CHANGES IN BODY WEIGHT ASSOCIATED WITH AGE AND MARITAL STATUS

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Although it has long been recognized that changes in body weight are characteristic of certain diseases, surprisingly little is known about the sources of variation in weight of healthy people. There is no doubt that weight is related to height and that it increases with age even after adult stature has been reached. There is some evidence of small variations in association with region, season, occupation, and social class (Morant, 1948; Martin, 1949; Kemsley, 1950; Roberts, 1953; Clements and Pickett, 1954). It is also known that the weight added during pregnancy is considerably in excess of that due to the products of conception, and it is generally believed that women who have borne children are heavier on the average than those who have not. And there our knowledge appears to end.

This paper is based on data recorded during the pre-employment medical examination of industrial workers at two large firms in Birmingham. It examines the relation between marital status, child-bearing, and weight in women, and between age and weight in both the sexes.

Material

Cadbury Brothers Ltd., Bournville, and the General Electric Company Ltd., Witton, together employ about 16,000 workers. The data examined below were extracted from medical record cards at these two firms. The inquiry relates to 1,684 men and 5,081 women who had entered the firms within the last ten years and were in the age group 20-59 inclusive at the time of their pre-employment examination. The information available included weight, height, sex, age, marital status, and, in the case of married women, size of family. The workers were wearing indoor clothes and boots or shoes when they were weighed and measured; the size of family recorded referred to the number of children alive at the time of the interview.

Weight and Age

The mean weight of the women increased fairly regularly by about 3 lb. (1.4 kg.) for every five years of age, from 123.8 lb. (56.1 kg.) in the age group 20-24 to 139 lb. (63 kg.) at 45-49, an increase of a little over 15 lb. (6.8 kg.) in 25 years (Table I and Fig. 1). At higher ages there was no further increase; in fact, the data suggest that at ages above 50 the mean weight of women may decrease slightly. These findings are in close agreement with other inquiries into the relation between weight and age in women, and in particular with two previous examinations of weight of women factory-workers in this country. The first, a report of the Industrial Fatigue Research Board (Cathcart *et al.*,

1927), related to 3,000 women factory-workers, actively employed, who were weighed and measured in 1926. The second, an inquiry carried out by the Ministry of Food (Kemsley, 1950), was concerned with 33,500 women who were weighed and measured in 1943. The Birmingham data confirm that in women there is no middle-aged spread, but a steady increase in weight throughout the whole of reproductive life.

In marked contrast to the regular increase in weight with age shown by the women, the mean weight of the men in this series varied very little with age (Table I and Fig. 1).

FIG. 1

FIG. 2

FIG. 1.—Weight of men and women related to age. In Figs. 2, 3, and 4 the age plotted is the mid-point of the age group to which the mean weight or height relates. FIG. 2.—Weight of men related to age.

Indeed, none of the five-yearly age groups from 20-24 to 45-49 inclusive deviated by more than 1 lb. (0.45 kg.) from 149.1 lb. (67.6 kg.), the mean for the whole series.

This has not always been so. In 1884 Galton measured 7,000 men at his Anthropometric Laboratory in South Kensington; they showed a regular increase in weight with age comparable to weight-age curves for women (Ruger and Stoessiger, 1927). The same was true of the 10,000 men weighed and measured between 1929 and 1932 by Cathcart *et al.* (1935). However, using data on 27,500 men working in factories and in mines (collected by the Ministry of Food in 1943), Kemsley (1950) found that the pattern had changed. The weight-age curve for these men differed from earlier series in that, although there was a fairly regular increase in weight with age up to about 35 years, above that age it remained almost constant. In support of this observation Kemsley (1952) referred to figures for air-crew candidates given by Morant (1946), which agreed very closely with his own observations on male civilians, and showed that during the early years of the war there was little or no increase of weight with age beyond the age of 30.

Further confirmation of this wartime observation has recently been provided by Clements and Pickett (1954) in an analysis of data recorded by medical boards of the Ministry of Labour and National Service in Scotland between 1939 and 1946. They found a steady increase in weight with age up to 30 years, but little change above that age. When attention was restricted to men in social classes 1 and 2, however, at ages over 30 the mean weight increased with age in much the same way as in pre-war series.

It seems clear that in this country during the past 30 years the weight-age relationship for male factory workers has changed (Fig. 2). At the beginning of the century weight increased regularly with age for both males and females. This association has persisted for women, but for men it has gradually been eliminated. In the early years of the war it was still in evidence up to the age of 30 or 35 years. Since the war, however, if the present series is representative, the increase of weight with age for males has almost entirely disappeared and there is now little variation in mean body weight once adult stature has been reached.

At this point it must be emphasized that in each of the three series illustrated in Fig. 2 (and in all comparable

TABLE I.—Mean Weight (lb.) Related to Age

	Age (Years)							
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59
Men ..	148.4 (396)	149.4 (381)	150.1 (246)	150.0 (170)	148.5 (153)	148.1 (147)	149.4 (109)	148.0 (82)
Women	123.8 (1,436)	127.1 (1,028)	129.8 (839)	132.7 (716)	136.4 (581)	139.0 (271)	139.0 (161)	135.9 (49)

investigations reported in the literature) the data related to a cross-section of the working population at a given time, and not to a follow-up of the same men weighed at different ages. Hence men in the different age groups were samples of populations born at different periods. Since there has been a steady improvement in the standard of living during the past half-century, it is conceivable that the recent change in the weight-age pattern of cross-sections of the adult population may reflect the influence of socio-economic

FIG. 3.—Height of men related to age.

support to this view; it demonstrates that there was no substantial change in the negative association between height and age in the three series.

It seems permissible to conclude that the tendency for male factory-workers to put on weight as they get older has disappeared during the past 20 to 30 years. On the other hand, the decline in height with age (Fig. 3) commonly observed in cross-sectional studies of the adult population is still present, and can be attributed mainly to a tendency for adults to decrease in height as they get older, rather than to the fact that the older members of the population had a less favourable childhood environment than the younger ones.

Weight and Marital Status

In each five-year age group married women were heavier than single women (Table II and Fig. 4), and the difference increased fairly regularly with age. Between the age groups 20-24 and 45-49 weight of married women increased by more than 16 lb. (7.3 kg.), while weight of single women increased by less than 6 lb. (2.7 kg.).

TABLE II.—Mean Weight (lb.) Related to Age and Marital Status

	Age (Years)							
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59
Single men	148.4 (305)	150.1 (157)	146.3 (76)	152.7 (39)	149.2 (29)	145.1 (13)	145.9 (8)	143.1 (8)
Married men	148.6 (91)	148.9 (224)	151.8 (170)	149.2 (131)	148.3 (124)	148.4 (134)	149.7 (101)	148.5 (74)
Single women	123.6 (907)	125.6 (394)	125.4 (192)	128.4 (114)	130.5 (87)	129.4 (35)	134.5 (23)	132.4 (16)
Married women	124.2 (529)	128.1 (634)	131.0 (647)	133.4 (602)	137.4 (494)	140.6 (236)	139.7 (138)	138.0 (33)

FIG. 4

FIG. 5

FIG. 4.—Weight of married and single women related to age. FIG. 5.—Weight of married women with children, married women without children, and single women related to age.

There was no very obvious difference between the weights of single and married men (Table II), and it seemed possible that the difference in the case of women would be due to the effect of child-bearing. It is true that at all ages women with children were heavier than those without children (Table III). The difference was not great, however, and at a given age weight did not increase very regularly with the number of children. Indeed, in the higher age groups women with small families were slightly heavier than those with large families.

Moreover, in each age group married women without children were heavier than single women; the difference increased with age and was considerably greater than the difference between married women without children and married women with children (Tables II and III). This observation is illustrated in Fig. 5, in which straight lines have been fitted to the data by the method of least squares. The equations for the regression of weight (y lb.) on age (x years) were as follows:

$$\begin{aligned} \text{For single women} & \dots \dots \dots y = 0.30x + 117.1 \\ \text{For married women without children} & \dots \dots \dots y = 0.54x + 112.3 \\ \text{For married women with children} & \dots \dots \dots y = 0.63x + 111.3 \end{aligned}$$

The effect of child-bearing is evidently not the sole or even the most important reason for the difference in weight between single and married women. It is not difficult, of course, to suggest other factors that may play some part in promoting this weight difference. For example, it may be related in part to opportunity and incentive for preparing meals. It is also possible that the present-day fashion for

TABLE III.—Mean Weight (lb.) of Married Women Related to Age and Size of Family

Size of Family	Age (Years)						
	20-24	25-29	30-34	35-39	40-44	45-49	50-54
0	123.6 (387)	127.8 (313)	129.5 (178)	129.6 (122)	136.1 (73)	140.7 (39)	135.8 (31)
1	125.2 (133)	128.0 (213)	130.1 (244)	135.0 (175)	135.9 (172)	137.5 (67)	138.5 (29)
2	132.4 (9)	128.4 (94)	132.3 (158)	133.0 (184)	135.9 (137)	145.6 (65)	147.7 (32)
3	—	135.9 (15)	135.9 (66)	135.7 (121)	142.5 (111)	138.3 (65)	137.6 (46)

slimness in women may have contributed to the observed difference. (Single women may make a more determined effort to control their weight by dieting.) Further, it is conceivable that in marriage regular intercourse may influence weight. The list of possible explanations could be extended, but in the absence of evidence it is sufficient to recognize that the association between weight and marital status in women is unlikely to be attributable to any single cause.

Summary

This inquiry relates to 1,684 men and 5,081 women in the age group 20-59 working in two large Birmingham firms. Data on weight, height, age, marital status, and, in the case of married women, size of family were extracted from medical record cards. The information had been recorded at the time of the pre-employment medical examination.

The mean weight of the women increased regularly by approximately 3 lb. (1.4 kg.) every five years (from 123.8 lb. (56.1 kg.) in the age group 20-24 to 139.0 lb. (63 kg.) at 45-49). The weight of the men showed very little variation with age. Comparison with earlier series suggested that an increase in weight with age exhibited by males at the beginning of the century has gradually disappeared.

In each five-yearly age group married women were heavier than single women. At corresponding ages married women with children were a little heavier than married women without children, but married women without children were considerably heavier than single women.

It is suggested that factors other than child-bearing play an important part in promoting the weight difference between married and single women.

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THE BETA-LIPOPROTEIN AND CHOLESTEROL CONCENTRATIONS IN SERA OF NIGERIANS*

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The relation of diet to the development of atherosclerosis can be studied in contrasting cultural groups which have different dietary habits. This appears to be one approach to a study of the late effects of diet upon this form of chronic disease.

In a previous study of Central American subjects (Mann, Munoz, and Scrimshaw, in press) we have demonstrated that there are striking differences in the serum lipid patterns among populations with different environmental characteristics. It was shown that the serum cholesterol levels of adults of either sex averaged less than 175 mg. per 100 ml. at all ages, that these levels were not significantly related to age, and that, while the rural Central Americans were thin as judged by relative weight ($\frac{\text{observed weight}}{\text{desirable weight}}$), this thinness could not account for the low serum cholesterol levels observed. In contrast to these findings with cholesterol, the serum beta-lipoprotein levels of the rural Central Americans were similar to those of age- and sex-matched North Americans. There was thus a unique disparity between the lipid patterns of the largely vegetarian Central Americans and the North American comparison group. A comparison group of urban Guatemalans were similar in both dietary and serum lipid patterns to North Americans. These observations promise to illuminate the problem of the relative atherogenicity of the various serum lipid components. They require further study to determine the mechanisms which control these various serum lipid components.

* A portion of this work was completed while Dr. G. V. Mann was an Established Investigator of the American Heart Association.

The studies reported here were undertaken at about the same time to extend these observations to another racial group in an entirely different environment in order to verify the findings described, and to minimize the possibility that genetic factors might be responsible. The serum cholesterol and lipoprotein levels of 46 Nigerian men have been studied, and dietary and cultural evaluations have been made which permit segregation of these into three groups. The resulting data resemble those obtained in Central America, and confirm the belief that primitive peoples, consuming largely vegetarian diets, with a high calorie turnover in relation to body size, show low levels of serum cholesterol coupled with beta-lipoprotein levels similar to those of urban United States citizens.

Methods

Nature of the Sample

The Nigerian subjects were drawn from three different areas of the country. The cultural characteristics and dietary patterns differ considerably between these three areas. Group A consisted of natives of the dry northern part of Nigeria, coming from Moslem tribes whose staple foods are sorghum and millet (*Pennisetum* spp.), who eat little fish or meat, and whose diet contains little fat apart from that present in the vegetables consumed. Group B was composed of natives of the Ibo tribe from the humid Eastern Region, whose staples are yams (*Dioscorea* spp.) and cassava (*Manihot utilissima*), which they supplement with reasonable quantities of green and leafy vegetables, fruit, and a little fish or meat. Their diet contains red palm oil, but the total fat content is low compared with that of North Americans. Group C was drawn from pagan tribes of the Middle Belt of Nigeria, that area which lies along the banks of the rivers Niger and Benue in their westward and eastward passage through the country. These people eat both roots and grain, a little fish, and red palm oil.

The wealthier members of these tribes were excluded from this investigation, and the three groups consisted of peasant farmers and the labouring classes. Such peasants, at all ages, expend large amounts of energy from their limited calorie resources to maintain themselves at a subsistence level, and, in contrast to that of North Americans, their weight decreases with age after the fourth decade (Nicol, 1952).

Apart from a clinical impression that the acute complications of atherosclerosis are rarely seen in these Nigerian peasants, little is known of the incidence of this disease from necropsy material studied in Nigeria. However, Edington (1954) has studied 3,645 reports of necropsies carried out in the Gold Coast, where the cultures are somewhat similar to those of Nigeria, and has recorded a low incidence of hypertension (0.2%), atheroma (0.5%), and coronary disease (0.8%).

Clinical Examinations*

The subjects in all three groups were examined in Kaduna General Hospital while they were convalescent from minor surgical procedures. A general clinical examination was performed, heights, weights, and blood pressures were recorded, and individuals suffering from gross infestations or active disease were excluded. Signs of cardiovascular disease were not observed clinically, and in all but one individual, whose blood pressure was 140/90, the systolic and diastolic tensions were low.

Dietary Methods

The diets of the subjects forming the sample were not measured individually. When in hospital they ate food brought in for them by relatives living in Kaduna, this being the normal custom in Nigeria. Such is the conservatism of these people regarding dietary patterns that their food intake, in whatever part of the country they happen