

BODY WEIGHT IN PAROUS WOMEN

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MATERNITY is commonly believed to be an important contributory cause of increased weight in women. Sheldon (1949) provided circumstantial evidence from the histories of obese parous women, and further support was given by the conclusion of Thomson and Hytten (1961) that about 30% of the average weight gained during pregnancy is due to an increase of body fat. Yet Thomson and Billewicz (1965) showed from cross-sectional data that parity added little to the tendency of weight to increase with age, though 'increasing parity does give rise to a minority of unusually heavy women'. Lowe and Gibson (1955) had previously concluded, also from a cross-sectional study, that marriage, but not parity, added to the effect of age, while the Joint Clothing Council Ltd. (1957) found no clear effect of either marital status or parity.

Though all investigators agree that weight tends to increase with age, an independent effect of parity must still be regarded as uncertain. Investigation is complicated by the fact that the average weights of women have tended to increase during recent years (Thomson, Billewicz, and Holliday, 1967).

In this paper, the effects of age, parity and other factors on body weight are reported on the basis of longitudinal data derived from women who were weighed during their first and subsequent pregnancies.

MATERIAL AND METHODS

SUBJECTS

In Aberdeen, during the years 1949 to 1954, 7,312 first pregnancies, including abortions, were recorded for women living in the city or its immediate surroundings. Since very few residents went elsewhere to have their babies, the count represents a nearly complete cohort of first pregnancies in a defined population.

The city maternity records were searched up to 1964 inclusive for subsequent pregnancies to the same women. Married women who had not reappeared in the maternity records were traced

where possible through local voting registers and by a postal follow-up, reinforced by personal enquiries. Tracing 'in the field' was undertaken by staff of the Medical Research Council Medical Sociology Unit (Director, Professor Raymond Illsley), and the subsequent histories of nearly all women who continued to live in or near the city were established. The follow-up period naturally varied with the date of the first pregnancy and the duration of subsequent residence in the city; 1,189 women were followed for less than 5 years, 858 for 5 to 9 years, and 5,265 for 10 or more years. The cohort of 7,312 women yielded a total of 18,112 pregnancies, the numbers of pregnancies per woman varying from one to six or more.

For present purposes, it was necessary to exclude certain cases—24 women with no viable pregnancy, 419 who were unmarried at the time of the first pregnancy and 1,039 for whom adequate records of body weight were not available. The analysis is therefore based on the records of 5,830 married women, most of whom were followed for at least 10 years after their first pregnancies.

All the weights were measured at antenatal clinics on accurate lever balances, the subjects wearing minimum clothing. Body weight was taken as weight at the 20th week of gestation, either measured at that time or estimated by interpolation. Errors are unlikely to be large, since each 20th week weight was supported by serial measurements made earlier and later during the pregnancy. There is no evidence that age or parity have much effect on the amount of weight gained during pregnancy.

The data for each woman were summarized on cards and subsequently transferred to magnetic tape for computer analysis. Tabulations are given in terms of parity; that is, first or intervening abortions have been ignored.

RESULTS

Any effect that parity may have on body weight is blurred by the tendency of weight to increase with

age. A secular change of weight in the adult population—such as may occur during a period of greater economic prosperity, changing food habits and increasing mechanization—should also be taken into account. Again, the suggestion of Lowe and Gibson (1955) that marriage itself may cause an increase in weight requires consideration.

DURATION OF MARRIAGE AT FIRST PREGNANCY

Primigravidae in different age groups were classified according to the duration of marriage and the mean weights of the sub-groups calculated. As expected, the means showed an increase with age, but there was no increase within age groups by duration of marriage. Duration of marriage up to the time of the first pregnancy therefore has no apparent influence on body weight and may be disregarded in further analyses.

AGE AND SECULAR TREND

The 20th-week weights of primigravidae delivered in Aberdeen between 1949 and 1964 (except 1960–62, for which it was not possible to prepare complete cross-sectional records) were examined for the effects of age and time. Figure 1 summarizes the findings. The average weight of the youngest age-group did not increase over the years, but in older age-groups primigravidae were about 2.0 kg. heavier, on average, in 1964 than in 1950. The secular increase in weight did not become established until 1955–56, possibly because post-war food rationing continued during earlier years. Up to 1955–56 primigravidae aged 30 and over were about 3.6 kg. heavier than those aged under 20; by 1964 the difference had increased to about 5.9 kg.

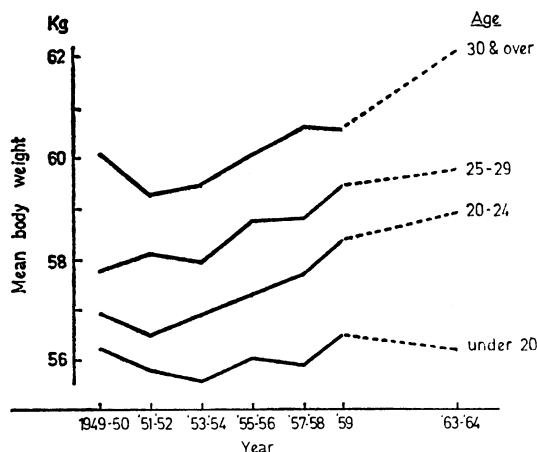


FIG. 1.—Mean weights of Aberdeen primigravidae, 1949–64, by age.

The absence of a secular trend before 1955–56 obviates the need for any concern about a rising trend in the initial weights of the cohort of primigravidae to be followed up, all of whom were delivered between 1949 and 1954. On the other hand, any effect of parity on weight may be influenced not only by maternal age but also by the years in which second or later births took place. We have shown elsewhere (Thomson *et al.*, 1967) that the average height of Aberdeen primigravidae did not change appreciably between 1950 and 1964, and growth in height is for all practical purposes complete by age 18, so that it is not necessary to consider height changes during the follow-up period.

Since our purpose was to investigate possible changes in weight due to pregnancy, it seemed necessary to derive corrections for age and secular trend from the trends in primigravidae, which could not be affected by previous pregnancies. We have, however, ascertained that women of parity 1 give trends reasonably similar to those shown in Figure 1. The data on which Fig. 1 is based were used to calculate regression corrections for the effects of age and secular trend on weight.

In many of the tables and diagrams which follow, 'unadjusted' and 'adjusted' values are given. The former are based on observed weights, which include the effects of age and secular trend. Adjusted values include a correction—necessarily approximate—for the effects of age and trend.

EFFECT OF PARITY

AVERAGE DIFFERENCES IN WEIGHT. We are concerned with the average change of weight occurring between the 20th week of the first pregnancy and the 20th week of some subsequent pregnancy. Before proceeding to the analysis, it was necessary to discard 2,089 primigravidae who had no more viable pregnancies during the follow-up period; they were of the same average weight as primigravidae who did have subsequent pregnancies.

Table I gives the mean and median gains from para 0 to para 1, 2 and 3 before and after adjustment for the effects of age and secular trend. The mean observed (unadjusted) gains were 1.8, 3.2 and 4.3 kg., respectively. After adjustment these were reduced to 1.0, 1.5 and 1.9 kg. The median values are considerably lower than the means, indicating that the distributions of changes in weight are positively skewed, i.e., that relatively high gains were more common than relatively large losses.

Figure 2 shows that the average amount of weight gained between parities depends much more on the time interval than on the parities involved. The unadjusted medians rise steeply with increasing interval,

TABLE I

MEAN AND MEDIAN WEIGHT CHANGES BETWEEN SPECIFIED PAIRS OF PREGNANCIES, BEFORE AND AFTER ADJUSTMENT FOR EFFECT OF AGE CHANGE AND SECULAR TREND

	Weight Change (kg.)		
	Para 0-1	Para 0-2	Para 0-3
Unadjusted mean	1.8	3.2	4.3
Unadjusted median	1.5	2.6	3.4
SD	4.1	5.3	6.1
Adjusted mean	1.0	1.5	1.9
Adjusted median	0.5	0.6	0.7
No. of cases	3583	1465	531

and at any given interval parity has no consistent effect. It may be noted also that women who had a rapid succession of viable babies (e.g., those who had four babies within 4 to 6 years) gained about the same amount of weight, on average, as those who had two or three children during the same period. The adjusted medians show a small residual increase of weight gain with interval. This could be due to some inadequacy in the corrections applied; non-linear functions were tried but failed to clarify the situation.

The above conclusions are true for the means as well as for the medians illustrated in Figure 2.

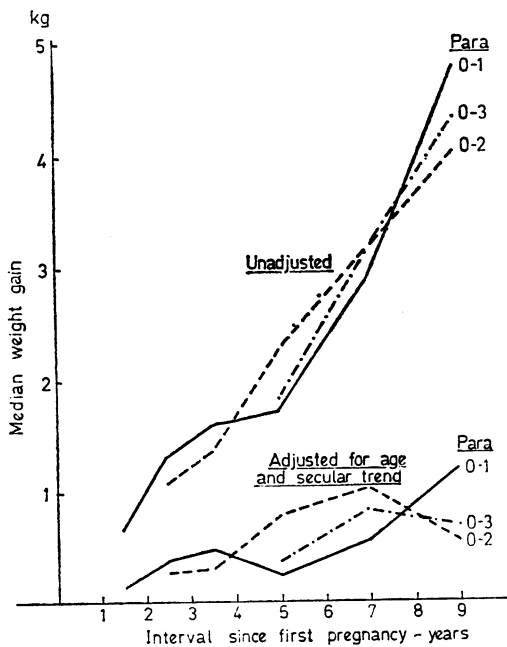


FIG. 2.—Median gains of weight from first to subsequent pregnancies by duration from first to indicated parity.

It is clear, therefore, that the average effect of parity *per se* on weight change between parities is small, after allowance has been made for the effects of age and of secular trend. Adjustment for age alone reduced the time-interval effect but did not remove it. A considerable part of the trend in the unadjusted medians (Fig. 2) is due to the fact that women aged 20 or over were becoming heavier during the follow-up period, irrespective of age.

DISTRIBUTIONS. We have noted, from the difference between the means and medians (Table I), that the distributions of changes in weight between parities are positively skewed. Figure 3 illustrates unadjusted percentile values for three parity groups. The 10th percentiles are practically the same for all groups. The medians (50th percentiles) show the rather small increase with parity already demonstrated in Table I. The 90th percentiles, however, show a considerable gradient with increasing parity. The proportion of women with an unusually large increase of weight therefore rises with parity.

Figure 4 illustrates the situation in another way. For any given parity group, the percentage of women who gained 7.5 kg. or more rose with the time interval involved, and the unadjusted gains rose with parity also. Adjustment for the effect of age and secular trend reduces, but fails to eliminate, the gradient by parity. This again shows that a minority of women gained unusually large amounts of weight in association with parity.

SELECTION FACTORS

It has been established that the apparent influence of parity on average body weight was mostly due to the effect of age and a secular increase in weight, but that a minority of women gained excessively, partly as a result of parity. Were there any differences between women who gained a lot or a little between parities?

Age, social class and stature seem to have little or no effect on the amounts of weight gained between parities. The only factor which showed a consistent relation to weight change was the ratio of observed weight to standard weight-for-height at para 0. The standards used were those of Kemsley, Billewicz, and Thomson (1962), which specify the distributions of weight in women of a given height in the population generally. Since the women with whom we are concerned were measured at the 20th week of gestation, the average ratio of observed to standard weight is not about 100% but nearer 109%.

Figure 5 shows mean weight changes, adjusted for the effect of age and secular trend, between para 0 and any subsequent pregnancy, according to the interval involved and the 'weight ratio' during the

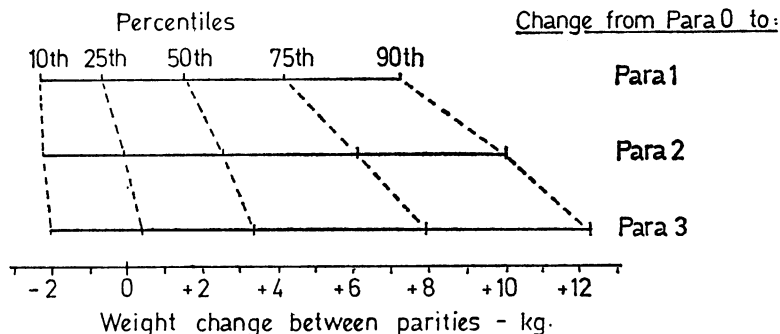


FIG. 3.—Percentile values of changes in weight (unadjusted) between first and subsequent pregnancies, for all intervals between births.

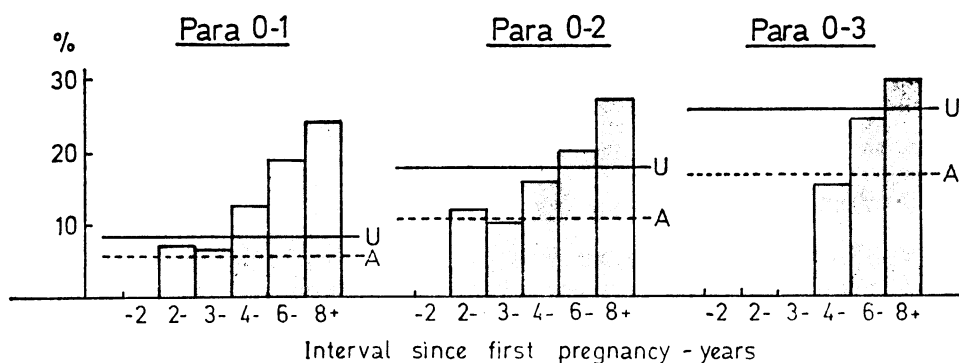


FIG. 4.—Percentages of women gaining 7.5 kg. or more between first and subsequent pregnancies, by interval between births. Unadjusted (U) and adjusted (A) averages for all intervals are shown as lines drawn across the histograms.

first pregnancy. The three weight-ratio groups distinguished are all of the same average parity (1.45). A more detailed analysis of the same kind, by separate parity groups, confirmed that parity *per se* had no appreciable influence on the trend indicated in Figure 5. Women who were initially underweight gained, on average, 0.8 kg. between the first and subsequent parities, and the interval between pregnancies had little influence on the amount gained. But women who were overweight to start with gained, on average, 2.4 kg. and the amount gained rose with increasing length of interval, despite the adjustment for age and secular trend. Whilst it is possible that women who were initially overweight showed an exaggerated increase with age and secular trend (which would therefore not be adequately allowed for by the adjustments we have used, we cannot test this hypothesis from the data at our disposal.

The standard deviations of gains in the underweight, average and overweight categories were, respectively, 3.6, 4.4 and 6.5 kg., showing that gains

were much more variable in the overweight than in the other categories.

It is of interest to consider whether gains of weight between parities are correlated with the amounts of weight gained during the pregnancies preceding the last one. Figure 6 shows the mean amounts of weight gained during the second halves of pregnancies before the final pregnancy in three parity groups, each of which has been classified into four weight-change categories (adjusted for age and secular trend). It is clear that, in all three parity groups, women who gained most weight between pregnancies also tended to gain most during pregnancy. The standard deviations around the mean pregnancy gains are all around 3.2 kg.; there is no indication that gains of weight during pregnancy are more variable in the 'high gainers' (between pregnancies) than in the 'low gainers'.

Weight gained during pregnancy is not appreciably correlated with parity or with initial weight-for-height, except indirectly through the fact that hypertensive complications, which are most common

in primigravidae, tend to be associated with high gains and with obesity (Thomson and Billewicz, 1957). There is, however, some evidence that the four weight gain groups in each parity (Fig. 6) differed according to the 'starting weight'. The mean weights at the 20th week of the first pregnancy from the lowest to the highest weight gain groups in Fig. 6 were as follows:

- Para 0-1: 59.4, 56.2, 57.6, 60.8 kg.
- Para 0-2: 59.0, 55.8, 57.2, 58.5 kg.
- Para 0-3: 57.6, 56.2, 55.8, 58.5 kg.

Thus women who gained least and most between pregnancies tended to be heavier than usual to start with. Conversely, women of relatively high initial weight tended towards unusually low or unusually high gains between subsequent pregnancies. This is in accord with the previous finding of a considerably increased standard deviation of the gains of overweight women. Presumably many women who were overweight to start with often continued to gain weight excessively, or took measures sufficiently drastic to reduce their gains considerably. This confirms the finding of McKeown and Record (1957).

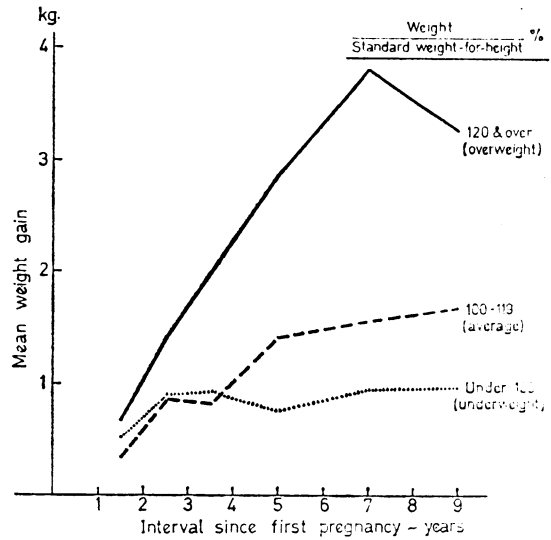


FIG. 5.—Adjusted mean weight gains (kg.) from first to any subsequent pregnancy, by duration from first pregnancy and by ratio of observed to standard weight-for-height during first pregnancy. The three weight-ratio groups distinguished are of the same average parity (1.45).

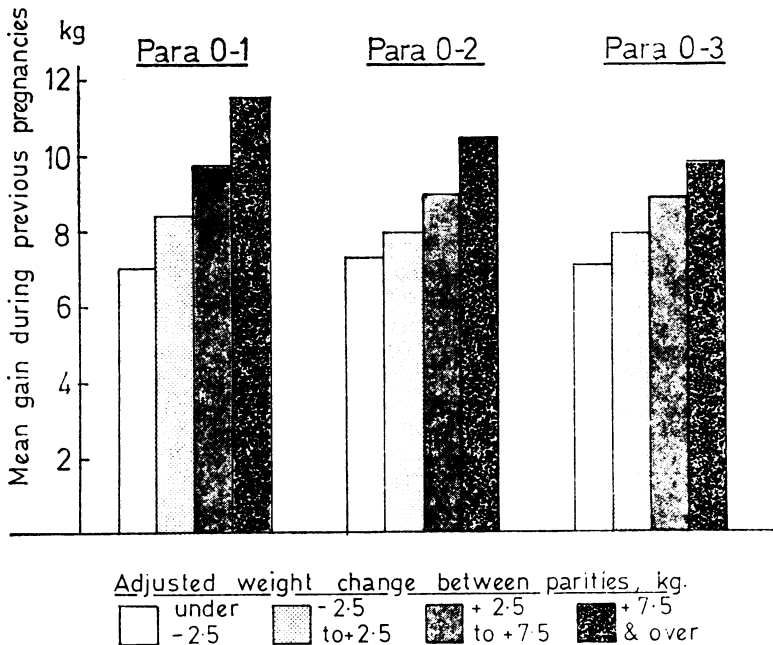


FIG. 6.—Mean weight gains (kg.) from 20th week of pregnancy until delivery in pregnancies preceding the final pregnancy, by change of body weight between specified pairs of pregnancies (adjusted).

GRADUAL OR SUDDEN GAINS?

So far, we have considered average changes between the weights recorded (at the 20th week of gestation) at parity 0 and some higher parity. The question arises whether the changes between consecutive pairs of pregnancies are correlated or not. Sheldon (1949) reported that some of his obese multiparae gave histories of having gained weight rather abruptly in association with one particular pregnancy.

In order to examine this question, we have analysed the weight changes, adjusted for age and secular trend, in 1,325 women for whom weights had been recorded during the first, second and third parities. Taking the cohort as a whole, the mean adjusted weights between para 0 and 1 and between para 1 and 2 were nearly the same; nevertheless, there was no association between the pairs of gains. In other words, many individuals showed markedly different gains during the two intervals concerned. We realise, of course, that the paired weight changes are not independent by definition, since weight at parity 1 is common to both the first and second intervals.

Since Sheldon's data were derived from obese multiparae, we next looked at 140 women who gained 7.5 kg. or more (adjusted) between para 0 and 2, *i.e.*, the high gainers. Table II shows the distributions of the gains between related pairs of pregnancies. Seven women (5%) gained 7.5 kg. or more in both intervals; 29 (21%) gained that amount between para 0 and 1 but lost weight or gained little (under 2.5 kg.) between para 1 and 2; and 20 (14%) gained 7.5 kg. or more between para 1 and 2 but lost or gained little between para 0 and 1. Thus a total of 35% had high gains predominantly during one interval only, and of these a majority did so after the first pregnancy. To that extent our data confirm Sheldon's finding.

TABLE II
DISTRIBUTION OF WEIGHT (ADJUSTED FOR AGE AND SECULAR TRENDS) BETWEEN PARA 0 AND 1 AND PARA 1 AND 2 IN 140 WOMEN WHO GAINED 7.5 KG. OR MORE BETWEEN PARA 0 AND 2

Weight Change, para 1-2 (kg.)	Weight Change, para 0-1 (kg.)					All
	Loss	0-	2.5-	7.5-	12.5 and over	
Loss	—	—	—	9	6	15
0-	—	—	12	12	2	26
2.5-	—	2	40	12	5	59
7.5-	4	12	10	3	1	30
12.5 and over	3	1	3	—	3	10
All	7	15	65	36	17	140

This conclusion was supported by examination of the records of 393 women for whom weights were available during the first four consecutive parities. Half the women who gained 7.5 kg. or more between parities 0 and 3 did so with a sudden increase after one particular pregnancy, and in 54% of such occasions the sudden increase occurred in the interval between parities 0 and 1.

CLINICAL CORRELATES

No evidence was found that the incidences of low birth weight (under 2,500 g.) or of perinatal mortality were associated with differences of weight gain between parities, but women with high gains had more hypertensive complications during pregnancy. Hypertension was defined as a diastolic blood pressure of 90 mm. Hg or more, recorded on at least two separate days during pregnancy: it includes cases of essential hypertension as well as of pre-eclampsia.

Figure 7 shows the incidence of hypertension in pregnancies after the first, according to whether the first pregnancy was hypertensive or not, by the amount of weight between pairs of pregnancies. As previously shown by MacGillivray (1958), the incidence of hypertension in subsequent pregnancies was considerably increased if the first pregnancy had been hypertensive. Although there are some irregularities, the incidence of hypertension tended to rise as the amount of weight gained between pregnancies increased. This is not attributable to the association between inter-pregnancy gains and weight gains during pregnancy, nor to differences of maternal age.

The incidence of severe pre-eclampsia (defined as hypertension plus definite proteinuria) is too low in pregnancies after the first to give clear trends, but there is some indication in those data that the incidence of such cases also tended to rise with increase of weight gain between pregnancies.

DISCUSSION

Any effect of parity on body weight is complicated by the tendency of weight to increase with age. Weight may also increase independently of age (but differentially according to age) if there is a secular trend in the population concerned. Both factors were influential in the cohort of Aberdeen mothers which we have studied. Since the time interval between parities is variable, there was a spurious association between the length of interval and the apparent change of weight between parities.

Standardization for the effects of age and secular trend largely eliminated the 'interval effect' and showed that parity *per se* had little influence on the

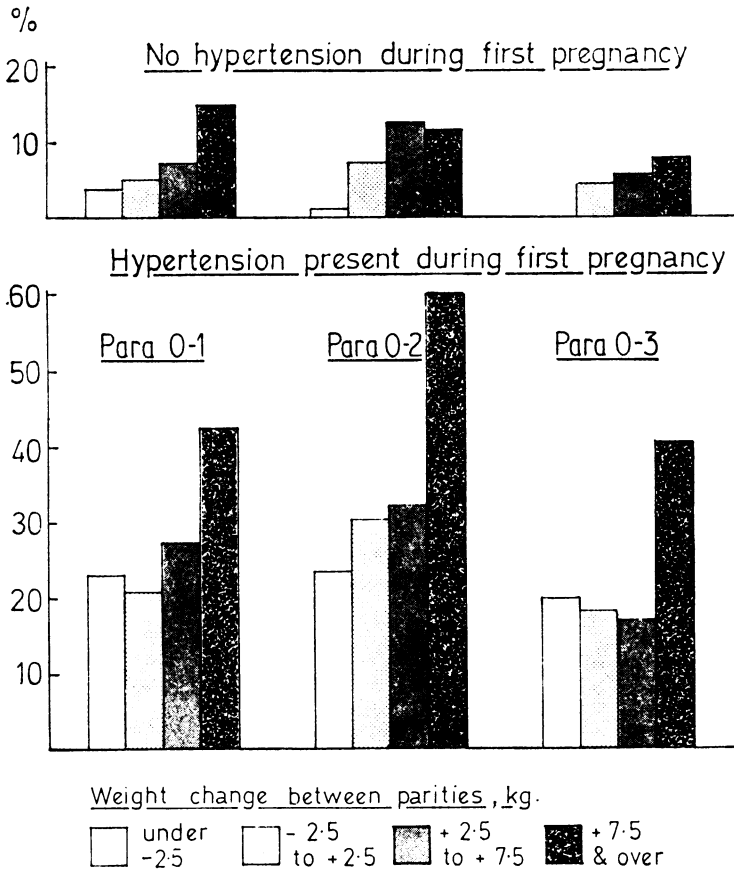


FIG. 7.—Percentage incidence of hypertension during pregnancies after the first, according to presence or absence of hypertension during first pregnancy, and weight gained between parities. Each case is counted once only, even if hypertension was repeated in different pregnancies.

mean weight at successive parities. In other words, the apparent effect of parity on weight was mostly attributable to the combined effects of age and secular trend. There was, however, a minority of women in whom parity itself was associated with unusually large average gains of weight between parities. These were, predominantly, women who were over average weight to begin with; an early tendency towards heaviness was thus accentuated by increasing parity as well as by increasing age. An interesting feature was that in such heavy women gains between parities were more variable than in women who were initially underweight or average; this was probably due to intermittent efforts at 'slimming'.

Some evidence was found to support Sheldon's (1949) suggestion that obese multiparae often gained weight rather suddenly in association with a particular pregnancy. Such sudden gains, in this series, occurred more commonly after first than after subsequent pregnancies.

The lack of any association (with the exceptions noted above) between parity and weight gain between parities indicates that the body fat laid down during pregnancy must be largely removed between pregnancies. There is no doubt that pregnant women do accumulate fat, especially on the lower trunk and upper part of the thighs; this is recognized by the women themselves and has been confirmed indirectly (Thomson and Hytten, 1961) and directly by means of skin-fold measurements (Taggart, Holliday, Billewicz, Hytten, and Thomson, 1967). Losses of fat after pregnancy has ended are much less easily discerned as they seem to take place slowly and with considerable differences from woman to woman (unpublished data). Losses of weight during the first three months post-partum, somewhat greater in lactating than in bottle-feeding mothers, have been reported by Dennis and Bytheway (1965).

The gain of body fat during pregnancy may be a result of progesterone activity. Experimental evidence to that effect has been obtained in rats by

Hervey and Hervey (1964). It may be that the removal of the progesterone stimulus when pregnancy comes to an end simply allows the body to revert to a 'normal' fat content, other things being equal. Information is too scanty at present to permit profitable speculation about the immediate mechanism regulating body fat and the possible influence of age and social circumstances upon it. Even less are we able to suggest why, in certain women, the fat-regulatory mechanism may be so 'unstable' as to permit rapid gains of weight in ordinary circumstances and—sometimes—failure to lose weight normally after pregnancy.

SUMMARY

The consecutive pregnancy records were studied of 7,312 Aberdeen primiparae delivered during the years 1949 to 1954: the majority (5,265) were followed for 10 years or more. The present analysis was based on the records of 5,830 women remaining after rejection of those who had inadequate weight records, were unmarried at the first pregnancy or had no viable pregnancy.

The effect of age on body weight was determined cross-sectionally from the records of primigravidae. In addition to an increase with age, there was also a secular increase after 1955-56, most marked in the older primigravidae. These trends were used to adjust the records of weight change between parities in the group as a whole.

After such adjustment, parity was found to have little effect on mean changes between parities. However, the proportion of women with high gains rose with increasing parity, even after adjustment of the data for the influence of age and secular trend.

Gains between parities (after adjustment) were not influenced by age, social class or stature. But women with an initially high weight-for-height tended to gain at a relatively high rate between subsequent parities. Changes of weight between parities were more variable in women who were initially overweight than in those who were underweight or of average weight-for-height, possibly as a result of attempts at 'slimming'.

Some support was found for Sheldon's (1949) claim that in some obese women a sudden gain occurred in association with one particular pregnancy, especially the first.

The absence of any general effect of parity on body weight leads to the conclusion that body fat gained during pregnancy must mostly be lost between pregnancies.

The data used in this paper were collected while the authors were on the staff of the Medical Research Council's Obstetric Medicine Research Unit, Aberdeen. The cooperation of our former colleagues in Aberdeen is acknowledged, particularly of those (now in the M.R.C. Medical Sociology Unit) who undertook the work of tracing patients 'in the field', and of Mrs. M. Paton and staff in the Records Office of the Aberdeen Maternity Hospital.

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