FURTHER OBSERVATIONS ON PERIOD OF INVOLUNTARY STERILITY, FERTILITY INDICES AND THE DEFINITION OF STERILITY

BY

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Introduction

During my investigations of infertile couples, I felt that our knowledge of the 'normal' pattern of human procreation was inadequate. When Nature is 'let loose', what shape does a family take?

So I interviewed about 500 married women at the Municipal General Hospital, Sion, and investigated them through their reproductive careers to date. This approach is an important departure from the usual statistical data which are usually gathered from a cross-section of the population at a given point in time. The importance of this 'dynamic' approach in collection of data, which maintains the continuity of information, is well illustrated by the following:

It helps us to trace and to analyse the reproductive career of the couple in its entirety. Thus, a pregnancy for a woman will now no longer be looked at as an isolated event, but one item in the chain of events. To get a complete picture, therefore, it is not correct to study isolated events. It is appropriate to study the whole chain of events.

Given the reproductive history of a woman, we should imagine the woman passing through the various phases of the reproductive career, thus, for example:

Conception order:	1	2	3	4	5	6	7
PIS in months:	60	3	9	15	72	6	9

In spite of the fact that this couple had 7 children, it was both primarily and secondarily (between 4th and 5th conceptions) sterile.

Similarly, if 2nd, 3rd and 4th conceptions (out of 6 conceptions) of a woman ended as abortions (the rest being full-term deliveries), the woman was a case of habitual abortion in spite of the fact that the condition subsequently regressed.

This method of analysis has led us to the preliminary conclusions regarding the course of events in 'sterile' couples as compared to the rest of the population. It will be interesting to study the natural history of childbearing in women who have had

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vesicular mole, ectopic pregnancy, congenitally malformed fetuses, etc.

Period of Involuntary Sterility

At the outset, it was necessary for me to lay certain unit of measurement in order to assess the reproductive performance of the couples.

If during a period of married life, a couple exposes itself to the chance of conception and yet conception does not occur we call such a period, period of involuntary sterility (PIS).

Is PIS a satisfactory measure for procreation?

Our knowledge of the physiology of the components of PIS, viz. (i) anovulatory period, usually following a childbirth or an abortion, and (ii) period following resumption of ovulation is far from satisfactory. Conception is the final outcome of several known and unknown factors. Mere presence of the requisites of conception or lack or absence of the etiological factors of sterility does not necessarily result in conception; so that till we know more about the 'dynamics' of human conception we shall not be in a position to judge the quality of the reproductive pattern of the couple, i.e., how well the couple has procreated, nor shall we have other measures for the quantitative estimation of the various factors involved in conception.

Till then, time is the only measure of the reproductive performance of a couple. To the clinician and to the couple, it really matters within how much time conception takes place.

The same comment is true for fertility indices.

The first component of the subsequent PIS is lacking in the first PIS, unless there are functional ovarian disturbances following marriage, which are uncommon in the population under study. So, if in Fig. 12* we were to shift the curve of the subsequent PIS by 9 months to the left, we would expect the curves of the first and the subsequent PIS to coincide within the limits of variation (9 months being the average difference in PIS following the deliveries when the baby was nursed as compared to that following the deliveries when the baby was not nursed—from Table 8) (Table 23). That this does not occur is shown by X^2 test. Once again it is shown that the first PIS is different from the subsequent PIS. If this is confirmed later by other series, one would like to go into the physiological aspects of this difference.

Fertility Indices

The implications of the two fertility indices have already been discussed. The two indices are—

(i) Average duration of marriage in years per conception. This is the average PIS plus the average duration of pregnancy, i.e. 9 months.

(ii) Minimal PIS.

The average PIS is the average of the first and the subsequent PIS. The average number of pregnancies in the sample is 3.697 (Table 6), and hence the subsequent PIS contributes much more to the average than the first PIS does. So, in Table 24 the indices are compared in women who have conceived more than once.

* For Fig. 12 and Table 8 see J. Obst. & Gyn. of India, Vol. VIII, No. 1, Sept. 1957.

If we were to shift the distribution of the average PIS to the left by 9 months, in view of the observation that minimal PIS is more frequently found following the delivery when the baby was not nursed and following an abortion than following a delivery when the baby was nursed, even then the curves of average PIS and the minimal PIS do not correspond within the limits of the variance (as seen by X^2 test). Before we conclude either way regarding the correspondence or otherwise of the distribution of both the indices, we have to take into account two things:

(i) We must compare the distribution of the indices in a population where mothers do not nurse the babies for any appreciable length of time. Prolonged nursing of the babies is the rule in the population studied.

(ii) We must remember that minimal PIS is due to variable reduction in both the components of PIS.

To these two indices, a third one may be added:

Chance (probability) of conception in relation to the duration of marriage (Table 25). Construction of similar tables will help us to arrive at probability. This index will be useful in comparing fertility of various populations at a varying time following marriage.

The manner in which the chance of conception is arrived at is as follows:—

Probability (Px) of conception during 6 months following marriage and puberty

$$= \frac{\text{number of conceptions which have occurred during the particular period } (Nx)}{\text{number of women who can conceive during the period } (Dx)}$$

$$\text{Thus } Px = \frac{Nx}{Dx - (Nx\text{-}1 + N\frac{x\text{-}2}{2} + Cx)}$$

The denominator was arrived at by finding the number of women (Dx) who passed through at the particular period of married life (Table 6) and then by substracting the following from Dx:

(i) Women who were pregnant during the particular period of married life under consideration (Nx-1 + $N\frac{x\text{-}2}{2}$ with suitable correction for abortions).

(ii) Number of couples who either did not stay together, practised abstinence, used contraceptives (no case in the present series), etc., during the period under consideration; also women incapable of conceiving at that particular time-interval (see definition of PIS) (Cx).

It will be seen from Table 25 that the relative frequency or the probability is the same throughout for the first seventeen years after the marriage and thereafter it reduces significantly. This result has to be confirmed by working on similar series.

Similar probabilities can also be deduced in relation to the age of the mother and the sum of PIS (SPIS), but these are less likely to be useful.

The difference between the probabilities worked out according to the duration of marriage and to the age of the mother depends on the difference in the age of the wife at the time of the marriage and the menarche, and hence comparison

between probabilities for various populations will be difficult.

Probabilities worked out according to the sum of PIS involve more cumbersome calculations, and are less easily interpreted by the clinician.

In future, we would like to find out the following fertility indices:

(i) Fertility index of the couple before actual reproductive performance.

(ii) Fertility indices of the husband and wife separately.

Definition of Sterility

The definition of sterility in terms of mean PIS plus twice the standard deviation* tends to fix the incidence of sterility at 5%

To work out the expected incidence of sterility, the etiological factors of sterility should be analysed.

The etiology of sterility consists mainly of two groups of factors:

(i) Factors causing absolute or 100% sterility, i.e. in presence of these factors conception is impossible, e.g., azoospermia, complete organic occlusion of the tubes, absence of the uterus, ovaries, etc.

(ii) Factors which reduce the chance of conception, i.e., the 'relative' factors, e.g., vaginal infections, oligozoospermia, etc.

The manner in which the relative factors contribute to infertility is variable; for example, sterility due to a factor A (α) = per cent incidence of A (IA) x per cent, which represents the incidence of sterility among A (FA)

$$\text{i.e. } \alpha = IA \times FA$$

Effect of various relative factors (FA, FB, FC .....) can be found by planning factorial analysis in the population under study.

In an unbiased sample of population, incidence of sterility in the various groups detailed below are studied; for example, consider four factors A, B, C, D. In each case, each of the factors may be present (A) or absent ($\bar{A}$); thus we have 16 groups:

ABCD	$\bar{A}\bar{B}\bar{C}\bar{D}$	$\bar{A}\bar{B}CD$	$AB\bar{C}\bar{D}$
$\bar{A}BCD$	$\bar{A}B\bar{C}\bar{D}$	$\bar{A}\bar{B}C\bar{D}$	$\bar{A}\bar{B}\bar{C}D$
$A\bar{B}\bar{C}\bar{D}$	$A\bar{B}C\bar{D}$	$A\bar{B}\bar{C}D$	$AB\bar{C}D$
$\bar{A}B\bar{C}D$	$\bar{A}BC\bar{D}$	$\bar{A}B\bar{C}\bar{D}$	$A\bar{B}CD$

If these very letters are used to denote their effects, e.g. effect of A is represented by A, etc., then the effect of various factors are found as follows:—

Effect of $A = (A - A)\ (B + B)\ (C + \bar{C})\ (D + D)$

Similarly the effect of B, C and D can be found.

The interactions between the various factors can also be found by the same method:

e.g., interaction between A and B is given by

$(A - \bar{A})\ (B - \bar{B})\ (C + \bar{C})\ (D + D)$;

interaction between A, B and C is given by

$(A - \bar{A})\ (B - \bar{B})\ (C - \bar{C})\ (D + \bar{D})$;

* In case of first PIS, the frequency distribution was assumed to be a normal curve (as mean + 1 S.D. = 85.45% of cases; mean + 2 x S.D. = 92.1% of cases; mean + 3 x S.D. = 95.43% of cases).

interaction between A, B, C and D is given by

$(A - \bar{A})$ $(B - \bar{B})$ $(C - C)$ $(D - \bar{D})$.

Similarly, the effect due to various factors in more or less combination can be analysed. Having found the values FA, FB, FC, . . . for the various relative factors, the validity of these values should be subjected to the tests of significance. The work can be diminished by the method of 'confounding' wherever possible.

Thus, if we have incidence of various relative factors (IA, IB, IC, . . .) and their effects in causation of sterility (FA, FB, FC, . . .), the expected incidence of sterility due to the relative factors is

IAFA + IBFB + ICFC ..... = SIAFA

The problem is simpler for the absolute factors.

The total incidence (SIx) of absolute factors directly gives the expected incidence of sterility due to these factors. The two precautions to be observed during these computations are

(i) If a couple has more than one absolute factor responsible for sterility, it should be included in ONE of the groups. That is, there should be no overlapping in the classification of absolute factors.

(ii) If a couple has both absolute and relative factors responsible for its sterility, ignore the relative factors for the purpose of calculation and classify it with the absolute factors only. It follows, therefore, that in the above mentioned factorial analysis for the relative factors, none of the couples included in the analysis had any absolute etiological factors for sterility.

Absolute factors for the secondary sterility consist only of those factors acquired after the last childbirth, e.g., occlusion of the tubes due to puerperal sepsis.

The total expected incidence of sterility (E) is, therefore, the sum of the expected incidence due to the absolute factors (SIx) and the expected incidence due to the relative factor (SIAFA).

$$E = SIx + SIAFA$$

Thus, the determination of rational definition for sterility for a population involves the following steps:—

(i) Frequency distributions of the first and the subsequent PIS.

(ii) Incidence of the relative and the absolute etiological factors of sterility in the population.

(iii) The expected incidence (E) of the sterile couples in the population.

(iv) In the frequency distribution graph of PIS, work backwards (i.e. to the left) by an amount equal to the expected incidence of the population; thus find the definition of sterility for the population in terms of PIS.

Concluding Remarks

Though the results of the analyses in these two papers are only preliminary in nature and will have to be substantiated by the analyses of several similar series, the present approach to the study of the problems of human procreation seems unorthodox. If this approach opens out new horizons in our knowledge of sterility and fertility, there cannot be greater satisfaction to the author.

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TABLE 23

Frequency Distribution of PIS
(This is Table 9 re-arranged)

1st PIS in months		0-6	-12	-18	-24	-30	-36	-42	-48	48+	Total
No. of pregnancies		203	101	68	23	30	8	15	12	21	481
Subsequent PIS in months	0-9	-15	-21	-27	-33	-39	-45	-51	-57	57+	Total
No. of pregnancies	295	402	226	222	35	61	11	25	8	23	1308

TABLE 24

Minimal Subsequent PIS and Average PIS in Women Who Have Conceived More Than Once

Average PIS in months	0-9	-15	-21	-27	-33	-39	-45	45+	Total
No. of cases	53	111	89	54	29	11	8	18	373
Minimal PIS in months		-6	-12	-18	-24	-30	-36	36+	Total
No. of cases		116	76	101	32	29	5	13	372

TABLE 25

The Relative Frequency (Probability) of Conceptions According To the Period Following Marriage

Period of married life (in 6 months) xth 6 months	Relative frequency Px	Period of married life (in 6 months) xth 6 months	Relative frequency Px
1	0.3839	21	0.2355
2	0.3767	22	0.2324
3	0.4017	23	0.2697
4	0.3511	24	0.3626
5	0.3148	25	0.2764
6	0.3197	26	0.3243
7	0.2799	27	0.2879
8	0.2876	28	0.2879
9	0.2783	29	0.3438
10	0.3026	30	0.3148
11	0.2962	31	0.2917
12	0.3284	32	0.3054
13	0.3334	33	0.2500
14	0.3109	34	0.3054
15	0.2784	35	0.1795
16	0.3537	36	0.1424
17	0.2999	37	0.1744
18	0.2971	38	0.2580
19	0.2560	39	0.2293
20	0.2868	40	0.0909