±0·8 (601)	152·3±4·4 (29)	141·9±0·5 (1,285)
Total	134·4±0·5 (1,072)	139·1±0·5 (1,181)	139·9±0·5 (1,395)	146·5±3·4 (44)	138·2±0·3 (3,692)

Means in lb. Numbers in each sample shown in brackets.

the nude in 1939 is 135·3 ± 0·2 lb. (Martin, 1944). Martin states that in 1939 the men were measured nude. Evidently 20-year-old men in 1941 may have been 1 lb. lighter, on the average, than those in 1939, after allowing 2 lb. for the weight of trousers.

The medical boards were grouped into the four regions used by the Registrar-General for Scotland. The mean weights for the regions are set out in Table I. Those for the Northern Region have the greatest mean weight and those from the West Central Region the lowest. The mean weights, alsd set out by age groups in Table I, show an upwaro trend with increasing age.

The statistics presented in Table I relate to heterogeneous data so far as socio-economic groups are concerned. The records were therefore separated into the social classes of the Registrar-General according to the man's stated occupation. Certain samples of small geographical areas, termed "separate" areas, showed a significant variation in stature from the mean for the whole region of which they were isolated parts, and these have been excluded from the data relating to each social class. The study of the "separate" areas indicates the extent of the geographical variation, and this is given in detail in a later section. The reclassified data are shown in Table II (opposite), which gives the mean weights of the samples of men by region and social class, standardized to an age of 26 years and a height of 67 inches, so as to take into account differences in the distribution of stature and age in the samples. The average weight of the sample of men in Social Class 1.2 from the Northern Region is 145·3 ± 2·0 lb. and the samples from this region have the greatest mean weights in every social class. In Social Class 1.2, the sample from the West Central Region has the smallest mean weight, 138·4 ± 1·2 lb. However, little difference exists between the average weights of the samples of men from the East and West Central Regions in each class, and one or other of these samples always provides the smallest mean weight.

DISTRIBUTION OF MEASUREMENTS OF WEIGHT.—The distribution of weight and the relationship of weight to both stature and age have been determined for the samples of each social class.

Measurements of body-weight are not Normally distributed when they are measured in pounds, but if they are transformed into a logarithmic scale the resulting distribution is almost Normal (Kemsley, 1952; Yuan, 1933). This finding has been confirmed by our own samples.

The samples from the social classes were examined separately by the method described by Snedecor (1946). The statistics indicating kurtosis and skewness were significant, thus indicating an excess of records round the mean and at the end of the distribution. After making a logarithmic transformation of the data the statistics were no longer significant in three out of four of the samples examined, but the exceptional sample (that of Social Class 4) still had a positive kurtosis after transformation. After combining the material for all the social classes, a comparison of the observed frequencies after transformation with the calculated frequencies assuming a Normal distribution shows that the distribution is not Normal ($\chi^2 = 35\cdot8$, *d.f.* 17). However, only three groups show a large variation between the observed and expected frequencies, and these occur in the middle of the distribution. There were no obvious discrepancies at either end of the distribution, and it may therefore be regarded as Normal for all practical purposes.

The variances of the log-weight distributions within groups of stature having a 2″ range are shown to be homogeneous by Bartlett's test (Bartlett, 1937). Thus the bivariate distribution of stature and the logarithm of weight is homoscedastic. These findings imply that a logarithmic scale rather than the more usual arithmetical one is more suitable for recording measurements of body-weight. The mean weight in pounds derived from the data after recording them on a logarithmic scale is 136·6; this approximates to the median value of 136·9 lb. and is about 2 lb. less than the arithmetical mean of the untransformed data. The relationship between the mean values may be expressed as follows:

Observed mean weight (lb.) = 1·045 mean log-weight (lb.) − 5·098.

TABLE II

MEAN WEIGHTS RELATED TO SOCIAL CLASSES AND GEOGRAPHICAL REGIONS

Data	Region	Social Class			
		1.2	3	4	5
Derived from measuring weight in pounds avoirdupois	Southern	142·1±3·2 (28)	—	143·0±1·9 (85)	—
	West Central	138·4±1·7 (105)	138·9±0·7 (542)	140·1±1·3 (188)	140·8±1·1 (174)
	East Central	139·6±2·1 (77)	138·9±0·8 (455)	140·3±1·5 (136)	139·7±1·1 (227)
	Northern	145·3±2·0 (129)	143·3±0·8 (464)	143·2±1·5 (163)	144·7±0·9 (319)
	Total	141·7±1·1 (339)	140·2±0·4 (1,461)	141·5±0·8 (572)	142·2±0·6 (720)
Derived from logarithm of measured weight (lb.)	Southern	2·1498±0·0095	—	2·1519±0·0059	—
	West Central	2·1375±0·0054	2·1395±0·0022	2·1428±0·0040	2·1460±0·0037
	East Central	2·1411±0·0066	2·1394±0·0024	2·1439±0·0045	2·1420±0·0035
	Northern	2·1577±0·0056	2·1528±0·0025	2·1523±0·0045	2·1575±0·0029
	Total	2·1470±0·0032	2·1437±0·0014	2·1471±0·0023	2·1498±0·0019
Means for regional samples homogeneous for log-weight after excluding heterogeneous areas	West Central		2·1450±0·0032 (276)		
	East Central		2·1406±0·0028 (355)		
	Northern		2·1476±0·0038 (220)		2·1409±0·0055 (87)
	Total		2·1439±0·0018 (851)		2·1432±0·0023 (488)

Medical boards comprising regional samples are homogeneous except where indicated for stature and for weight measured as the logarithm of weight.
Mean weights standardized to age 26 yrs, and height 67 in.

The weight of each man has been transformed into the logarithm (to base 10) of the weight in pounds (henceforth referred to as "log-weight") and the relationship of weight to other variables has been investigated using measurements of weight in this form.

The standard deviation of the whole distribution of weight in men is 17·8 lb. (0·0553 log lb.) when measured on the transformed scale. Clearly, in a measurement with so large a variance, the distribution must always be taken into account, and this implies that mean weights should only be used as descriptive statistics.

RELATIONSHIP OF WEIGHT TO STATURE.—The bivariate distribution of log-weight and stature is given in Table III. For convenience, the stature groups have a span of 2 in. in the Table, but the computations have been made on the ungrouped data. The coefficient of correlation between the two measurements is 0·595 and compares with the average value of 0·61 found in the past for weight and stature (Kemsley, 1952). If the relationship between two variables is linear it may be expressed in the form of a regression equation $y = a + bx$, where x and y are variables, a is a constant, and b is the regression coefficient. The last statistic indicates

TABLE III

DISTRIBUTION OF BODY-WEIGHT (log lb.) AND STATURE (in.)

Log-weight	Stature									
	57–58·99	59–60·99	61–62·99	63–64·99	65–66·99	67–68·99	69–70·99	71–72·99	73–74·99	75–76·99
2·350–2·399	—	—	—	—	—	—	—	1	1	—
2·300–2·349	—	—	—	—	—	2	2	2	0	—
2·250–2·299	—	—	—	1	7	13	17	11	5	—
2·200–2·249	—	—	2	6	42	87	90	42	17	1
2·150–2·199	—	2	7	60	199	273	213	74	7	—
2·100–2·149	—	2	33	198	414	370	125	18	6	—
2·050–2·099	1	8	67	170	188	102	18	—	—	—
2·000–2·049	4	14	52	60	34	8	—	—	—	—
1·950–1·999	0	3	6	2	3	—	—	—	—	—
1·900–1·949	2	—	—	—	—	—	—	—	—	—
99th centile	2·1309	2·1552	2·1795	2·2038	2·2282	2·2525	2·2768	2·3012	2·3255	2·3498
Observed mean	2·0120	2·0518	2·0731	2·1021	2·1264	2·1474	2·1711	2·1937	2·2093	2·2175
Mean from regressions	2·0283	2·0526	2·0769	2·1012	2·1256	2·1499	2·1742	2·1986	2·2229	2·2472
1st centile	1·9257	1·9500	1·9743	1·9986	2·0230	2·0473	2·0716	2·0960	2·1203	2·1446

that the variable y increases a constant amount for each unit increase in the other variable. The observed mean log-weights, and the estimated values derived from regression, are given for stature groups in Table III. It will be seen that they are very similar, a finding which suggests that the relationship between log-weight and stature is linear, and this relationship was confirmed by an analysis of variance after grouping the data on stature into groups with a range of 1 in. Thus, itmay be concluded that, when expressed in log lb., the rate of increase in weight is, on the average, the same for equal increases in stature measured in inches. Other recent data (Kemsley, 1952) indicate that the relationship of body-weight (lb.) and stature is linear for practical purposes. Probably because of the limited range within which the mean values occur, the trends of mean body-weights with increasing stature are much the same for measurements of weight recorded either on an arithmetical or logarithmic scale.

The regression coefficients relating log-weight to stature have been calculated from the data for the social classes separately. The coefficients do not differ significantly, so that the estimates have been pooled, and the best estimates of the regression coefficient (b) is $+ 0{\cdot}0122 \pm 0{\cdot}0003$ log lb./in. This analysis establishes the following relationship between stature and log-weight:

Log-weight (log lb.) $= 0{\cdot}0122$ Stature (in.) $+ 1{\cdot}323$.

The values corresponding to the mean, the 1st, and the 99th centiles of the weight distribution for each stature group are given in Table IV in log lb.; these results have been transformed into pounds weight, and the regression, 1st, and 99th centile lines for weight on stature are given in Fig. 1.

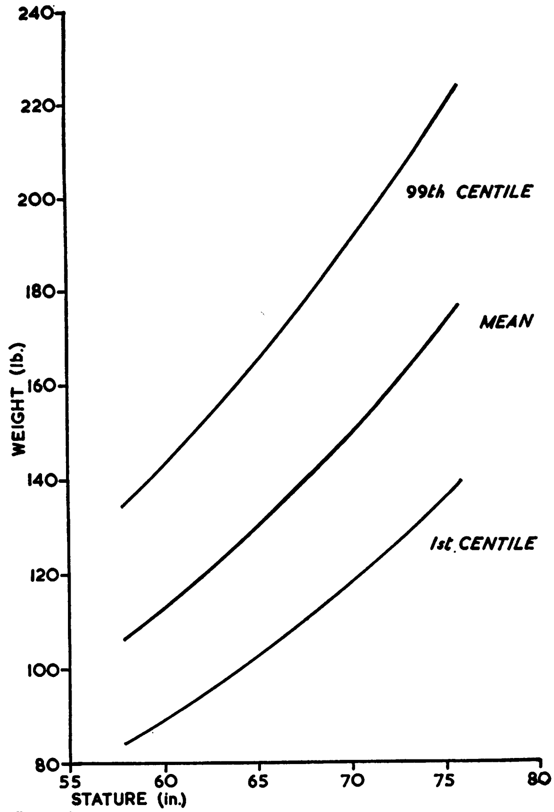

FIG. 1.—Regression, 1st, and 99th centile lines for weight on stature Values calculated in log lb. have been transformed into pounds avoirdupois.

RELATIONSHIP OF WEIGHT AND AGE.—A bivariate frequency distribution of log-weight and age is given in Table IV with the mean values at each age.

TABLE IV
DISTRIBUTION OF BODY-WEIGHT (log lb.) AND AGE (yrs)

Log-weight	Age													
	17	18–19	20–21	22–23	24–25	26–27	28–29	30–31	32–33	34–35	36–37	38–39	40–41	42–
2·350–2·399 ..	—	—	—	—	—	—	—	—	1	—	1	—	—	—
2·300–2·349 ..	—	1	1	—	—	—	—	—	—	1	3	—	—	—
2·250–2·299 ..	—	5	8	—	2	2	3	4	7	6	14	3	—	—
2·200–2·249 ..	—	46	41	4	10	20	30	25	15	31	60	1	3	1
2·150–2·199 ..	—	210	151	9	21	44	52	74	45	66	141	16	6	—
2·100–2·149 ..	1	363	237	9	25	62	61	74	56	65	186	15	12	—
2·050–2·099 ..	2	192	106	3	8	23	18	32	27	32	97	10	4	—
2·000–2·049 ..	—	47	40	1	2	8	9	6	8	8	31	10	2	—
1·950–1·999 ..	—	5	1	—	—	1	—	—	—	1	5	1	—	—
1·900–1·949 ..	—	1	—	—	—	—	—	—	—	—	1	—	—	—
99th percentile ..	2·2373	2·2415	2·2457	2·2499	2·2539	2·2579	2·2618	2·2657	2·2697	2·2735	2·2773	2·2810	2·2848	2·2885
Observed mean ..	2·0875	2·1258	2·1309	2·1453	2·1532	2·1410	2·1487	2·1444	2·1443	2·1497	2·1371	2·1195	2·1334	2·2480
Mean from regressions	2·1283	2·1298	2·1313	2·1329	2·1344	2·1359	2·1374	2·1389	2·1405	2·1420	2·1435	2·1450	2·1466	2·1481
1st percentile ..	2·0193	2·0181	2·0169	2·0159	2·0149	2·0139	2·0130	2·0121	2·0113	2·0105	2·0097	2·0090	2·0084	2·0077

For convenience the age groups have a span of 2 years in the Table, but the computations have been made on the data grouped into intervals of 1 year.

The relationship between weight and age is difficult to express mathematically; both linear and quadratic* equations have been fitted to the data for each social class. The regressions of log-weight on age, both with and without the square of age, are parallel in the different social classes, but the mean weights of each class differ significantly. The regression coefficients may therefore be pooled but the constants of the equations will differ. This finding is expected, because the data have not been standardized for stature differences.

The estimated value of the linear regression coefficient (b_1) is $+0\cdot00076 \pm 0\cdot00013$ log lb./yrs.

The constant takes the following values:

Class 1.2 + 2·116; Class 3 + 2·115;
Class 4 + 2·108; Class 5 + 2·128;
Pooled Classes + 2·115.

These statistics provide the relationship:

Weight (log lb.) = Constant + 0·00076 Age (yrs).

The estimated values of the regression coefficients for the quadratic relationship are:

$b_1 = +0\cdot0115 \pm 0\cdot0017$
$b_2 = -0\cdot00020 \pm 0\cdot00003$.

The constant takes the following values:

Class 1.2 + 2·024; Class 3 + 1·950;
Class 4 + 1·960; Class 5 + 2·016;
Pooled Classes + 1·979.

These statistics provide the relationship:

Weight (log lb.) = Constant + 0·0115 Age (yrs) − 0·00020 (Age)^2.

The quadratic equation gives a better fit over the age range of 17 to 30 years, but the linear regression is more satisfactory after age 30.

The values corresponding to the mean, the 1st, and the 99th centiles of the weight distribution in each age group have been derived from the linear regression and are given in Table IV in log lb. These results have been transformed into lb. weight and the regression, 1st, and 99th centile lines for weight on age are given in Fig. 2.

The mean weights show the same trend with age as do both the war-time survey made by the Ministry of Food (Kemsley, 1950), and a survey of Royal Air Force personnel (Morant, 1946). A steady increase in mean weight occurs up to age 30, a trend which is similar to that shown by all earlier reports. After age 30, changes in the mean weights are small. This

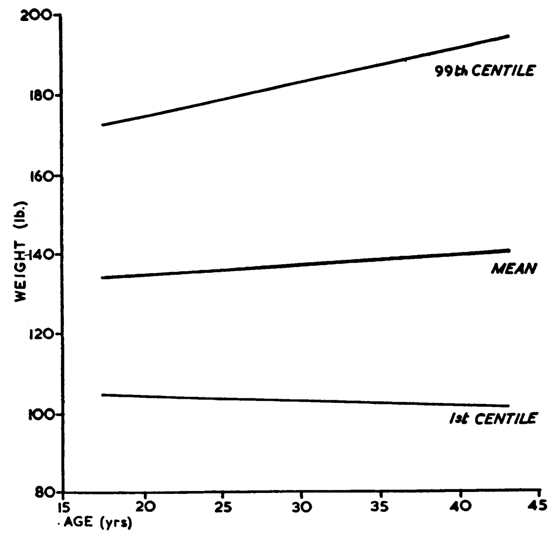

FIG. 2.—Regression, 1st, and 99th centile lines for weight on age.

result contrasts strongly with those of earlier studies, all of which indicate an increase in weight with age after the 30th year has been passed (see Kemsley, 1952). Kemsley's data show that the trend of mean weight with age in men older than 40 years is similar to that found for men aged between 30 and 40 years. These findings may reflect war-time conditions, and it is uncertain whether they apply to present-day conditions. However, the fact that a similar trend exists amongst American service personnel (Newman, 1952) suggests that the findings cannot be entirely attributed to war-time rationing.

The variance of body-weight expressed in log lb. is not homogeneous in each age group. It increases from 0·0023 log lb. in men aged 18 to 19 years to 0·0041 log lb. in those aged 38 to 40 years. The observed variances have been smoothed by fitting a linear regression, and the resulting smoothed values have been used to provide estimates of the 1st and 99th centile limits of body-weight in each age group. These estimates are based on the mean weight at each age after smoothing the observed values by a linear regression. (For convenience, a linear regression has been employed over the whole age range). It is apparent that the values of the 1ts centile change from 104 lb. at age 18–19, to 102 lb. at age 36–37. These values represent the lower limits of the distribution and only diverge slightly from the trend of the mean values. On the other hand, the 99th centile, which may be taken to represent the upper limit of the distribution, diverges considerably. The 99th centile limit at age 18–19 is 174·4 lb., and at age 36–37 is 189·4 lb. These findings confirm those

* Equations of the form

$$y = a + bx + cx^2,$$

where x and y are variables, a is a constant, b is the regression coefficient for the 1st degree term, and c is the regression coefficient for the 2nd degree term.

of Kemsley (1952) who concluded that, if the assumption is made that men retain about their same relative position in the distribution of weight from year to year, the increase in mean weight with age is not due to a general increase by every man, but rather to the fact that some men show large increases in weight while others show little or none.

SECULAR TRENDS.—The mean weights of men by age groups and social classes are given in Table V, in lb. derived from the untransformed data and standardized for height, together with similar material (for Great Britain) which was recorded about the year 1880 (British Association Anthropometric Survey, 1883). The mean weight increases in each social class up to the age of about 30 years. The succeeding period of 10 years shows little change in the mean weights with age, with the exception of the mean weights of men in Social Class 1·2 which increase by about 7 lb., and where the trend is much the same as in earlier studies.

The mean weights of men aged 20–29 years in all the social classes are greater than the corresponding samples of men aged 17–19 years, but the increase in weight over the period is not the same in each social class. The early data which are available suggest that the differences are now less than they used to be, because young men under 20 years of age weigh more, on the average, than they used to. For example, the mean weight of men in Social Class 3 aged 20–29 years in 1941 is 3·7 lb. more than that of the sample of men aged 17–19 years, whereas the difference in 1880 was 9·4 lb.

STANDARDIZATION OF LOG-WEIGHT FOR STATURE AND AGE.—The relationship of log-weight to the variables of stature and age taken together requires consideration. The partial regression coefficients have been derived from a multivariate analysis. The coefficient on stature is always significant, but in Class 1.2 neither age nor the square of age is significant, largely because of the higher error attributable to the smaller numbers. The regressions relating log-weight, stature, and age have been examined within the different social classes by means of a covariance analysis, because, although the variances about the within-class regressions are not homogeneous, the amount of heterogeneity is unlikely to affect the conclusions arrived at by pooling the regressions. The regression coefficients do not differ significantly and the best estimates have been derived from the data for the pooled social classes.

The partial regression coefficient relating log-weight and stature (b), keeping age constant, is:

$$+ 0{\cdot}0127 \pm 0{\cdot}0004.$$

The partial regression coefficients relating log-weight to age (c) and the square of age (d), keeping stature constant, are respectively:

$$+ 0{\cdot}0103 \pm 0{\cdot}0017 \text{ and } - 0{\cdot}000168 \pm 0{\cdot}000031.$$

These statistics taken together establish the following relationship:

$$\text{Weight (log lb.)} = 1{\cdot}141 + 0{\cdot}0127 \text{ Stature (in.)} + 0{\cdot}0103 \text{ Age (yrs)} - 0{\cdot}000168 \text{ (Age)}^2.$$

In the remaining sections of this paper, the significance of differences between mean log-weights have been tested by multiple covariance analyses which take into account the differences in mean stature and age (including the square of age) between the samples.

GEOGRAPHICAL FACTORS.—The geographical variation in weight within a region is indicated by the detailed study of the data relating to the "separate" areas already referred to. The mean log-weight was calculated for each of the medical boards included in a region. When a significant difference was found, the sample for the medical board showing the greatest discrepancy when compared with the mean

TABLE V

STANDARDIZED MEAN WEIGHTS OF SCOTSMEN BY AGE GROUP AND SOCIAL CLASS

Age Group (yrs)	Data for Scotsmen				Comparable data from British Association Anthropometric Survey, 1883	
	Social Class				Social Class	
	1.2	3	4	5	1.2	3
17–19	132·7±1·8	134·5±0·6	135·3±1·2	135·2±1·2	131·4±0·3*	127·2±0·6*
20–29	137·7±1·7	138·2±0·7	139·7±1·2	142·1±1·1	138·2±0·4	136·6±0·6
30–39	144·7±1·9	140·5±0·9	142·0±1·2	141·2±0·8	154·7±1·6	146·8±1·2

* Variances derived from Scottish data.
Comparable data from B.A.A.S. (1883) have been standardized for stature and included for convenience. Seven pounds allowed for weight of clothing.
Mean weights standardized to a height of 67 in.

for the whole region was removed from the combination of boards and became a "separate" area. The procedure was repeated whenever it was necessary, until the remaining boards were homogeneous. The mean log-weights of the regions are given for each Social Class in Table II.

Social Classes 1.2 and 4 required no adjustment, but the areas represented by six medical boards in Class 3 and by three boards in Class 5 were defined as separate areas for weight. The mean log-weights for these areas, together with the mean log-weights of the separate areas previously defined for stature, are given in Table VI. The findings for weight and stature are remarkably consistent.

The samples of men from Lerwick for Social Classes 4 and 5, and from Wick for Social Classes 3 and 4, differed from the Northern Region on evidence provided by measurements of stature. A further class of each board is not homogeneous with the rest of the region when the measurement of log-weight is analysed; thus the areas of Lerwick and Wick are separate areas for Social Classes 3, 4 and 5. The mean log-weights of men in Social Classes 3 and 5 at Kirkwall and Inverness differ from the mean log-weight of the rest of the region. The Northern Region may thus be separated into two parts:

Part 1 includes Lerwick, Kirkwall, Wick, and Inverness, where either the mean stature or the log-weight is above average in Social Classes 3 and 5 (and also in Class 4 for Lerwick and Wick.)

Part 2 comprises the urban areas of Aberdeen and Perth.

The mean statures of samples of men in Social Class 5 from Paisley and Glasgow are below the average stature for the West Central Region, and the mean weight of the sample of men from Social Class 3 from both these areas is below the average weight of the Region.

The mean weight of men in Social Class 3 is less in Edinburgh than in the rest of the East Central Region.

The mean weight of the homogeneous and adjusted regions proved to be homogeneous for each social class, and these have been combined into a national sample for each social class. The means of each of these samples are given in the "Total" entry in the centre and lower parts of Table II.

WEIGHT RELATED TO SOCIAL CLASS.—The unstandardized mean weights of the samples of the social classes look different. For example, the mean weight of Social Class 1.2 is 141·6 lb. whereas that of Social Class 5 is 134·9 lb.

The differences between the mean weights of the national samples of the social classes are, however, not significant after standardizing for both stature and age (including the square of age). It is clear that the apparent differences between the mean weights of the classes are mainly accounted for by differences in stature.

Comparison with earlier data is difficult because of the need to use the untransformed data and to standardize the material before making the comparison, but it seems that the mean weight of men in Class 1.2 at age 18 to 19 and 20 to 29 and of men in Class 3 at age 20 to 29 have changed little over the years, as is evident from Table V, which gives the mean weights in 1883 of British men

TABLE VI

MEAN LOG-WEIGHT* OF MEDICAL BOARDS COMPRISING SEPARATE AREAS

Region	Board	Social Class 3	Social Class 4	Social Class 5
Southern	Dumfries ..	2·1473±0·0053 (104)†	—	2·1442±0·0079 (62)†
	Galashiels ..	2·1423±0·0063 (97)†	—	2·1520±0·0085 (33)†
Northern	Lerwick ..	2·1560±0·0075 (58)	2·1628±0·0089 (31)†	2·1548±0·0078 (59)†
	Kirkwall ..	2·1522±0·0055 (79)	—	2·1596±0·0039 (104)
	Wick ..	2·1411±0·0071 (78)†	2·1460±0·0069 (42)†	2·1510±0·0071 (66)
	Inverness ..	2·1458±0·0048 (107)	—	2·1506±0·0077 (62)
West Central	Paisley ..	2·1269±0·0050 (111)	—	2·1322±0·0066 (63)†
	Glasgow ..	2·1314±0·0037 (155)	—	2·1312±0·0095 (31)†
East Central	Edinburgh ..	2·1294±0·0050 (100)	—	—

* Weights standardized to age 26 yrs and height 67 in.
† Boards defined as separate areas because of their unusual mean stature.
Numbers in each sample shown in brackets.

in Social Classes 1.2 and 3 in three age groups after standardization for stature differences. On the other hand, men aged 18 to 19 in Class 3 now weigh, on the average, 1·8 lb. more than men of the same age in Class 1.2, whereas they weighed 4·2 lb. less in 1883. Men aged between 30 and 39 years in Class 1.2 weighed, on the average, about 4 lb. more than those in Class 3 in 1941, whereas they weighed about 8 lb. more, on the average, in 1883. Both samples show a considerable reduction in mean weight (10 lb. in Class 1.2 and 6 lb. in Class 3) attributable to the different trend of mean weights with age already discussed.

WEIGHT RELATED TO OCCUPATION.—The standardized mean log-weights of samples of men in various occupational orders have been compared within each social class. The mean weights of men following the different occupational orders in Social Class 1.2 differ significantly at the 1 per cent. level of probability, mainly because of the above-average mean weights found in the two groups of "manager" which are both approximately 13 lb. heavier (after standardization) than the mean weights of men in the remaining occupations in this class. The mean weights of the occupational groups in Social Class 4 differ at the 5 per cent. level of probability. No occupational group differs particularly from the rest, and the finding is rather the expression of a general heterogeneity within the social class.

WEIGHT RELATED TO MEDICAL FITNESS FOR MILITARY SERVICE.—The mean weight of men classed as fit for military service is 4 lb. greater than the mean weight of men classed as unfit. The difference is significant at the 1 per cent. level of probability. When the social classes are examined separately, fit men, on the average, are found to be significantly heavier than unfit men in Social Classes 3 and 4, but the difference is not significant in Social Classes 1.2 or 5. The difference is, however, in the same direction in Class 5, but the mean weights of fit and unfit men in Class 1.2 are almost identical.

WEIGHT RELATED TO CLASSIFICATION AS VOLUNTEERS OR CONSCRIPTS.—The mean weights of volunteers do not differ significantly from the mean weights of conscripts, either when the social classes are pooled or when they are examined separately.

This finding confirms the conclusion derived from the analysis of measurements of stature: that, physically, volunteers do not differ from conscripts, and it disposes of any doubt that the large number of volunteers who joined the forces in 1939 and 1940 may have affected the validity of the sample.

DISCUSSION

The results of the analysis described in this paper confirm the general impression that body-weight is a good means of assessing physique. However, weight is associated with other factors, which should be taken into account whenever an assessment is made.

Weight and stature are highly correlated measurements, and this implies that, on the average, tall men weigh more than short men. The regression coefficients relating weight to stature and age are the same for men in each social class. It would follow that, for many practical purposes, variation in weight attributable to social factors can be disregarded if the variables of stature and age are taken into account. The similarity of the regression coefficients under the very diverse environmental conditions present in Scotland is good evidence that coefficients relating anthropometric measurements are stable.

The normal variation in body-weight from one person to another is great, and the range is still large in groups of men with the same stature. Thus, men of light weight and spare physique exist at one end of the distribution, and at the other are heavy men of stout physique. It is obvious from this that tables giving the values of mean weight for various statures have only a limited use, and that for many purposes, for example when assessing over- or under-weight in clinical practice, tables of centile values will be of more practical use. Estimates of the 1st, 50th, and 99th centiles of body-weight have been prepared for each stature group from the data (see Table III and Fig. 1). The range, expressed in lb., between the 1st and the 50th centiles is less than that between the 50th and the 99th centiles in each stature group. For example, the ranges are 22·5 and 28·4 lb. respectively for men with statures between 57 and 59 in., and 36·2 and 44·5 lb. respectively for men with statures of 73 to 74·9 in.

The bivariate frequency distribution provides a firm and objective basis for classifying the physique of men into similar groups and estimating the frequency with which the men in each group exist in the population. In the scheme given in Table III, as a matter of convenience, each group has a range of 2 in. stature and about 18 lb. body-weight.

Observation shows that measurements of girths and widths of the body vary amongst men with similar statures and weights, and there is little doubt that further investigation will show this variation to be attributable to differences in the amount or form of the subcutaneous, muscular, and bony tissues. The parallel with somatotyping (Sheldon, 1940) is evident.

Apparently men near the 1st centile limit of the distribution for weight comprise the various groups which are rated in Sheldon's classification as low in mesomorphy and endomorphy, whereas those near the 99th centile limit have high ratings. This latter group of men, as has been observed earlier, probably includes most of the individuals who experience a large increase in body-weight as they become older.

Summary

(1) Statistics on body-weight have been derived from a sample of records of the medical examinations of Scotsmen made in 1941 on being called up for national service.

(2) The distribution of body-weight recorded as the logarithm of the measurement in lb. may be regarded as Normally distributed. This implies that for many purposes body-weight is more satisfactorily recorded on this scale than in lb. avoirdupois.

(3) Body-weight is related to stature by the regression:

Log-weight (log lb.) $= 0{\cdot}0122$ Stature (in.) $+ 1{\cdot}323$.

(4) The mean weights of men by age groups show an upward trend until age 30. After age 30 the trend is very small.

(5) The material has been standardized for differences in stature and age, and it has been found that:

(*a*) The mean weights in the different social classes do not differ significantly.

(*b*) The mean weight of fit men is 4 lb. more than that of unfit men.

(*c*) The mean weights of some occupational orders differ both in Social Classes 1.2 and in Social Class 4.

(*d*) The mean weight of conscripts does not differ from that of volunteers.

(6) The variation in weight associated with geographical factors is limited and confirms the conclusions reached from the study of the measurement of stature.

We gratefully acknowledge the receipt of a grant from the Medical Research Council. We are also most grateful to Professor S. Zuckerman and Mr. M. J. R. Healy for many helpful discussions.

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