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ASSOCIATION BETWEEN PERIOD OF GESTATION AND LENGTH OF MENSTRUAL CYCLE

BY

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It has often been stated that the period of gestation may be a multiple of the length of the menstrual cycle. This possibility is suggested by evidence, in experimental animals and in man, of cyclic activity in the ovary during pregnancy, and by a supposed association between the length of the cycle and the duration of pregnancy. The association can by no means be said to be established in man, the lack of good data being due largely to the difficulty of establishing the length of the menstrual cycle. In the course of an inquiry in which pregnant women were investigated from the first antenatal attendance until two years after the birth of the

between April 1, 1949, and March 31, 1950. We are here concerned only with the period of gestation and the length of the menstrual cycle.

(a) *Period of Gestation*.—Our only indication of the period of gestation is the duration of amenorrhoea. The date of onset of the last menstrual period was recorded at the first antenatal attendance,* and the date of birth was extracted from the records of notification of birth submitted to the public health department.

(b) *Length of Menstrual Cycle*.—Either on leaving hospital or at the first home visit of a health visitor, mothers were given a calendar on which they were asked to cross off each day of bleeding during the year after the birth of the child. This calendar was printed on a child's record card, on which were entered other items of more interest to the mother (such as the weight of the child). Mothers were subsequently interviewed at a welfare centre or at home within two weeks of each quarter during the year following birth, at which time the record card was inspected and the menstrual history copied on to another document. These documents provided the data used in the analysis which follows.

As a means of excluding some pregnancies of abnormal length, the examination is restricted to the 1,227 mothers of single births whose children survived to the end of the first year. (For example, this device excludes several pregnancies whose duration is influenced by the presence of a malformed foetus.) For 362 of the 1,227 mothers the data were considered incomplete, either because the period of amenorrhoea was not reliable or because fewer than three menstrual cycles were recorded in the year after birth.

Of the 865 cases in which the data were thought to be complete enough, 149 were excluded because the menstrual history was irregular. It is not possible to give any precise indication of what constituted an irregular history, except to say that two observers inspected the data independently, and with few exceptions decided upon exclusion of the same cases.

Table I shows the association between the length of the cycle and the period of amenorrhoea for the 716 women who had at least three regular cycles, and for whom the period of amenorrhoea was recorded unequivocally. The shortest mean length of cycle was 23 days (six women) and the longest 45 days (one woman).

The data suggest that the period of amenorrhoea increases slightly with the length of the cycle. The association is, however, somewhat irregular. This irregularity is attributable largely to the fact that the mean length of cycle for each woman has been calculated from all cycles during the year. Inspection of the records indicates that many women whose menstrual cycles are in general quite regular have one or two cycles which are grossly inconsistent with the others, and whose inclusion must make the mean less

TABLE I.—*Period of Amenorrhoea Related to Length of Cycle. Length of Cycle is Given as a Crude Mean*

Mean Length of Cycle (Days):	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Over 38	Total
Mean period of amenorrhoea (days) ..	271.5	271.0	280.0	277.5	278.9	278.1	280.8	281.7	285.4	280.7	279.3	285.2	286.0	283.0	281.8	290.1	—	280.9
No. of women ..	6	6	24	51	76	113	126	111	65	51	34	18	12	6	8	7	2	716

child, we have recorded both the period of amenorrhoea and the length of the cycle for 1,227 mothers of single births, and the data are here used in an examination of the association between the two variables.

Period of Amenorrhoea Related to Length of Cycle

We have attempted to collect fairly extensive data in respect of pregnancies of all mothers domiciled in the County Borough of Smethwick whose children were born

accurate. We have therefore recalculated the mean length of cycle for each of the 716 women, after excluding cycles whose lengths were judged to be inconsistent with the other observations. Table II gives the number of recorded cycles upon which the adjusted means are based: thus for 37 women the mean is based on three cycles, and for 34 on four.

*70% of the mothers were supervised during the antenatal period by one of us (T. D.).

TABLE II.—Number of Cycles upon which Adjusted Mean Length of Cycle is Based

No. of Cycles	No. of Women	No. of Cycles	No. of Women
3	37	8	105
4	34	9	137
5	56	10	129
6	70	11	60
7	88		716

In Table III the adjusted means are used to relate the period of amenorrhoea to the length of the cycle. The chart shows a straight line* fitted to the observations, and the means have also been plotted. The data indicate that the period of amenorrhoea increases by about a day for each additional day on the length of the cycle.

TABLE III.—Period of Amenorrhoea Related to Length of Cycle. Length of Cycle is Given as an Adjusted† Mean

Period of Amenorrhoea (Days)	Mean Length of Cycle (Days)																Total
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
238-244	—	—	—	1	—	3	1	1	—	—	—	—	—	—	—	—	6
245-251	—	—	1	2	1	1	1	2	—	2	—	—	—	—	—	—	10
252-258	1	—	2	3	3	4	1	1	2	—	1	—	—	—	—	—	18
259-265	—	1	3	3	6	6	5	1	1	2	1	—	—	—	—	—	29
266-272	1	2	2	11	9	18	13	10	4	4	2	1	—	—	—	—	78
273-279	2	2	7	9	15	26	32	24	8	7	3	5	3	—	—	—	143
280-286	1	2	7	15	29	43	38	21	20	9	—	4	2	—	1	—	192
287-293	1	—	4	13	15	21	27	27	24	13	7	5	5	1	1	2	166
294-300	—	—	1	4	8	7	7	11	5	4	2	5	2	—	—	2	58
301-307	—	—	—	1	—	2	2	2	3	1	—	—	—	—	—	—	11
308-314	—	—	—	—	—	1	—	—	4	—	—	—	—	—	—	—	5
Total ..	6	7	27	62	86	132	127	100	71	42	16	20	13	1	2	4	716
Mean‡ ..	274.8	274.0	276.0	278.0	279.9	279.1	280.7	282.2	286.1	281.8	281.7	285.8	285.1	—	—	—	280.9
Error of mean	4.49	2.72	2.32	1.68	1.21	1.04	0.88	1.13	1.33	1.87	3.05	1.97	2.33	—	—	—	0.43

† See text for method of adjustment. ‡ Means have been calculated from the ungrouped data.

Chart showing mean period of amenorrhoea related to mean length of cycle.

*The regression of mean period of amenorrhoea on mean length of cycle was estimated by the method of least squares from the data given in Table III. The equation of the fitted line is $y = 253.39 + 0.95x$.

Before accepting these results we should consider the possible objection that a menstrual history recorded in the year after the birth of a child may not be typical. It is difficult to know what could be regarded as a typical menstrual history of parous women. We have, however, excluded grossly abnormal cycles, as indicated above, and we have satisfied ourselves that the results are not substantially affected by variation associated with birth order or maternal age.

Discussion

The possibility that the period of gestation may be a multiple of the length of the menstrual or oestrous cycle, and that the time of onset of labour coincides with an estimated time of reappearance of the cycle, is suggested by three kinds of evidence.

1. It is well established that all cyclic activity of the ovary does not cease during pregnancy. As a rule this activity consists in ripening of fresh follicles without ovulation, a phenomenon observed in several species by Loeb (1923) and Evans and Swezy (1931). But occasionally overt manifestations of cyclic activity have been noted; for example, by Nelson (1929) in the rat, and by Tinklepaugh (1933) and Elder and Yerkes (1936) in the chimpanzee. Hartman (1932) referred to two reports (by Saint Hilaire and Cuvier, and by Allesch and Fox) of menstrual bleeding throughout pregnancy in women, and Wintz (1925) described two interesting cases of periodic bleeding from the empty horn of a bicornuate uterus.

2. The fact that in a few species the mean duration of gestation is approximately a multiple of the mean length of cycle has been considered significant (Shaw, 1926; Snyder, 1938). In animals such as the rat and mouse the association is scarcely surprising, since the duration of pregnancy (20-21 days) would be a multiple of any cycle of less than six days. But in man the observation that the mean period of amenorrhoea (280 days) is ten times the mean length of the menstrual cycle (28 days) is more suggestive.

3. In man, the length of the cycle and the duration of gestation are said to be correlated. Jolly (1928) recorded histories of five women with regular 24-day cycles whose pregnancies were 265 days, when estimated from the middle day of the last menstruation to birth, and corresponded roughly to 11 cycles. Results on women with longer cycles were inconsistent. More extensive data published by Wahl (1936, 1937) undoubtedly suggest that the duration of gestation increases with the length of the cycle, although the increments are too small to be consistent with the view that the one is a multiple of the other.

In the present communication it is shown that among women with regular cycles the mean duration of amenorrhoea (from onset of menstruation to birth) increases by about a day for each additional day in the mean length of the menstrual cycle. This also suggests that the period of gestation is not a multiple of the length of the cycle. A more plausible explanation of the association between the two variables is as follows.

There is good reason to believe that the length of the post-ovulatory phase is fairly constant, being about 14 days, and that variation in the length of the cycle is due mainly to variation in the pre-ovulatory phase (Zuckerman, 1937; Latz and Reiner, 1942; Corner, Hartman, and Bartelmez, 1945; Rock and Hertig, 1948; and Krohn, 1949). The period of amenorrhoea might therefore be expected to increase by one day for each additional day in the length of the cycle, even if the time between ovulation and birth were constant. In Table IV the period between ovulation and birth has been estimated by subtracting the interval between

TABLE IV.—Period Between Ovulation and Birth Related to Length of Cycle

Mean Length of Cycle (Days)	Period of Amenorrhoea (Days)	Assumed Interval between Onset of Menstruation and Ovulation (Days)	Estimated Period between Ovulation and Birth (Days)
23	274.8	9	265.8
24	274.0	10	264.0
25	276.0	11	265.0
26	278.0	12	266.0
27	279.9	13	266.9
28	279.1	14	265.1
29	280.7	15	265.7
30	282.2	16	266.2
31	286.1	17	269.1
32	281.8	18	263.8
33	281.7	19	262.7
34	285.8	20	265.8
35	285.1	21	264.1

the onset of menstruation and ovulation (assumed to be 14 days for women with 28-day cycles, and adjusted according to length of cycle) from the periods of amenorrhoea recorded in Table III. The estimated periods between ovulation and birth obtained in this way are all reasonably close to the mean of 266 days, based on 716 births.

It is concluded that variation in the period of amenorrhoea according to the length of the menstrual cycle is probably determined by variation in the interval between the onset of menstruation and ovulation. If this is so, the period between ovulation and birth seems to be independent of the length of the cycle.

It is perhaps necessary to stress that the observation that the period of amenorrhoea increases by about a day for each additional day in the length of the cycle is based on mean values derived from a large number of cases. The mean duration of gestation is of course associated with many other variables, and it seems unlikely that its association with the mean length of cycle can be used in individual cases to give an estimate of the expected date of delivery more accurate than the conventional one.

Summary

The association between the period of gestation and the length of the menstrual cycle has been investigated in 1,227 women whose menstrual history was recorded for one year after the birth of a child. The data were considered adequate for 716 women with regular cycles.

It is shown that the period of amenorrhoea (from the onset of menstruation to birth) increases by about a day for each additional day in the length of the cycle.

It is suggested that variation in the period of amenorrhoea according to the length of the menstrual cycle is determined by variation in the interval between the onset of menstruation and ovulation. If this is so, the period between ovulation and birth seems to be independent of the length of the cycle.

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THE ACUTE HYPOXIC EPISODE*

BY

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"Anoxia not only stops the machine, but wrecks the machinery."—HALDANE.

A good deal has been written on the subject of hypoxia, and great stress has been laid upon its deleterious effects on certain systems and organs, and on the organism as a whole. All authors stress the importance of avoiding hypoxia and of promptly terminating it should it occur.

Courville (1939) has examined the pathological findings associated with acute hypoxia in nitrous oxide anaesthesia. Although it is more than 10 years old his classification of the pathological findings, based on the severity of the hypoxic episode and the length of survival time, retains as much of its value to-day as it did when it was first published.

Many conditions, both medical and surgical, may be accompanied by hypoxia, but the surgeon encounters it in its most dramatic form—that is, as acute cardiac failure, arrest, or standstill. It is generally recognized that in these cases the immediate concern is to re-establish efficient pulmonary ventilation by artificial respiration combined with oxygen, and to restore the circulation to the vital centres by manual systole. Efficient manual systole must be accomplished within four minutes from the time that heart action has ceased, and more quickly if possible. If chronic hypoxia has preceded the acute episode, then the period within which circulation to the vital centres must be restored may be very much shorter than four minutes. There are many cases on record in which recovery has followed cardiac arrest lasting longer than four minutes, but as the minutes pass the chances of full, and later of partial,

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