
A Prospective Study of the Preselection of the Sex of Offspring by Timing Intercourse Relative to Ovulation

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The relationship between the sex of offspring and the time interval between coitus and ovulation/fertilization has been prospectively investigated in 33 pregnancies using the rise in luteinizing hormone in the early morning urine, the peak cervical mucus symptom, and the shift in basal body temperature as indicators for ovulation.

Reference to the peak cervical mucus symptom showed a significant association of conception of a male child with longer intervals (>2 days) between coitus and fertilization ($P < 0.03$). However, while a similar trend for male conceptions was evident when the duration of sperm survival was determined by reference to each of the other two indicators of ovulation, the relationship was not significant.

The results clearly refute the theory that intercourse close to ovulation favors male conceptions. While the findings are con-

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sistent with the contrary theory, it may be premature to conclude that a male child is more likely to be conceived if coitus takes place several days before ovulation.

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CURRENTLY THERE are two approaches for trying to preselect the sex of an infant before conception. One involves collection and processing of the husband's semen to separate the X and Y spermatozoa with subsequent artificial insemination of the wife with the fraction appropriate to the sex of offspring desired.¹ The second approach is based on the timing of intercourse in relation to ovulation. While this method is more popularly known through being frequently featured in lay publications, its basis is controversial. The studies that have been carried out to investigate the relationship between the sex of offspring and the timing of intercourse have produced conflicting evidence and contradictory claims.²⁻⁸ The majority of these studies have been retrospective, often relying on poorly documented records, and very few have used a reliable indicator of ovulation for reference. It is not surprising, therefore, that opposing theories have arisen and are promoted.

One theory claims that intercourse early and late (after ovulation) in the fertile period is most likely to result in conception of a male child, while a female is more probable from intercourse close to the day of ovulation.⁵⁻⁸ An alternative but opposing proposal, originating from Kleegman,² claims that a male child is more likely to be conceived from intercourse close to the time of ovulation. Despite the lack of support for Kleegman's theory from Cohen's studies,³ this approach to sex-preselection, popularized in recent years by Shettles,⁴ is, nevertheless, currently perhaps the best known.

According to Shettles,⁴ the Y-bearing sperm move more rapidly in the female reproductive tract than the X-bearing sperm but lose fertilizing capability more quickly. Therefore, if insemination occurs close to the time of ovulation when cervical mucus

is most easily penetrated by sperm, a Y-bearing sperm is more likely to reach the ovum first. Conversely, if insemination takes place several days before ovulation, most Y-bearing sperm will be nonviable before the ovum becomes available for fertilization. Studies of sperm migration in cervical mucus *in vitro*⁹ and *in vivo*¹⁰ have shown that Y-bearing sperm do appear to migrate more rapidly than X-bearing sperm, supporting Shettles' theory. However, there appears to be no evidence to support the contention of a shorter life span for the Y-bearing sperm. Shettles⁴ reported a success rate for his method of 85% in a study involving 41 pregnancies. Vear¹¹ has also reported success for Shettles' method in achieving the preselected sex of offspring in ten consecutive pregnancies.

Frequent inquiries from the public for information on sex-preselection and the lack of reliable data in the literature were the stimuli for the present study. The study was designed to prospectively investigate the relationship between the sex of the offspring and the interval between intercourse and fertilization. In addition, the study would provide information on characteristics of conceptual cycles, sperm survival time, and fertility rates. The surge in urinary levels of luteinizing hormone (LH), the "peak day" of cervical mucus symptoms,^{12,13} and the rise in basal body temperature (BBT) have been used to identify the time of ovulation and of fertilization in the cycle.

Materials and Methods

Subjects

Couples contemplating pregnancy and with a desire to preselect the sex of their child were recruited through general practitioners who also screened responders to publicity of the study in the local press and on radio. The couples were then interviewed at National Women's Hospital, and the objectives and protocol of the study were explained. It was pointed out that no guarantee could be given on the sex of children conceived in the study. Written informed consent was obtained from each couple.

Study Protocol

The sex-preselection theory of Shettles⁴ was chosen as the basis for the study because it was likely to be familiar to the subjects through being recently featured in a popular New Zealand weekly magazine. Shettles⁴ also recommends that intercourse be preceded by an acid vaginal douche to enhance the possibility of conceiving a female and by an alkaline douche for a male. However, since the migration of X- and Y-bearing sperm have been shown not to be differentially affected by pH,¹⁰ precoital douching was not incorporated in our study method. Furthermore, since there is no evidence to support the contention of Shettles⁴ that the sex of offspring may be influenced by the occurrence or nonoccurrence of female orgasm and the position and degree of male penetration at intercourse, these aspects of his method were also not adopted. Essentially, then, our study method consisted of appropriate timing of intercourse in the cycle, at ovulation if the couple desired a boy or 2 to 3 days before ovulation if the couple desired a girl.

To enable the couple to recognize the fertile period of the menstrual cycle and to anticipate ovulation, the woman was instructed on how to observe her cervical mucus symptoms and their significance in identifying the fertile period. These instructions were given by an accredited teacher of the New Zealand Association of Natural Family Planning, following the guidelines set out in the *Atlas of the Ovulation Method*.¹⁴ In brief, the woman was asked to note the sensation and the appearance of the mucus at the vulva and to record her mucus symptoms on a chart at the end of each day. The fertile period was considered to commence with a change in vulvar sensation from dryness to dampness, or to feeling wet, or with the onset of increased mucus secretion draining at the vulva. The "peak day" was the last day on which "fertile type" mucus (resembling raw egg white or identifiable by the lubricative or wet sensation produced) was recognized. The "peak day," i.e., the day of the peak mucus symptom, has been shown by a number of investigators^{12,13} to be a reliable indicator of ovulation. The woman was also in-

structed on how to take and chart her BBT.

The woman was seen monthly by the natural family planning teacher, who reviewed her mucus charting and reinforced or corrected her learning. The couples were requested to avoid trying to achieve a pregnancy during these teaching cycles, which were usually no more than three.

After completing the teaching period, the couples were advised to use the following guidelines for timing intercourse: (1) Abstain from the onset of fertile mucus symptoms or from day 7 of the cycle, whichever comes first. (2) If a female infant is desired, have intercourse 2 to 3 days before the mucus "peak" symptom, using the pattern and duration of symptoms observed in previous cycles as a reference guide. (3) If a male infant is desired, have intercourse on the day after the mucus "peak" symptom.

The couples were asked to have only the one act of intercourse in the fertile period, then abstain until at least the fifth day after the peak. They were asked to record all acts of intercourse. The woman was requested to collect her first morning urine, for measurement of LH, from the onset of the fertile period until the third day after the "peak" symptom. The urine samples were stored at -18° C until assayed.

Until pregnancy occurred, the natural family planning teacher usually saw the woman at the completion of each active cycle. If pregnancy had not occurred within six active cycles, the subjects were discontinued from the study.

Assays

Urinary levels of LH were determined by double antibody radioimmunoassay following acetone extraction.¹⁵ The protocol and reagents for the radioimmunoassay were provided through the World Health Organization Matched Reagents Programme for the Radioimmunoassay of Hormones in Reproductive Physiology. The intraassay precision was 8.7%. The samples from each subject were assayed together as a batch.

Urinary creatinine was measured by an Autoanalyzer (Tech-

nicon Instruments Corporation, Tarrytown, NY) method based on the Jaffe reaction. The intraassay precision was 3.7%.

Ovulation Indices

Three indicators were used to define the time of ovulation in the cycle.

THE PREOVULATORY SURGE IN LH. From studies reported in the literature (see Discussion) we have concluded a consensus value of 32 hours for the time interval from the commencement of the urinary LH surge of ovulation. The commencement of the LH surge was defined as the first value of the LH creatinine ratio that was > 1.5 times the mean of preceding baseline values. The error associated with the use of LH levels in early morning urine for the estimate of the time of ovulation is likely to be between ± 12 hours and ± 24 hours.¹⁶

THE PEAK MUCUS SYMPTOM. The time relationship between the peak in cervical mucus symptoms and ovulation has been reported to be on average -0.9 days,¹² -0.6 days,¹⁷ and +0.31 days.¹³ In their study of 65 normal menstrual cycles, Hilgers and co-workers¹³ estimated ovulation in 95.4% of the cycles to have occurred from 2 days before to 2 days after the peak symptom. For this study, we have defined ovulation as occurring on the day following the peak mucus symptom.

THE SHIFT IN BBT. The day preceding the rise in BBT to sustained postovulatory levels was defined as the day of ovulation. The rise was identified by the coverline method as the first of the sustained BBT readings that was higher than the six readings immediately preceding.⁶ This is the least precise of the reference indices. Hilgers and Bailey,¹⁸ in the study of BBT in 66 normal cycles, found the day preceding the rise in BBT was on average 0.49 days before the estimated time of ovulation, with a range of 2 days before to 2 days after ovulation in 77.3% of the cycles.

Interval from Ovulation to Fertilization

Since fertilization rather than ovulation is the more significant event in this study, the time required in the fertilization process for sperm capacitation, for the acrosome reaction, and for the

fertilizing sperm to induce the mechanism blocking penetration of the ovum by other sperm is of importance. Observations from in vitro studies indicate that these steps to fertilization may take between 5 and 8 hours.^{19,20}

In calculating the duration of sperm survival from intercourse to fertilization, we have added a further 8 hours to the 32-hour period assumed as the interval from the commencement of the LH surge to ovulation. The peak mucus symptom and the shift in BBT are less precise indicators of ovulation, and it was considered not necessary to include an allowance for fertilization in using these as references in calculating sperm survival.

Statistical Analysis

The Wilcoxon-Mann-Whitney rank sum test, two-tailed, was used for statistical evaluation of results.

Results

A total of 185 couples have participated in the study to date. The present status of these subjects is summarized in table 1.

TABLE 1

Status of Sex-Preselection Study as of November 1983

No. of subjects entering study	185
No. of live births in study	52
No. of miscarriages	4
No. of ectopic pregnancies	1
No. currently pregnant	9
No. in teaching or trying to become pregnant	30
No. of discontinuations	85
No. failed to become pregnant	4

There have been 57 completed pregnancies, of which 52 went to term and produced a viable infant. Four ended in miscarriage during the first trimester, and one was an ectopic pregnancy. None of the pregnancies have been associated with multiple births. Of the 52 term pregnancies, there were 19 for which uncertainty existed about which act of intercourse caused the pregnancy; i.e., contrary to the given instructions, there was more than one act of intercourse during the fertile period. These pregnancies have been excluded from the analysis in this report, which is thus principally concerned with reviewing the 33 pregnancies in

which the fertile coital act could be unequivocally identified.

Relevant details of the parents concerned with the pregnancies are as follows: the mean age of the mother was 29.7 years (range, 22 to 35 years), and the mean age of the father was 32.5 years (range, 26 to 48 years). They had an average of two living children (range, 0 to 5), males being 1.3 times as prevalent as females. Nineteen of the subjects entered the study with the intention of trying for a female, and 14 subjects intended to try for a male.

Twenty-two male infants and 11 female infants were born. The relationship between the sex of the infant and the time interval from intercourse to fertilization as identified from urinary LH levels is illustrated in figure 1, and the data are listed in table 2.

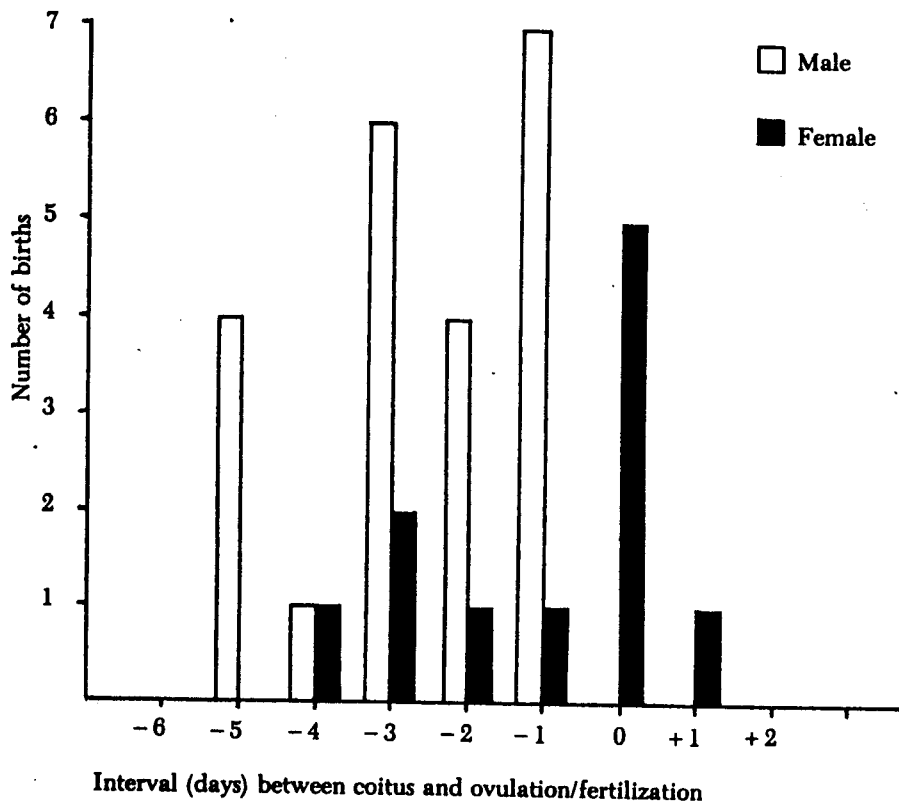


Fig. 1. Relationship between the sex of the offspring and the interval between coitus and ovulation/fertilization defined by reference to the rise in LH in early morning urine.

TABLE 2

The Day of Occurrence in 33 Conceptual Cycles of the Fertile Coital Act and of Each of the Indicators of Ovulation: the Rise in Urinary LH, the Cervical Mucus (CM) Peak Symptom, and the Rise in BBT^a

Subject	Day in menstrual cycle of				Interval (days) coitus to fertilization ^b defined by ovulation indicator			Sex of infant
	Fertile coitus	LH rise	CM peak	BBT rise	LH ^c rise	CM ^c peak	BBT rise	
A. O'S.	12	16	15	18	-5	-4	-5	M
A. O.	16	20	16	22	-5	-1	-5	M
M. G.	14	18	17	15	-5	-4	0	M
E. H.	13	17	16	18	-5	-4	-4	M
C. H.	12	15	16	17	-4	-5	-4	M
S. T.	9	12	11	13	-4	-3	-3	F
S. N.	11	13	15	14	-3	-5	-2	M
C. C.	10	12	12	12	-3	-3	-1	M
K. N.	18	20	22	22	-3	-5	-3	M
H. O.	15	17	17	18	-3	-3	-2	M
A. L.	14	16	13	Monophasic	-3	0	NA	M
J. R. S.	9	11	14	NA	-3	-6	NA	M
H. M.	15	17	17	19	-3	-3	-2	F
C. B.	11	13	12	15	-3	-2	-3	F
J. M.	11	12	11	12	-2	-1	0	M
A. B.	11	12	12	13	-2	-2	-1	M
M. B.	17	18	20	16	-2	-4	+2	M
S. K.	13	14	15	16	-2	-3	-2	M
A. D.	14	15	14	16	-2	-1	-1	F
S. McA.	12	12	14	14	-1	-3	-1	M
R. P.	14	14	15	15	-1	-2	0	M
N. R.	15	15	16	17	-1	-2	-1	M
S. S.	17	17	19	19	-1	-2	-1	M
G. S.	18	18	18	20	-1	-1	-1	M
Y. N.	15	15	17	NA	-1	-3	NA	M
J. S.	16	16	16	19	-1	-1	-2	M
V. L.	14	14	16	15	-1	-3	0	F
J. W.	16	14	14	17	0	0	0	F
S. L.	13	12	13	14	0	-1	0	F
M. C.	14	13	12	14	0	+1	+1	F
J. C.	27	26	26	28	0	0	0	F
D. H.	18	17	18	19	0	-1	0	F
C. J.	13	11	14	13	+1	-2	+1	F

^aAlso tabulated is the interval in days, as defined by each indicator of ovulation, between coitus and fertilization for preovulatory intercourse and between ovulation and coitus for postovulatory intercourse.

^bFor postovulatory intercourse the interval is from ovulation to coitus.

^cRefer to the text for the time relationship between the reference indicator, ovulation, and fertilization.

Male infants were conceived from intercourse occurring from 5 days to 1 day before fertilization, while female infants were conceived from intercourse occurring from 4 days before fertilization to 1 day after ovulation. Sixty-eight percent of the male infants resulted from sperm survival of 2 days or more before fertilization. In contrast, the majority of the female infants (64%) were conceived from sperm present for 1 day or less in the mother's reproductive tract. On statistical analysis, however, the association of a higher incidence of male conceptions with longer fertile sperm survival times did not reach significance ($P = 0.06$, $z = 1.87$).

Cervical mucus symptoms gave the couples predictive information on ovulation for determining the timing of intercourse. The peak mucus symptom provided a second indicator of ovulation for the study. Using this indicator as a reference, 75% of the male infants were found to have been conceived with sperm surviving 2 days or longer following intercourse, compared with 45% of the female infants (table 2, fig. 2). The relationship favoring male conception with longer sperm survival times was significant at $P < 0.03$ ($z = 2.19$).

Biphasic temperature charts were recorded for 30 of the 33 conceptual cycles. In one cycle the BBT remained monophasic, while for the two remaining cycles the women neglected to keep temperature records. For the 30 cycles with interpretable charts, the association between male conceptions and longer sperm survival times was not significant when the day before the rise in BBT was taken as the reference for ovulation. Only 47% of the male births resulted from fertilization with sperm survival of 2 days or longer (table 2, fig. 3).

The study offers useful information on viable sperm survival in normal fertile couples. Using the rise in urinary LH to define the time of ovulation and fertilization, 12% of the pregnancies resulted from intercourse 5 days before fertilization. No pregnancies occurred from intercourse beyond that interval. Eighteen percent of the pregnancies arose from sperm survival of 4 days or more.

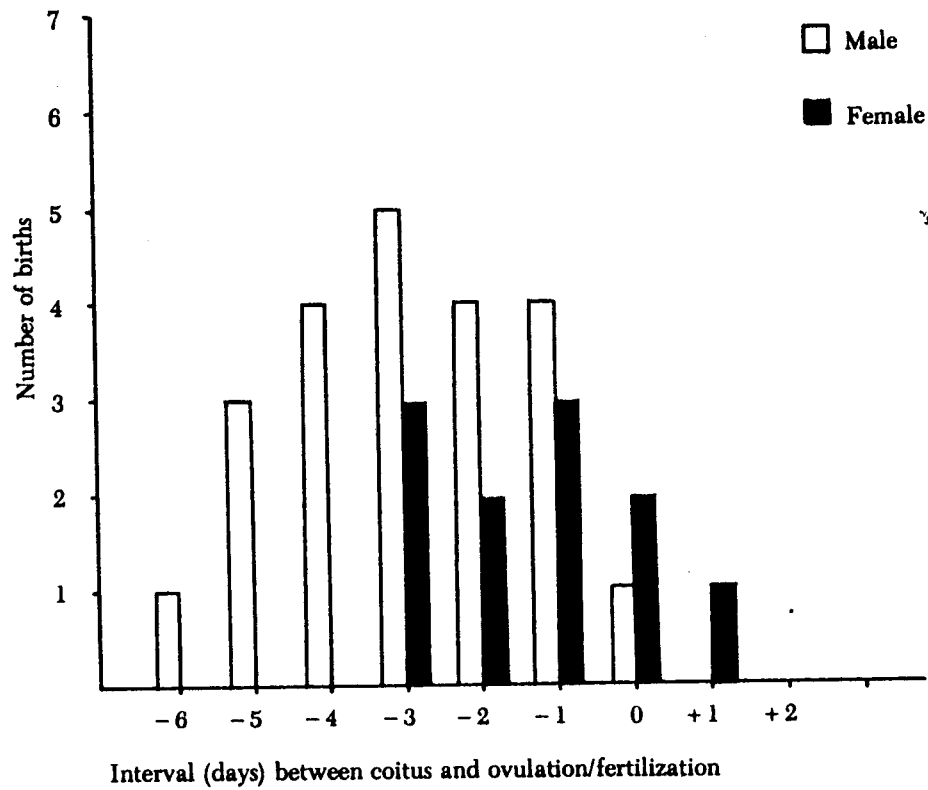


Fig. 2. Relationship between the sex of the offspring and the interval between coitus and ovulation/fertilization defined by reference to the day of the peak cervical mucus symptom.

On the average, the couples required two active cycles to achieve pregnancy. Fifteen of the couples (45%) achieved pregnancy in the first active cycle, with births subsequently of ten male and five female infants; the range of fertile sperm survival was 0 to 5 days.

Only 39% of the couples obtained an infant of the sex they desired.

Eighty-five couples (46%) dropped out of the study for the following reasons: there was a change of mind about pregnancy (27%); the requirements of the study were too demanding (16.5%); or the requirements of the study caused marked stress (11.8%).

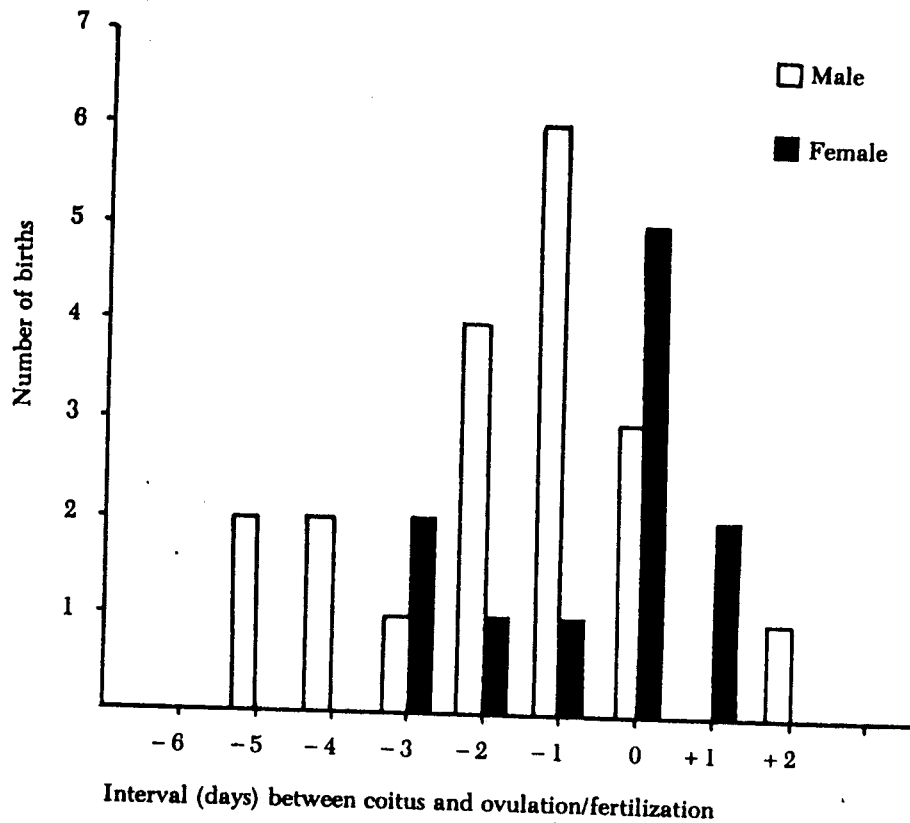


Fig. 3. Relationship between the sex of the offspring and the interval between coitus and ovulation/fertilization defined by reference to the shift in BBT.

Discussion

In this study, we used the LH level relative to creatinine in first morning urine samples as the principal reference indicator for the time of ovulation. For the subject, collection of first morning urine samples is simpler, more convenient, more acceptable, and less likely to be stressful than 24-hour collections or providing daily blood samples. We considered that these advantages were of importance to the successful recruitment of subjects. It has been clearly demonstrated that the urinary excretion level of LH mirrors the plasma concentration.²¹ The LH level in samples of first morning urine, furthermore, has been found to correlate well with the level in complete 24-hour collections²² and has been

shown to be of value in predicting and detecting ovulation.²³ Expressing the LH level relative to that of creatinine²² seems a useful refinement and in our experience appears to adequately correct for variations in urine concentration and improves reliability of interpretation.

Defining the time interval between the beginning of the LH surge and ovulation has received much attention in recent years, particularly with the advent of in vitro fertilization. For urinary LH, the studies of Edwards et al.²⁴ indicate an interval >30 hours from the onset of the rise to ovulation. Collins et al.,²³ using daily early morning urine samples, showed that ovulation invariably occurred from 20 to 44 hours after the rise in urinary LH, with a mean time of 30 hours. On the basis of these and other reported studies, we concluded that 32 hours was a realistic consensus value for the purpose of the present study. The error associated with the use of early morning urine for the estimate is likely to be between ± 12 hours and ± 24 hours.¹⁶

Fertilization, rather than ovulation, however, is the event of importance in determining sperm survival. Observations from in vitro fertilization^{19,20} suggest that the process of fertilization at least to induction of the block to polyspermy may take up to 8 hours. We therefore used a period of 40 hours from the initial rise in urinary LH levels to identify the time of fertilization in calculating active sperm survival times from preovulatory intercourse. Assuming that an early morning urine sample is usually collected at about 7:00 A.M. and that the LH content represents an integral value of metabolic processes occurring during the previous 8 hours, the 40-hour time interval places ovulation at about 11:00 P.M. or earlier in the evening the following day. Because pregnancy in all our couples but one resulted from evening intercourse, fertile sperm survival times can therefore be calculated correctly in terms of whole calendar days. The error in the calculation essentially is the error associated with defining the time of ovulation.

The study is one of the few closely monitored prospective investigations of sex-preselection by the appropriate timing of

intercourse. While 33 pregnancies is a small total number for analysis, the data contributed by these pregnancies are unequivocally defined, although, as in all studies such as this, there is reliance on subjects for accurate and honest reporting of intercourse. The findings clearly refute the theory of Kleegman² and Shettles⁴ used as the working hypothesis for the study. The occurrence of significant numbers of male conceptions from sperm survival of 3 to 5 days does not support their contention that sperm bearing the Y chromosome have only a short survival time in the female reproductive tract. On the other hand, the results are consistent with the contrary claim of James^{5,8} and the observation of Guerrero,⁶ that the sex ratio favors males, the longer the interval between intercourse and ovulation. This relationship between sperm survival and male conceptions was significant in our study for one marker of ovulation, the cervical mucus "peak" symptom, and was close to significance for another, the preovulatory rise in urinary LH. We would, nevertheless, in view of the relatively small number of pregnancies, emphasize caution in concluding from our findings that the sex of offspring can be predetermined by appropriately timing intercourse. Currently we are extending our study to confirm the present results.

The pregnancies in this study produced more males than females, continuing the overall bias in sex ratio present among the existing children of the subjects. A predisposition among our subjects to the conception of male offspring would be an alternative explanation of the sex-preselection findings of the study. This explanation, however, would seem unlikely, for while familial tendencies to mainly male or female offspring do occur in the general population, they are usually considered to be a matter of chance; furthermore, our subjects did not have a history of a consistent predominance of male children (or female) in the context of their families at large.

The fertile period of the menstrual cycle is frequently proposed as being of 4 to 5 days' duration, consisting of the 3 days before ovulation and 1 to 2 days after ovulation.¹⁶ In the present study, 18% of the pregnancies resulted from intercourse 4 to 5

days before ovulation, suggesting that the beginning of the fertile period could well be revised accordingly, extending the duration of potential fertility in the cycle to perhaps 7 days.

Four first-trimester spontaneous abortions and 1 ectopic tubal pregnancy occurred in a total of 57 completed pregnancies. These incidences, allowing for small numbers, appear to be no different from those commonly seen. Three of the abnormal pregnancies (including the ectopic) resulted from sperm survival of 3 days, one resulted from a 2-day sperm survival, and one resulted from intercourse at ovulation. These data do not support the proposal that spontaneous abortion is more likely to occur when fertilization has involved over-aged sperm.²⁵

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