

RATIONALISATION OF WORKING OF OPD IN A HOSPITAL - A CASE STUDY

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ABSTRACT

The paper deals with the working of two major out-patient departments, namely, Medical and Paediatrics of a Delhi Hospital. These have been discussed in order to suggest ways and means to reduce the waiting time of patients, adequacy of doctors and pattern of their deployment in OPDs and to reduce overcrowding in these departments. It has been observed that if the registration and consultation timings are slightly staggered, the average queue length of patients waiting for consultation at different instants of time will be considerably reduced resulting in low waiting time and less crowding.

During the last decade the facilities in the hospitals have not increased at the same rate as the population seeking medical care. Because of the increased rush of people visiting hospitals for treatment, long queues of patients are seen awaiting for medical care in almost all the hospitals, resulting in overcrowding and long waiting times. One of the major hospitals of Delhi also faced a similar problem of overcrowding of patients in a number of Out-patient Departments (OPDs). Concerned with the seriousness of the situation and for providing better medical care to the residents of Delhi, a study was conducted in order to suggest remedial measures for reducing the waiting time and overcrowding in the hospital.

Objectives

The study was mainly focused on the following:

- i. the arrival pattern and load of patients in the outpatient departments under study;

- ii. the waiting time of patients for registration and consultation;
- iii. the normal availability of doctors and the time spent by them in the OPD;
- iv. the service time *i.e.* time spent by the doctor to render the services; and
- v. working hours of OPD including registration and consultation.

Methods and Materials

The problem of overcrowding in hospitals is not merely because of shortage of doctors and other paramedical staff. Some of the problems leading to this phenomenon are of management. Thus, the problem of overcrowding was studied in its totality of situation and not merely a queuing problem.

A number of studies on out-patient departments in hospitals have been reported out of which the most relevant ones were Bailey, Welsh *et al*, Gabrielson *et al*. But it was found in practice that the queuing model M/M/C, where arrivals follow Poisson distribution; service times follow negative exponential distribution and number of servers are $c(7-0)$, was not suitable for this study because the patients visiting various departments (except orthopaedics) formed a single queue outside the OPD block from early morning and were allowed to go in respective departments slightly before the registration time. Because of this restriction, the inter-arrival times were not independently distributed random variable which is a basic assumption for using exponential distribution. To overcome this problem, the work study approach was used as discussed in succeeding sections.

The study broadly covered, four major departments *viz.* Medical, Surgical, Orthopaedic and Paediatrics, which were selected after a detailed discussion with the hospital authorities. However, for the illustration purposes, only Medical and Paediatrics departments have been discussed as their functionings were not similar.

Methods

a. Record Study

Under this method, the data for the last three years of old and new patients was collected from October 1978 to September 1981 from the hospital records. The information collected from records was utilized for obtaining patient loads during the different parts of the year on the departments under study.

b. Observational Study

Observational study was conducted on six working days in each of the four departments under study to collect data regarding patient oriented characteristics such as arrival of patients, waiting time of patients for registration and consultation, service time *i.e.* time spent by a patient with the doctor in consultation, actual deployment of doctors in OPD and working hours of OPD. For the observational study, a sample of 15 per cent of patients was selected using systematic random sampling procedure on the basis of average number of old and new patients who had attended OPD during the last one year. Every sampled patients was given a proforma with time of joining the queue for registration entered and was then followed by the research staff from entry to the consultation room of the doctor. This procedure was followed in all departments under study to obtain information on the waiting time of patients for registration, consultation and service time.

The data collected through observational study was analysed to determine: (i) arrival rate of patients; (ii) waiting time of patients for registration and consultation; (iii) average service time of the doctor; (iv) average number of patients seen by doctors during the normal OPD working hours; and (v) patients' load on OPD during the observation period.

The information collected through these two methods was used to work out the desired staff deployment, working hours of the OPD including registration timings, space requirements etc.

Findings of the Study

The study in general, reveals that although the average waiting time for registration was not much, the maximum time was very high because most of the times, specially in medical units registration did not start at the scheduled time *i.e.* 8.30 A.M. Because of this, the initial batch of patients had to wait for a long time for registration. Similarly, the registration in all departments closed sharply at 11.00 A.M. Because of this restriction, all the patients, who required medical care, had to register within this short span of time, otherwise, even if they were in the queue, they were not registered after 11.00 A.M. This leads to overcrowding in the departments. Since in Medical and Paediatrics Departments, the patients were permitted to enter the OPD just before 8.30 A.M., the waiting time for registration had been counted from 8.30 A.M. onwards only. Because of varying nature of data from department to department, the detailed findings are discussed separately for each department and details of the findings are given in Tables 1 to 6.

Medical Department

In this department, two units functioned simultaneously daily, each having a separate registration. The registered patients were seen in the front two rooms of Registrars alongwith the Junior Residents and Interns. In the rear two rooms of consultants (*i.e.* lecturer and above), only referred cases were seen. One Junior Resident also sat with each of the Consultants. The average patient load on each day of the month (per unit) in the OPD during the last three years is given in Table 1 (Medical). The total number of patients show a decreasing trend indicative of the fact that excessive rush during some months of 1978-79 and 1979-80 was not normal for that season but due to natural calamities. The increase in patient load in the month of March and August was seasonal. The maximum average number registered during 1980-81 was varying between 350-380. Only once in 1979-80 it touched more than 400. In November 1981, the average number was 272 with maximum reaching on Monday to 319 as shown in Table 2. During previous years, in November, this average number had been varying between 310-330. This establishes that (i) the average patient load during the last three years *i.e.* 78-79, 79-80, 80-81 had not been increasing. In fact, it varied

TABLE 1
THE AVERAGE PATIENT LOAD PER DAY, MONTH-WISE AND
CLASSIFIED INTO NEW, OLD AND TOTAL (PER UNIT)

Month	1978-79			1979-80			1980-81		
	New	Old	Total	New	Old	Total	New	Old	Total
October	147.96	164.88	312.84	172.35	140.42	312.77	163.50	154.75	318.25
November	159.37	165.46	324.77	158.27	148.88	307.15	174.81	155.81	330.62
December	154.19	135.38	289.57	138.27	152.50	290.77	131.27	142.92	274.19
January	146.92	166.88	313.80	161.27	139.23	300.50	145.40	148.40	293.80
February	140.92	144.23	285.15	187.77	179.58	367.35	173.43	175.17	348.60
March	181.73	256.03	437.76	215.04	206.61	421.65	172.92	189.68	362.60
April	208.50	230.58	439.08	200.27	166.35	366.62	153.35	154.00	307.35
May	212.69	181.35	394.04	182.04	152.31	334.35	167.35	147.85	315.20
June	174.38	175.08	349.46	202.88	159.08	361.96	195.42	157.00	352.42
July	211.96	178.73	390.69				178.74	147.74	326.48
August	233.19	187.00	420.19	STRIKE PERIOD			214.40	162.68	377.08
September	135.49	164.81	300.27				188.80	170.96	359.76
Average	175	179.20	359.81	179.79	160.55	340.34	171.62	158.91	330.53

TABLE 2
ARRIVAL PATTERN OF PATIENT DURING OBSERVATIONAL STUDY (PER UNIT)

Date	8.30-9.00			9.00-10.00			10.00-11.00			Total		
	New	Old	Total	New	Old	Total	New	Old	Total	New	Old	Total
9.11.81	36	24	60	42	31	73	102	84	186	180	139	319
10.11.81	30	20	50	58	44	102	96	30	126	184	94	278
12.11.81	21	27	48	53	68	121	70	38	108	144	133	277
13.11.81	12	16	28	45	57	102	43	39	82	100	112	212
14.11.81	11	33	44	67	50	117	52	50	102	130	133	263
18.11.81	7	17	24	72	44	116	107	34	141	186	95	281
Total	117	137	254	337	294	631	470	275	745	924	706	1630
Average	19.5	22.8	42.3	56.2	49	105.2	78.3	45.8	124.1	154	117.7	271.7

around 300 during normal season and exceeded beyond 360 during change of season i.e. in the months of March and August, (ii) the average number of old and new patients was not much different. Generally new patients registered are slightly more than old patients but during the months of heavy rush, this number had been either almost the same or more new patients coming. The data regarding average waiting time for registration and consultation, average service time, average number of patients attended in consultants as well as in Registrar's rooms as given in Table 3. From Tables 1,2 and 3 the following observations are drawn:

- i. On Mondays, the rush was more;
- ii. average waiting time for registration was 20 minutes. It was more on those days when registration, in the unit observed, did not start in time i.e. 8.30 A.M. (official registration time);
- iii. arrival rate of patients was high during 10.00 to 11.00 A.M. because registration closed at 11.00A.M. but average arrival rate was not much different;
- iv. average waiting time for consultation was about 50 minutes. It was more also because of the fact that consultation did not start in time and large number of cases of staff were seen in the initial hours without any queue;

TABLE 3

AVERAGE WAITING TIME OF PATIENTS, AVERAGE NUMBER OF
DOCTORS AVAILABLE IN OPD ETC., DURING OBSERVATIONAL PERIOD

Date	No. of	Average	waiting	time	No. of	No. Of	Average	No. of doctors	No. of doctors	Average
	patients	Regis-	Consul-	Total	patients	patients	service	in consultant's	in Registrar's	No.
	regis-	tration	tation		attended in	attended in	time	rooms	rooms	of
	tered				consultant's	Registrar's		(inc1uding Jr.	(including	patients
					rooms	rooms		doctors)	interns)	attended
										in
										consultant
										' rooms
9.11.81	319	34.30	57.38	91.68	39	280	4.61	3	11	13.00
10.11.81	278	16.51	65.30	81.81	59	219	6.08	4	9	14.75
12.11.81	277	17.28	29.56	46.84	35	242	6.04	2	13	17.50
13.11.81	212	3.96	58.07	62.03	27	185	5.54	3	12	9.00
14.11.81	263	4.45	57.51	61.96	12	251	6.74	2	10	6.00
18.11.81	281	45.04	26.26	71.30	35	246	5.43	4	11	8.75
Average	271.67	20.26	49.01	69.27	32.80	237.2	5.74	3	11	10.93

Average service time (New =5.57 5. 5 minutes
(Old = 5.91 6. 0 minutes

- v. very few patients were seen in Consultant's rooms;
- vi. average total number of doctors available in Registrar's and Consultant's rooms per unit, were 11 and 3 respectively.
- vii. average service time for new patients was about 5.5 minutes whereas for old patients, it was about 6 minutes; and
- viii. average total waiting time of patients was 70 minutes and sometimes it increased to even 92 minutes.

Assuming that consultation hours of OPD were from 9.00 A.M. to 1.00 P.M. and doctors were available for 80 per cent of the time in OPD, 368 patients could be seen in Registrar's rooms with an average number of 11 doctors; and at least 40 patients in Consultant's rooms amounting to more than 400 patients. This shows that even with increased patients load during some months of the year, the number of doctors were sufficient. The next problem was how to reduce the waiting time of the patients and overcrowding in the OPDs? The probable solutions could be (i) staggering of the hours of registration and consequently consultation; (ii) issuing of numbers to patients so that they don't have to stand in the queue all the time; (iii) making the number of doctors in two Registrar's rooms same; and (iv) more consultation rooms for junior doctors.

Paediatrics Department

In this department one of the units functions daily. Patient load of the department during the last three years, the arrival rate and load of patients during the observational period are given in Tables 4 and 5 respectively. It had been observed that in this department, there was not much variation in the average patient load during the last three years. The Table 4 also reflects that there had been around 300 patients per day attending OPD during 1978-79, 1979-80, but the average number increased to 325 during 1980-81. During August and September, 1981, it has crossed the 400 mark. The same trend was reflected during the observational period with large numbers turning up on Mondays. Arrival rate during 9.00 - 10.00 A.M. and 10.00 - 11.00 A.M. was almost same but higher than that in the first hour. The following observations were drawn from Tables 4,5 and 6:

TABLE 4
THE AVERAGE PATIENT LOAD PER DAY, MONTH-WISE AND
CLASSIFIED INTO NEW, OLD AND TOTAL (PER UNIT)

Month	1978-79			1979-80			1980-81		
	New	Old	Total	New	Old	Total	New	Old	Total
October	146.15	173.42	319.58	125.92	149.77	275.69			
November	92.15	106.62	198.77	127.04	164.62	291.65		Record not available	
December	87.77	111.31	199.08	134.19	127.88	262.08			
January	88.23	110.96	199.19	109.27	148.27	257.54	108.84	124.56	233.40
February	98.62	135.73	234.35	133.65	173.50	307.15	136.83	148.09	284.92
March	150.12	198.00	348.12	148.04	175.96	324.00	155.71	180.96	336.67
April	152.62	174.85	327.46	134.88	152.65	287.54	153.54	166.54	320.08
May	157.00	171.88	328.88	150.77	181.04	331.81	158.80	162.88	321.68
June	154.15	186.85	341.00	157.35	173.92	331.27	151.61	165.69	317.30
July	157.50	189.04	346.54				144.52	156.41	300.93
August	163.92	165.85	329.77		STRIKE PERIOD		213.40	197.60	411.00
September	161.96	200.35	362.31				176.00	223.83	399.83
Average	134.2	160.4	294.6	135.7	160.80	296.5	155.5	169.6	325.1

TABLE 5

Date	8.30-9.00			9.00-10.00			10.00-11.00			Total		
	New	Old	Total	New	Old	Total	New	Old	Total	New	Old	Total
23.11.81	12	26	38	63	100	163	114	74	188	189	200	389
24.11.81	13	16	29	60	81	141	64	71	135	137	168	305
25.11.81	8	13	21	60	69	129	79	80	159	143	156	309
26.11.81	4	5	9	64	86	130	69	77	146	137	168	305
27.11.81	10	17	27	58	92	150	55	76	131	123	185	308
28.11.81	5	18	23	40	52	92	56	61	117	101	131	232
Total	52	95	137	345	480	825	437	439	876	830	1008	1848
Average	8.5	16	24.5	57.5	80	137.5	72.8	73.2	146	138.3	168	308.0

ARRIVAL PATTERN OF PATIENTS DURING OBSERVATIONAL
PERIOD (PER UNIT)

Table 6

AVERAGE WAITING TIME OF PATIENTS, AVERAGE NUMBER OF
DOCTORS AVAILABLE ETC., IN OPD DURING OBSERVATIONAL PERIOD

Date	No. of patients registered	Average waiting time			No. of Patients attended in consultant's rooms	No. of patients attended in Registrar's rooms	Average service time	No. of doctors in consultant's rooms (including Jr. doctors)	No. of doctors in Registrar's rooms (including interns)	Average No. of patients attended in consultant's rooms
		Regis- tration	Consul- tation	Total						
23.11.81	389	3.67	66.51	70.18	41	348	6.93	1	7	41
24.11.81	305	2.25	19.78	22.03	17	288	7.23	1	8	17
25.11.81	309	9.03	38.78	47.81	25	284	7.25	2	7	12.5
26.11.81	365	6.77	26.91	33.68	15	290	8.20	1	9	15.0
27.11.81	308	5.91	47.49	53.40	30	278	7.00	2	7	15.0
28.11.81	232	7.93	29.32	37.25	28	204	7.59	2	8	14.0
Average	308	5.93	38.13	41.06	26	282	7.37	1.5	7.6	17.33

(New = 7.9 minutes = 8 minutes

Average service time (Old = 6.84 minutes = 7 minutes

- i. on Mondays, the rush was more touching almost the same number which was observed during August -September, 1981 {i.e. around 400};
- ii. arrival rate of old patients during 9.00 A.M. - 10.00 A.M. and 10.00 A.M. - 11.00 A.M. was almost same but number of new patients turning up, increased during 10.00 A.M. - 11.00 A.M. This may be because of winter season and children are brought to OPD when the day warms up slightly;
- iii. number of old patients was more than number of new patients;
- iv. the average service time for the new patients was approximately eight minutes whereas for old patients it was approximately 7 minutes. The overall average service time was 7.37 minutes;
- v. average number of patients attended in Registrar's rooms was about 40 per doctor;
- vi. average number of patients seen in Consultant's room was about 20 per doctors which is much higher than those seen in Medical OPD;
- vii. average total number of doctors available in the OPD in Registrar's rooms varied between 7 and 8; and
- viii. since registration started in time, the waiting time for registration was not much.

Assuming that consultation hours of OPD were from 8.30 A.M. to 1.00 P.M. and doctors were available for 80 per cent of the time in OPD, about 40 patients could normally be attended in Consultant's rooms (because in this case average service time is more as compared to Medical OPD) and about 230 patients in Registrar's rooms when all the vacant posts are filled. Thus, in all, the present strength of the department can cater to about 270 patients. Therefore, with average service time of 7.37 minutes, to attend the normal load of 325 patients within OPD hours, the department needs two more doctors. Since, the number of patients during the last three years show an increasing trend with approximately 10 per cent increase during 1980-81, it is necessary that in order to

cater to large number of patients during the months of August-September and also to the normal increase in the patient load, the department needs three additional doctors.

Discussion

The normal working hours of OPD are from 9.00 A.M. to 1.00 P.M. and registration timings from 8.30 to 11.00 A.M. Because of restricted registration timings, the arrival of patients during the last one hour is very high. Moreover, the OPD start functioning effectively by 9.15 A.M. only and by that time a long queue awaits for consultation. This results in quite high waiting time specially for initial batch of patients and those arriving during 9.00 A.M. and 10.00 A.M. It has been observed that if the registration and consultation timings are slightly staggered, the average queue length of patients waiting for consultation at different instants of time will be considerably reduced resulting in low waiting time and less crowding.

The queue lengths have been shown only for patients attended in Registrar's and junior doctor's rooms because more than 80 per cent of the patients are attended there. Consultants examine mainly referred cases for which service time is very high resulting in very low number of patients attended in their rooms. Further, it has been assumed that:

- i. OPD starts functioning effectively after 15 minutes of the scheduled time- i.e. if timings are from 8.30 A.M. the effective time will be 8.45 A.M.;
- ii. by staggering the hours of registration upto 11.30 A.M., there will be only marginal increase in the number of new patients and will not affect the conclusions significantly; and
- iii. the arrival rate of patients who were attended in Registrar's rooms during successive hours, has been estimated from the average total in proportion to the average number of patients attended in Consultant's and Registrar's rooms, respectively.

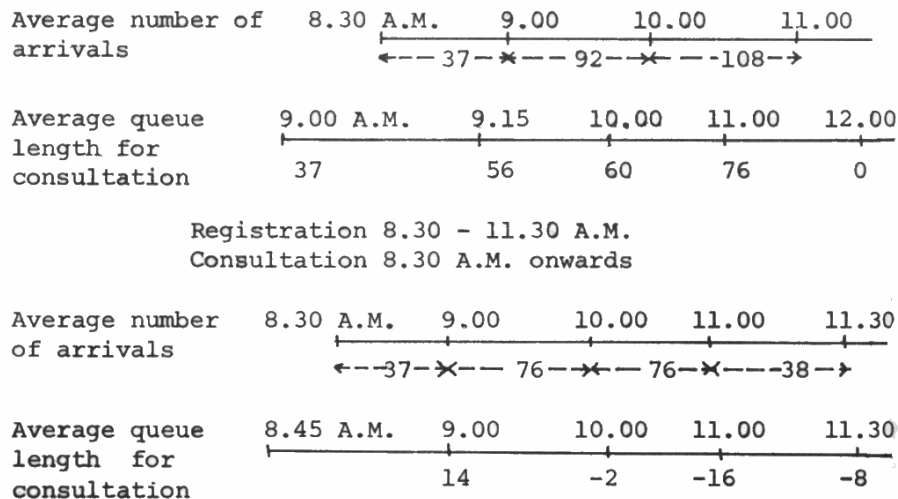
The queue lengths for various departments at different instants of time are given here under:

Medical

Average OPD attendance during observational period	= 271
Average number of patients seen by Registrars and junior doctors	= 237
Average number of doctors available in OPD	= 11
Average service time (in minutes)	= 5.74
Average OPD attendance during last three years	= 350
Average number of patients likely to be attended by Registrars and junior doctors	= 300 (approx.)

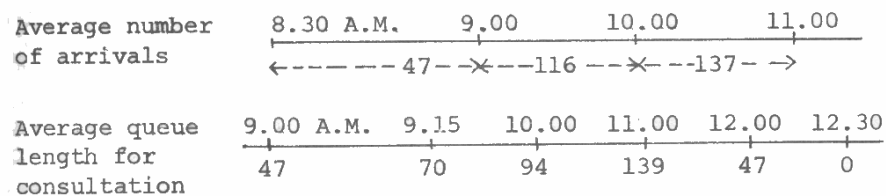
Assuming that the doctors are available in the OPD for 80 per cent of the time, the queue lengths for consultation are shown below:

- i. Total number of arrivals = 237
 Registration 8.30 - 11.00 A.M.
 Consultation 9.00 A.M. onwards

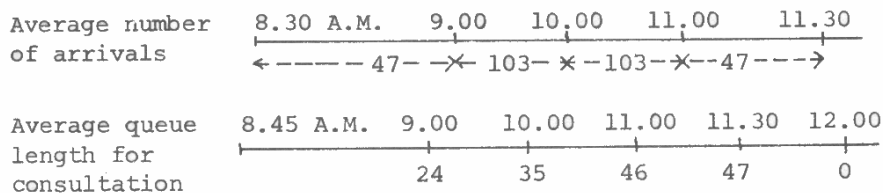


In this case, doctors will have idle time in between

- ii. Total number of arrivals = 300
 Registration 8.30 - 11.00 A.M.
 Consultation 9.00 A.M. onwards



Registration 8.30 - 11.30 A.M.
 Consultation 8.30 A.M. onwards



This shows that when number of patients examined by Registrars and junior doctors is around 300, slight staggering of registration and consultation times reduces the queue length by about 50 per cent whereas total duration of OPD remains almost the same. During observational period, the OPD attendance was less because of winter season otherwise it is normally more than 300. It is also concluded from the above discussion that number of doctors are sufficient and can even attend increased workload upto nearly 25 per cent.

Paediatrics

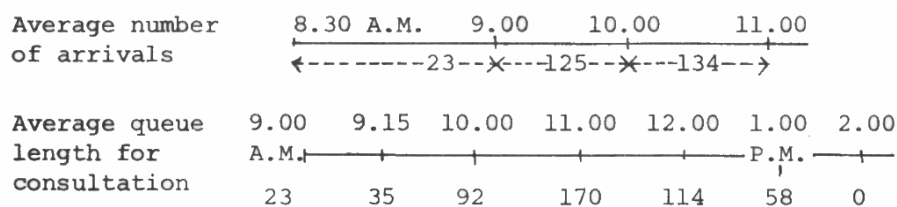
Average OPD attendance during
 observational period = 306

Average number of patients
 attended in Registrar's and other
 junior doctor's rooms = 282

Average number of doctors available in OPD	= 7.6
Average service time (in minutes)	= 7.37
Average OPD attendance during last three years	= 305

Because in this department, only one unit functions daily and the workload is heavy, it is assumed that doctors are available for 90 per cent of the time while determining average queue length for consultation.

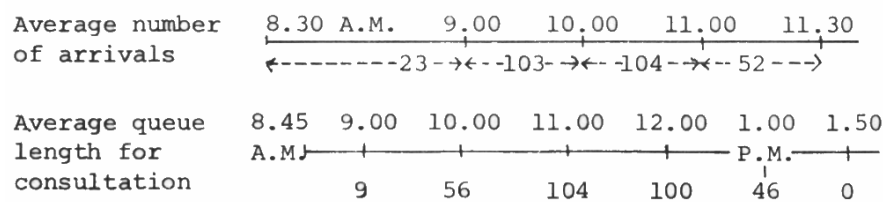
- i. Total number of arrivals = 282
 Registration: 8.30 - 11.00 A.M.
 Consultation: 9.00 A.M. onwards



(i.e. the OPD lasts upto 2.00 P.M. The arrivals in the first hour were less probably because of winter season and children are brought to OPD slightly later.)

- ii. Registration : 8.30 - 11.30 A.M.

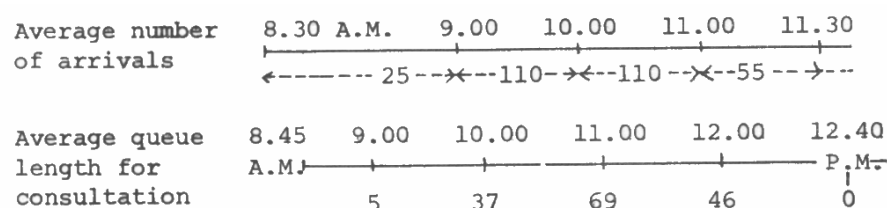
Consultation : 8.30 A.M. onwards



In this case, although the OPD lasts nearly the same time, the queue lengths at various time instants are reduced to some extent but are still of considerable size. In order

to reduce the waiting time of patients specially those arriving after 10.00 A.M., the number of doctors have to be increased. The increase in number of doctors is necessary because there is increasing trend of workload in OPD by about 10 per cent. Thus to cater about 300 patients with a reasonable waiting time, we examine queue lengths with average availability of three more doctors *i.e.* $7.6+3 = 10.6$.

Total number of arrivals	= 300
Average availability of doctors	= $7.6+3 = 10.6$
Service time per patients	= 7.37 minutes
Registration timing	= 8.30 - 11.00 A.M.
Consultation timing	= 8.30 onwards



In order to finish OPD in a reasonable time and also to account for emergencies, three more doctors are required in Paediatrics Department.

Acknowledgement

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Lkkjk'k

दिल्ली के एक अस्पताल के दो प्रमुख बहिरंग रोगी विभागों—अर्थात् चिकित्सा विभाग तथा बाल चिकित्सा विभाग की कार्यप्रणाली से संबंधित इस लेख में, रोगियों के समय प्रतीक्षा समय में कमी लाने, डाक्टरों को पर्याप्त

संख्या में उपलब्ध कराने और बहिरंग रोगी विभागों में उनकी नियुक्ति संबंधी ढांचे के बारे में, तथा इन विभागों में रोगियों की भीड़ को कम करने के बारे में तरीके सुझाये गये हैं।

यह देखा गया है कि यदि पंजीकरण के समय तथा परामर्श के समय में थोड़ा सा अन्तर कर दिया जाये तो विभिन्न समय बिन्दुओं पर परामर्श के लिए प्रतीक्षा कर रहे रोगियों की औसतन लम्बी लाइनों में काफी कमी की जा सकती है जिसके फलस्वरूप प्रतीक्षा समय को कम किया जा सकता है तथा भीड़ में कमी लाई जा सकती है।

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A MODIFICATION OF PROBABILITY DISTRIBUTION FOR FIRST BIRTH INTERVAL

**R N. Mishra, K. N. S. Yadava, K. K. Singh
and S.R.J. Singh**

ABSTRACT

In this paper, a probability distribution for the first birth interval has been derived taking into account (i) two groups of females with different levels of fecundability, and (ii) some of the females may not be exposed to the risk of conception just after marriage due to temporary separation for a specific period. The application of the model has been illustrated using a survey data.

The duration of time from marriage to first birth, defined as first birth interval, indicates the characteristics of a couple in the beginning of married life. Obviously, the analysis of data on this interval provides information on fertility performance of the married life in early years. First concep-tive delay has been studied by Singh, Potter and Parker Sheps, Pathak, Chakraborty and others. Later, Das Gupta and Hickman, Singh and Chakraborty Mishra and Singh have propounded the truncated probability distribution to overcome this limitation. In their truncated models they have taken fecund-ability to be same among the females. However, because of poor health conditions and other social factors prevalent in the community the level of fecundability may not be same to all the females.

The objective of this paper is to dervie a probability distribution for the first birth interval, taking into account (i) two groups of females with different level of fecundability, and (ii) some of females may not be exposed to the risk of conception just after marriage due to temporary separation for a specific period. The findings are based on data, collected in a survey entitled, "Rural Development and Population Growth. A Sample Survey 1978", under the auspices of Centre of Population Studies (formerly known as Demographic Research Centre), Banaras Hindu University.

Model

Let X be a random variable which denotes the length of first birth interval to females of marital duration T . The probability density function (p.d.f.) has been derived under the following assumptions:

- i. The waiting time of first conception after marriage follows a displaced exponential distribution with p.d.f.

$$f(t) = m e^{-m(t-k-g)}$$

where, k is the duration since marriage after which the female is exposed to the risk of conception and g is the gestation period.

- ii. Let a and $(1-a)$ be the proportion of two types of females with the fecundability of m_1 and m_2 respectively. Thus, p.d.f. of the waiting time from marriage to first conception extends to

$$f^*(t) = a m_1 e^{-m_1(t-k-g)} + (1-a) m_2 e^{-m_2(t-k-g)}$$

Under the above assumptions, the p.d.f. of the random variable X , say $h(x)$, is given by

$$f^*(t) = a m_1 e^{-m_1(t-k-g)} + (1-a) m_2 e^{-m_2(t-k-g)}$$

Under the above assumptions, the p.d.f. of the random variable X , say $h(x)$, is given by

$$h(x) = \frac{a m_1 e^{-m_1(t-k-g)} + (1-a) m_2 e^{-m_2(t-k-g)}}{G(T)} \quad g < x < T$$

$$\begin{aligned} \text{where } G(T) &= \int h(x) dx \\ &= (1-a) e^{-m_1(T-k-g)} - (1-a) e^{-m_2(T-k-g)} \end{aligned}$$

The expressions for $E(X)$ and $E(X^2)$ are obtained as

$$E(X) = \frac{a \left[\frac{k+g+1}{m_1} - \frac{e^{-m_1(T-k-g)}}{m_1} \right] + (1-a) \left[\frac{k+g+1}{m_2} - \frac{e^{-m_2(T-k-g)}}{m_2} \right]}{G(T)}$$

and

$$E(X^2) = \frac{a \left[\left\{ \frac{(k+g)^2 + \frac{2(k+g)}{m_1} + \frac{2}{m_1} - e^{-m_1(T-k-g)} \left(T^2 + \frac{2T}{m_1} + \frac{2}{m_1} \right) \right\} \right.}{G(T)} \\ \left. + (1-a) \left\{ \frac{(k+g)^2 + \frac{2(k+g)}{m_2} + \frac{2}{m_2} - e^{-m_2(T-k-g)} \left(T^2 + \frac{2T}{m_2} + \frac{2}{m_2} \right) \right\} \right]$$

Application

For illustration, we have applied the model to observe data on the first birth interval taken from, "Rural Development and Population Growth - A Sample Survey 1978" collected by Centre of Population Studies, Banaras Hindu University. In the study we have included only those females whose marital duration are (7-20) years as well as age at marriage. (16, 17, 18) years have given atleast one birth within first seven years of their married life. The grouping of females according to their age at R.M. and marital duration has been done with a view to get significant number of observations. The observed and expected frequency distribution of first birth interval of 528 females is shown in Table 1. In the model derived we have taken k as a constant, but it is observed (Survey 1978) that k is a variable. Empirically it is observed that k takes three values $k_1 = 0.25$, $k_2 = 1.00$ and $k_3 = 2.00$ with respective proportions of females β_1, β_2 and β_3 ($\beta_1 + \beta_2 + \beta_3 = 1$) Then the model has presumably an extension. The extended model and the expression of $h^*(x)$, $E^*(x)$ and $E^*(x^2)$ are given by

$$h^*(x) = \frac{\sum_{j=1}^3 \beta_j h(x/k = k_j)}{\sum_{j=1}^3 \beta_j G(T/k = k_j)},$$

$$E^*(X) = \frac{\sum_{j=1}^3 \beta_j E(X/k = k_j) G(T/k = k_j)}{\sum_{j=1}^3 \beta_j G(T/k = k_j)}$$

and

$$E^*(X^2) = \frac{\sum_{j=1}^3 \beta_j E(X^2/k = k_j) G(T/k = k_j)}{\sum_{j=1}^3 \beta_j G(T/k = k_j)}$$

In the present case $k_1 = 0.25$, $k_2 = 1.00$, $k_3 = 2.00$, (observed from survey), $T = 7.00$ years and $g = 0.75$ years. The first and second moment of the observed distribution (calculated from ungrouped data) is 3.31 and 12.83 respectively. Here we have three parameter a , m_1 and m_2 in the distribution which are estimated by comparing proportion of first cell frequency, first moment and second moment with the theoretical expressions. The estimates obtained are; $a = 0.142$, $m_1 = 0.360$ and $m_2 = 0.602$. The expected frequencies given in column 3 of Table 1 are computed by using extended expression of p.d.f. for first birth interval. The calculated values of X^2 is 2.2166 at 3 degree of freedom which is insignificant. If the agreement between observed and expected frequencies is a criterion for the suitability of model, the proposed one is a reasonable approximation.

Acknowledgement

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TABLE 1
OBSERVED AND EXPECTED DISTRIBUTION OF FEMALES
ACCORDING TO TIME FROM MARRIAGE TO FIRST BIRTH

Birth Interval	Observed frequency	Expected frequency
0.75 - 1.75	65	65.00
1.75 - 2.75	131	133.79
2.75 - 3.75	157	156.53
3.75 - 4.75	90	88.43
4.75 - 5.75	56	50.32
5.75 - 6.75	23	28.86
6.75 - 7.00	6	5.07
Total	528	528.00

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इस लेख में पहले बच्चे के जन्म अन्तराल के संबंध में प्रायिकता बंटन निकाला गया है, जिसमें दो पहलुओं को रखा गया है: 1— अलग-अलग गर्भाधारण-स्तर की दो महिला समूहों को लिया गया है तांम 2— कुछ ऐसी महिलाओं को लिया गया है, जिनकी विवाह होने के पश्चात किसी निश्चित अवधि में अस्थायी तौर से पृथक रहने के कारण तत्काल गर्भाधारण करने की संभावना नहीं की जा सकती। इस मॉडल का प्रयोग, सर्वेक्षण आंकड़ों के माध्यम से समझाया गया है।

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DISCONTINUATION OF CONTRACEPTIVES

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ABSTRACT

This paper presents the continuation and discontinuation rate of spacing methods such as oral pills, implants, Net/Oen injections, vaginal rings and various types of intrauterine devices.

The findings revealed that the discontinuation rate of orals as well as injectables was about 70 per cent as compared to IUD discontinuation of 30 per cent. The reasons for discontinuation, medical and non-medical are also discussed.

Today, about 26 per cent of eligible couples are being protected by contraception in our country. Of these, 23 per cent have accepted sterilization and the rest use other methods such as IUDs, conventional contraceptive and oral pills. It is necessary that atleast 60 per cent of eligible couples are effectively covered to achieve our target of a net reproduction rate of 1 by the year 2000 AD. To achieve this, it is very necessary to have effective spacing methods in our country which the patients do not discontinue. Most women marry young and have their children soon after marriage. Moreover, infant mortality rate is high. A permanent method such as sterilization is, therefore, not suitable for many women with very young children. As most contraceptives need continuous motivation and persuasion, methods such as depot injectables, IUDs, are likely to have a better continuation rate.

Materials and Methods

The study was carried out on women attending the family planning centre of the KEM Hospital. Only those women who had discontinued the contraceptive after a period of use were included. They were interviewed and the reasons for discontinuation

of contraceptives were recorded. The data available from the record cards preserved at the centre were used for analysis. The medical and non-medical reasons for discontinuation were identified and tabulated.

Information obtained from the following categories of contraceptive acceptors was included in this study: 1250 acceptors of an oral contraceptive containing norethisterone acetate (100 meg.) and ethinylestradiol (30 meg.); 225 users of silastic implants (length - 22 mm and thickness - 0.59) containing 40 mg. norethisterone acetate and the action lasting for 6-8 months; 172 acceptors receiving injections of 200 meg. of norethisterone enanthate once in two or three months depending on random allocation; 33 users of silastic vaginal rings containing 4.66 gms. of levonorgestrel with average release rate of 20 meg/day; and 4425 women using different types of intrauterine devices including Cut, CuY, ML, CuT 250 and progesterone T.

Results

Oral Pills - A majority of these women were between 20-30 years, their mean age being 29.43. Although most of our patients come from the lower socio-economic group, the acceptors of oral pills were relatively better educated. The mean parity was 1.68.

Table 1 shows that a very significant number (40.96%) accepted pills after MTPs. This is probably under some

TABLE 1

TIME OF ACCEPTANCE OF ORAL CONTRACEPTIVE ACCEPTORS AND DISCONTINUATION

Time of Acceptance	No & percentage	Discontinued
After MTP	512 (40.96%)	370 (72.27%)
Interval	671 (53.68%)	441 (72.28%)
Lactating Amenorrhoea	67 (5.36%)	38 (56.72%)
Total	1250	849 (67.92%)

pressure from the medical staff and social workers, as a great effort is made to motivate patients for accepting contraception, especially when they come for abortions. By accepting the pills they could get the service of abortion and could later discontinue them easily. Oral contraceptive acceptors were 53.68 per cent but these were interval cases. However, the discontinuation rate was the same in MTP and interval acceptors.

Almost the same percentages of post MTP (72.27%) and interval acceptors (72.28%) discontinued the pill. In post-partum period, oral contraceptives are rarely given because the combined oral contraceptives are known to reduce the breast milk volume and shorten the duration of lactation.

Cases of discontinuation of the oral contraceptives for medical reasons were 70. Of these 44 gave only vague reasons, four had amenorrhoea, three had breakthrough bleeding, ten had abdominal pain and seven had nausea and vomiting. Most of these complaints were within the first seven months. The reasons for discontinuation of oral pills according to the months of use are given in Table 2 and 3.

TABLE 2
MEDICAL REASONS FOR DISCONTINUATION OF ORAL
CONTRACEPTIVE USERS ACCORDING TO MONTHS OF USE

Medical Reasons	Upto 7	8-23	24-35	Total
Amenorrhoea	3	1	-	4
B.T. Bleeding	2	1	-	3
Abdominal Pain	7	2	1	10
Nausea/Vomiting	5	2	-	7
Jaundice	1	1	-	2
Other Medical	34	9	1	44
Total	62	16	2	70

TABLE 3

NON-MEDICAL REASONS FOR DISCONTINUATION OF ORAL
CONTRACEPTIVE USERS ACCORDING TO MONTHS OF USE

Non-Medical Reasons	Upto 7 months	8-23 months	24-41 months	Total
Planned pregnancy	142	62	57	261
Change of method	34	16	14	64
Taking pills from outside	22	16	-	38
Inconvenient to visit	57	5	-	62
For social reasons (objection by family members)	25	8	-	33
Out of Bombay	120	43	15	178
Lost-to-follow-up	84	57	2	143
Total	484	207	88	779

A total of 143 cases were lost to follow-up and 261 patients planned pregnancies. Among the non-medical reasons, 178 cases discontinued because they left Bombay, 64 changed to another method and 33 discontinued because of objection from family members. Easy and free availability of oral pills is likely to keep continuation in only a few more women, as only 62 gave it up for inconvenience to visit and 38 found it convenient to buy them from outside. On the whole, oral pills are discontinued by 70 per cent of acceptors and reasons for discontinuation for medical reasons from only 10 per cent of them.

Implants

As lack of sustained motivation is the main cause of the large dropout of oral pills, it is necessary to try long

acting depot preparations. A subcutaneous implant containing norethisterone acetate effective for six months was tried in 255 cases. The mean age of acceptors was 25.09 years and the parity was 1.90. The patients were observed for a total period of 11.96 months. First insertions were done postabortal in 147 women, post-partum in 20 women and in 88 interval cases. The second insertions were done in 45 women of which 33 had 3rd insertions, 10 had 4th insertions and only 2 had 5 insertions and continuation of 2.5 years.

The cumulative rate of accidental pregnancy at 6 months was 2.2 per cent. The major reasons for discontinuation at the end of 6 months were bleeding problems (7.7%). A total of 12.9 per cent discontinued during the six months of use. However, only 45 wanted 2nd insertions and therefore discontinuation rate at the end of 6 months was 67 per cent. A lot of reassurance was needed to overcome the problem of some degree of discomfort involved during subcutaneous insertion and removal. Although 87 per cent continued for 6 months most of them were rather unhappy about the irregular menstrual pattern.

Norethisterone Oenanthate Injections

Another long-acting hormonal preparation for contraception is injectable preparation. A total of 174 patients were selected, 134 were post MTP and 40 were interval cases. Their average age was 23.75 years, average parity was 1.75 and average weight was 40.26 kg. The number of women enrolled for two monthly and three monthly schedule were approximately the same.

In the post MTP group, 31.1 per cent acceptors completed the two years trial, but with some amount of persuasion and 13 per cent were very satisfied and continued even after the period of two years. Out of 69 per cent who discontinued for various reasons during the course of treatment, about 19 per cent were for medical reasons and rest for non-medical reasons as shown in Table 4.

There was no significant difference in the discontinuation rate between two and three-monthly schedule which was 21 and 19 per cent respectively as given in Table 5. Weight gain was observed in 70 per cent of women, which is beneficial for our lower socio-economical class of underweight women. One accidental pregnancy occurred but the woman continued and delivered a normal female child.

TABLE 4

CONTINUATION OF NET-OEN INJECTION IN POST-MTP CASES

Period	No. of Cases	Completed 2 yr. trial	Closed	Continuing after 2 yrs.
Two monthly	68	20 (30.4%)	48 (70%)	8 (12%)
Three monthly	66	22	44	9
Total	134	42 (31%)	92 (69%)	17 (13%)

TABLE 5

MEDICAL REASONS FOR DISCONTINUATION AND RATE PER 100 WOMEN YEARS IN POST MTP PATIENTS

Medical Reasons	Two Monthly		Three Monthly	
	No. of Cases	Rate/ 100 W.Y.	No. of Cases	Rate/ 100 W.Y.
Involuntary pregnancy	-	-	1	1.17
Irregular/continuous bleeding	6	8.63	6	7.07
Amenorrhoea	5	7.19	7	8.25
Jaundice	1	1.43	-	-
Oedema/joint pains	1	1.43	-	-
Incomplete abortion	1	1.43	-	-
Desired pregnancy	-	-	2	2.35
Chest pain	1	1.43	-	-
Total	15	21.58	16	18.87

Eleven cases were lost to follow-up and 33 went out of Bombay. Non-medical reasons seem to be the common cause of dropouts forming about 40 per cent of total discontinuation, as given in Table 6. It is possible that some women deliberately refused their identity when field workers visited their homes. Although depot injectable preparations were expected to have a better continuation rate, since it does not need day-to-day motivation as for oral pills, the continuation rate is not so impressive. Medical reasons such as irregular bleeding and amenorrhea are more in this group (7-8%) as compared to the oral pills and the discontinuation rate for non-medical reasons is also high.

Vaginal Rings

A trial of torus-shaped vaginal silastic ring containing levonorgestral was undertaken by our centre recently and following were the preliminary observations.

TABLE 6
NON-MEDICAL REASONS FOR DISCONTINUATION

Non-medical Reasons	Two No. of Cases	Monthly Rate/ 100 W.Y.	Three Monthly No. of Cases	Rate/ 100 W.Y.
Out of Bombay	19	27.33	14	16.50
Loss-to-follow-up	6	8.63	6	7.07
Inconvenient to visit	3	4.31	4	3.71
Came late for injection	3	4.31	1	1.71
Husband died/objected	2	2.81	2	2.35
Changed - Indifferent	-	-	1	1.17
Total	33	48.92	28	34.68

Already 33 cases have been enrolled. Of these, five cases have dropped out because of expulsions, three on account of irregular and continuous bleeding, one had vaginal infection and one dropped out because of urinary problems.

Although it was assumed that the high dropout rate in oral contraceptives is because of lack of day-to-day motivation and steroid depot preparation would overcome the problems, but no substantial improvement either with implants, injectables or vaginal rings was found.

Intra-uterine Device

Four thousand, four hundred twenty-five cases of IUD insertions were studied for their discontinuation rate. Five types of IUD - CuT, CuY, ML Cu 250, Lippe's loop and progesterone T were used and analysed. The mean age of IUD acceptors was 24.35 years and mean parity was 1.56.

The continuation rate with Lippe's loop was as high as 91.79 per cent as most of them were inserted recently when CuT was not available freely in the centre (Table 7). Duration of use for Lippe's loop was proportionately small as shown in Table 8.

TABLE 7
CONTINUATION OF VARIOUS TYPES OF IUD

	Cu T	Cu Y	Multiload	L P	Prt	Total
Total Cases	2547	300	968	585	25	4425
Cases Closed	740	31	270	48	10	1189
Percentages	29.05	43.67	27.89	8.21	40.00	26.87
Cases continuing	1807	169	698	537	15	3236
Percentages	70.95	56.33	72.10	91.79	60.00	73.13

TABLE 8

DISCONTINUATION AND MONTHS OF USE OF PATIENTS USING
DIFFERENT TYPES OF IUD

	Cu T	Cu Y	Multiload	L P
Number of patients	2547	300	960	585
Months of use	44470	10561	27554	3164
Discontinued	740	131	270	48
Percentages	(29.05)	(43.67)	(27.89)	(8.21)

Time of insertion of IUD is given in Table 9 and 73.02 per cent accepted it after MTPs, when they were very receptive to the counselling for contraception. Because of the probability of expulsion being high in early post-partum period, only 3.16 per cent of IUDs were inserted in this group.

The discontinuation rate and reasons per 100 women years is shown in Table 10. Closures for medical reasons such as bleeding and expulsion among Lippe¹'s loop acceptors is higher as compared to other IUDs. Other medicated and copper IUDs, have more or less similar discontinuation rate for medical reasons, 1, 0.8 and 9.65 for bleeding in CuT, CuY and ML Cu 250 respectively. There was a small series of progesterone IUD studied. It contains progesterone 38 mg. releasing 65 ug/per day and is effective only for 12 months. As the locally acting hormone is supposed to decrease the menstrual bleeding, this was used in selected cases where there was excessive menstrual bleeding with other IUDs. In this group only two cases discontinued for bleeding but at the end of 12 months all progestaserts had to be removed, as the life is only 12 months.

Bleeding and expulsion are the main reasons for discontinuation within the first 6-7 months. After that, most of the women settle down and continue with the IUDs. Therefore, some reassurance and medical treatment of side-effects in the first six months could help to achieve a better continuation rate. Reasons for discontinuation with months of use are shown in Table 11.

Non-medical reasons of discontinuation and months of use of IUD are given in Table 12. Planning pregnancy is the most

TABLE 9
TIME OF ACCEPTANCE OF IUD

Case Selection	Number of Acceptors	Discontinued
Medical Termination of Pregnancy	3231 (13.02%)	859 (25.85%)
Interval	1034 (23.77%)	288 (27.85%)
Post-partum	160 (13.16%)	42 (26.25%)
Total	4425	1189 (26.87%)

TABLE 10

MEDICAL REASONS FOR DISCONTINUATION OF IUD RATE PER 100
WOMEN YEARS

Reasons	Cu T	Cu Y	Multiload	Lippe's Loop
Bleeding	1.00	0.80	9.65	3.41
Expulsion	1.21	1.82	0.52	8.34
Menorrhagia	0.57	0.11	0.13	0.38
Pain in abdomen	0.40	0.11	0.39	1.14
Method failure	0.32	-	0.39	1.14
Incomplete abortion	-	-	0.04	-
Infection	-	-	-	0.76
Other medical	-	-	-	0.76

TABLE 11
MEDICAL REASONS FOR DISCONTINUATION AND MONTHS OF USE OF
IUD ACCEPTORS

<u>Total acceptors - 4425</u>		<u>Discontinued - 1189</u>			
Medical Reasons	Total	7 mths	8-23 mths	24-47 mths	48\more mths
Bleeding	70	53	13	4	-
Expulsion	95	72	19	4	-
Pain in abdomen	28	14	10	4	-
Menorrhagia	26	8	15	3	-
Accidental pregnancy	14	7	6	1	-
Other Medical	54	25	23	6	-
Total	287	179	86	22	-

TABLE 12
NON-MEDICAL REASONS FOR DISCONTINUATION AND MONTHS OF
USE OF IUD ACCEPTORS

Non-medical Reasons	Total	7 mths	8-23 mths	24-47 mths	48/more mths
Planning pregnancy	579	75	335	154	15
Change of method	69	16	34	19	-
Other non-medical reasons	133	31	25	77	-
Objection from family members	121	20	58	43	-
Total	902	142	452	293	15

important reason, the largest number being 335, discontinued between 8.23 months. Thus, at present medicated IUD - CuT, Multiload and CuY seem to be having the best continuation rates amongst the temporary methods.

Discussion

Unless a very effective family planning programme is implemented by the year 2000 AD, our population of 700 million will grow to 1200 million. The maternal mortality of 4/1000 and infant mortality of 120/1000, which at present are staggering figures, could be effectively reduced, only after a Family Welfare and Maternal Child Health programme could be implemented effectively. In the year 1982-1983, Maharashtra State had the most successful programme in Family Welfare with 6.22 lakh sterilization, 0.88 lakh IUD insertions, 0.54 lakh using oral contraceptive pills and 3.01 lakhs using conventional contraceptives.

The use and effectiveness of each sterilization operation is equal to two new acceptors of IUDs, eight new acceptors of oral pills and 15 new acceptors of condoms. The use and effectiveness of spacing method definitely needs to be improved by better motivation, effective communication, individual and social acceptability, appropriate delivery system and rapport with medical and paramedical personnel as well as good follow-up.

Better understanding, awareness and education will decrease the objections from the families especially mothers-in-law's and at times by husbands. False rumours through news media and hearsay regarding side-effects and fear of malignancy have to be curtailed effectively. The delivery system should be so effective, that lack of availability should never be an excuse. Better methods with lower medical complications would also have some impact. IUDs with lesser menstrual blood loss, and depot preparations causing no disruption of menstrual cycle. However all possible spacing methods should be available for the physician's as well as the patient's choice.

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इस लेख में बच्चों के जन्म में अन्तराल रखने संबंधी तरीकों, जैसे खाने की गर्भनिरोधक गोलियां, निरोपक, नेट/ ओएन इन्जेक्शनस, योनि में लगाये जाने वाले छल्ले, तथा विभिन्न प्रकार के अन्तर-गर्भाशयीय गर्भ-निरोधक तरीकों संबंधी असातत्य दर तथा सांतत्य दर को प्रस्तुत किया गया है।

परिणामों से ज्ञात होता है कि आईयूडी, जिसका अंसातत्य दर 30 प्रतिशत था उसकी तुलना में गर्भनिरोधक गोलियों जैसे तरीकों के साथ-साथ इस प्रकार की इन्जेक्शन-दवाईयों के बारे में अंसातत्य दर 70 प्रतिशत था इस लेख में इन तरीकों के प्रयोग को बन्द कर देने संबंधी चिकित्सकीय तथा गैर-चिकित्सकीय कणों पर भी विचार किया गया है।

**SIMPLE STOCHASTIC MODEL OF WAITING
TIME FOR FIRST CONCEPTION**

R. N. Pandey

ABSTRACT

In this paper, attempt has been made to develop mathematical models incorporating the concept of variation in fecundability over ages. Here, the attempt is limited to suggesting a function for the risk of first conception. This knowledge will be very useful to identify the age of high conception and thus getting a well defined target group.

"Delay the first, space the second and stop the third" is the official policy of government's family planning programme. It shows the emphasis on the importance of early reproductive behaviour of the couple in the total fertility. Keeping in view vast illiteracy of Indian couples an attempt should be made for giving proper advice to them regarding use of contraceptives. For this, data on conception times may be used. The distribution of time from marriage to first birth is an important segment of the reproductive life of a couple. The data on first conceptive delay provides reliable figures in the sense that the marriage month as well as month of first delivery is easily identifiable. Also it is free from post-partum amenorrhoea period.

Several probability models, viz. Singh, Potter and Parker, Sheps and Pathak have been derived on the assumption that either fecundability is fixed for all women or is variable among women. Though some simulation models of Sheps, Venkatachari? incorporated the concept of variation in fecundability over age, there seems to be very few efforts to introduce this concept in developing mathematical models which has been tried here. Here our attempt is limited to suggest a function for the risk of first conception. This knowledge will be very much useful to identify the age of high conception and thus getting a well defined target group.

It is known that in rural area age at marriage is still low. Due to this almost all the females get their first child

by the age of 25 years provided they are physically fit to do so. Accordingly a function may be defined as:

$$P_{x_0}(X) = \theta_{x_0} (X-a) (a+12-X)^2, a \leq X \leq a+12 \quad (i)$$

here $P_{x_0}(X)$ is the risk of first conception at age X provided age at marriage is X_0 .

a = age at which women becomes able to conceive

θ_{x_0} : age constant depending on X_0 .

The Model

Derivation of the model is based on following assumptions:

- i. Conception is a chance variable.
- ii. The woman begins her reproductive cycle after marriage in a fecundable non-pregnant state.

Let T , $f_{x_0}(t)$ and $F_{x_0}(t)$ denote the waiting time of first conception, conditional density function and distribution function of T given marriage age is X_0 respectively. So we have

$$f_{x_0}(t) = P(t < T < t+dt / X_0)$$

$$= P[\text{first conception does not occur in age-interval } (X_0, X_0 + t) \text{ and it occurs in the age-interval } (X_0 + t, X_0 + t + dt) / X_0]$$

$$= P[(\text{first conception does not occur in age-interval } (X_0, X_0 + dt))]$$

$$= P[\text{first conception occurs in age-interval}$$

$$(X_0 + t, X_0 + t + dt) / \text{first conception does not occur upto age } (X_0 + t) \text{ and marriage age is } X_0]$$

$$f_{x_0}(t) dt = (1 - F_{x_0}(t)) \times (P_{x_0}(X_0 + t) dt + o(dt))$$

or $\frac{f_{x_0}(t)}{1 - F_{x_0}(t)} dt = P_{x_0}(X_0 + t) dt + o(dt)$

which gives

$$F_{x_0}(t) = 1 - \exp \left\{ - \int_0^t P_{x_0}(x_0 + v) dv \right\}, 0 < t < \infty$$

$$f_{x_0}(t) = \frac{d}{dt} F_{x_0}(t) = P_{x_0}(x_0 + t) \exp \left\{ - \int_0^t P_{x_0}(x_0 + v) dv \right\}, 0 < t < \infty \text{ iii}$$

Using the function proposed here, we get

$$f(t) = 1 - \exp \left[\theta_{x_0} \left\{ (x_0 - a) (a + 12 - x_0)^2 t + \frac{3}{2} t^2 (a + 12 - x_0) + \frac{t^3}{4} (x_0 - a - 8) \right\} \right], 0 < t < \infty \text{ iii (a)}$$

$$f(t) = \theta_{x_0} (x_0 + t - a) (a + 12 - x_0 - t)^2 \exp \left[- \theta_{x_0} \left\{ (x_0 - a) (a + 12 - x_0)^2 + \frac{3}{2} t^2 (a + 12 - x_0) + \frac{t^3}{4} (x_0 - a - 8) \right\} \right], 0 < t < \infty \text{ iii (b)}$$

Estimation

The model proposed in (i) involves two parameters, namely a and θ_{x_0} . Though maximum likelihood equations may be obtained for both the parameters but they are complicated. So we have taken $a = 13$ years on the basis of empirical studies (See Backman⁸ and Tanner⁹). The resulting maximum likelihood estimator for θ_{x_0} is

$$\hat{\theta}_{x_0} = \frac{n}{\sum_{i=1}^n \left\{ (x_0 - a) (a + 12 - x_0)^2 t_i + \frac{3}{2} t_i^2 (a + 12 - x_0) + \frac{t_i^3}{4} (x_0 - a - 8) \right\}} \quad \text{(iv)}$$

where n is the total number of observations.

Application

The distribution has been applied to the data on the time of first birth, taken from Demographic Survey of Banaras Tehsil, 1956. Singh¹⁰ relating to the parous couples with age of females, 15 years at their return marriage that is the date of consummation of their marriage by assuming that a conception leads to a pregnancy ending into a live birth.

Using $x_0 = 15$ years, $a = 13$ years, maximum likelihood estimate of θ_{x_0} was found to be 0.00129. Based on these estimates expected frequencies in different cells are given in Table 1.

TABLE 1
OBSERVED AND EXPECTED DISTRIBUTIONS OF COUPLES (WITH
FEMALE'S AGE 15 YEARS AT R.M.)

Time (in years) from R.M. to		Observed	Expected
First birth	First complete conception		
0-2	0.0 - 0.6	47	44.95
2-4	0.6 - 2.6	96	107.03
4-6	2.6 - 4.6	50	47.22
6-8	4.6 - 6.6	17	17.23
8-10	6.6 - 8.6	11	11.37
10-16	8.6 - 14.6	13	6.12
18 and above	16.6 and above	5	5.08
Total		239	239
χ^2			5.16
D.F.			6

TABLE 2
RISK OF FIRST CONCEPTION OVER AGES

Age (Years)	RFC
13	0
14	0.156368
15	0.258460
16	0.314029
17	0.330828
18	0.316613
19	0.279137
20	0.226152
21	0.165414
22	0.104676
23	0.051691
24	0.014215
25	0

Conclusion

The proposed model describes the data satisfactorily. It enables us to know the rate of first conception at each age of woman's reproductive span until she gets her first child. The RFC is highest at the age of 17 years for woman married at the age of 15 years as given in Table 2. This may be due to the fact that cohort of women married at the age of 15 years may include some adolescent women. Also in the area from which data had been collected, there is a custom of frequent visits to parents in the early years of marriage which is still more frequent for those married at lower age; thus reducing the effective period of exposure in the earlier period of marital duration. Moreover, the females though living with their husbands, get lesser chances of coitions in joint family. Where these practices are not prevalent, pattern may be different. Accordingly model may be modified with the help of parameter θ_{x0} .

One of the common complaints against use of model is their complications. Here a simple model involving only one parameter has been proposed and hence increase in applicability of the model.

To delay the first child, couple should start use of some contraceptives because RFC is quite high at the initial years of marital duration. They should not be deceived by the prevalent notion that conception usually does not occur in early years of marriage if the age at marriage is low.

It is observed that the frequency for the cell (8-10) years is inflated as shown in Table 1. This may be due to the fact that the data on the timings of events suffers from digit preference. Also the fit is not so good for the first three cells. On the one hand, data is retrospective one and a significant amount of recall error might be responsible for the concentration of more women reporting their waiting times very near to the point of marriage. On the other hand, there may be an adjustment error in data while converting the time on first birth into the time of first conception.

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इस लेख में सदियों से चली आ रही गर्भाधान क्षमता विचरण की धारणा के आधार पर एक गणितीय निदर्श (मैथमैटिकल मॉडल) विकसित

करने का प्रयास किया गया है। यहां इस प्रयास को प्रथम गर्भाधान की संभावना के लिए आवश्यक क्रियाओं का सुझाव देने तक ही सीमित रखा गया है। इस प्रकार की जानकारी ऐसे आयु वर्ग की पहचान करने में लाभ प्रद होगी जिस आयु वर्ग में गर्भाधान के अवसर अधिक रहते हैं तथा इस प्रकार एक सुपरिभाषित लक्षित समूह (टारगेट ग्रुप) आसानी से मिल सकता है।

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**SOME BIO-SOCIAL CHARACTERISTICS OF
PENSIONERS OF LUC KNOW CITY**

**J. K. Dhaon, V. C. Jain, V. Narayan,
V. K., Srivastava and V. Bhusan**

ABSTRACT

This study is of 440 pensioners of Lucknow City, the majority 92.3 per cent retired when aged between 55-59 years and most of them by superannuation. Majority (75.0 per cent) of the retired personnel was Hindus and more than 80 per cent of them were educated up to high school and above. There were 78.6 per cent married and rest were widowers. The members of the family of pensioners ranged between 2-9 and the average family size was 5.4. The average number of living children was 4.1 while 1.6% did not have a child. The dependency rate in respect of children was 53.8 per cent. Service was the main occupation of the pensioners before retirement and majority (52.7 per cent) of them had undertaken some occupation after retirement. The social class of majority of the pensioners (51.1 per cent) did not change after retirement while a fair number of them had to move to a lower social class after retirement. Gossiping and reading were the most preferred leisure time activities of the pensioners. Health and vigour after the retirement was found affected in 14.3 per cent pensioners and this was more in those who compulsorily retired.

Old age is a natural process of human life and is characterised by unique features presenting a broad spectrum of social problems. Retirement, after years of active service is a crisis in every man's life and brings with it many problems. The retirement age for workers in public and private sectors have been fixed as 55 or 58 years in most, and 60 or 62 years in few institutions.

Today, there is a growing number of retired persons. A few welcome retirement as blessing while, for others it is synonymous

with apprehension and unending period of idleness. After retirement, there is sudden and sharp fall in family income, superadded with physical limitations leading to the lowering of socio-economic status. It becomes increasingly difficult for people to continue with the same standard and the style of living they had got used to. This not only affects the living conditions and status of the individual and family, but also the body and mind.

This study was, therefore, carried out to know the bio-social characteristics of the pensioners and also to find out various problems emerging out after their retirement.

Material and Methods

Study of the pensioners was conducted in the city of Lucknow, the capital of Uttar Pradesh. The retired employees of the State Government who draw their pension from Lucknow Treasury have formed the basis of this study. At the time of study, there were 7,245 pensioners whose pension was being paid from the treasury. Of these, 1,497 (20.6 per cent) were residing outside Lucknow City, and 639 (8.8 per cent) were females and they have been excluded from the study. Thus, 5,109 retired males residing in Lucknow City have constituted the field source of this study. A ten per cent sample of this population was taken by systematic random sampling method and by this procedure a total of 510 pensioners could be incorporated in the study. However, only 440 of them could be studied because of various limitations.

Each pensioner was interviewed in detail regarding his bio-social characteristics, state of health, socio-economic conditions etc. The data and information thus collected were recorded on a pretested schedule which have been analysed.

Results and Discussion

The aged form a vulnerable group highly susceptible to physical and mental health deterioration as well as social crisis which are closely interrelated.

Table 1 shows the maximum number (92.3 per cent) of persons retired when aged between 55-59 years. A majority (79.1 per cent) retired on superannuation, 15.0 per cent were compulsorily retired and 5.9 per cent had undertaken voluntary retirement. Presently, 46.6 per cent were aged 60-64 years, while 5.9 per cent and 12.5 per cent were between 50-54 years and 70 and above as shown in Table 2.

TABLE 1
AGE AT THE TIME OF RETIREMENT WITH REASONS OF
RETIREMENT

Age (Years)	Reasons of Retirement						Total	
	Voluntary		Compulsory		Superannuation		No.	Percentage
	No.	Percent	No.	Percent	No.	Percent		
40-44	1	100.00	-	-	-	-	1	0.2
45-49	7	100.00	-	-	-	-	7	1.6
50-54	8	30.8	18	69.2	-	-	26	5.9
55-59	10	2.5	48	11.8	348	85.7	406	92.3
Total	26	5.9	66	15.0	348	79.1	440	100.0

TABLE 2
AGE AT THE TIME OF RETIREMENT AND PRESENT AGE OF PENSIONERS

Age at the time of retirement (years)	Present age (years)					Total	
	50-54	55-59	60-64	65-69	70 & +	No.	Percentage
40-44	1	-	-	-	-	1	0.2
45-49	3	4	-	-	-	7	1.6
50-54	22	1	3	-	-	26	5.9
55-59	-	52	202	97	55	406	92.3
Total	26	57	205	97	55	440	100.0
Percentage	5.9	12.9	46.6	22.0	12.5		

The religious composition of the study population did not differ very much from the population of Lucknow District in respect of Hindus (75.0 per cent) and Muslims (19.1 per cent) while those belonging to other religions were found more in the study population. Sudani in his study of the aged of Lucknow had 70.5 per cent Hindus and 19.2 per cent Muslims.

The literacy rate of the study population was 92.9 per cent and 80.8 per cent pensioners were educated upto high school and above. The educational attainments of the pensioners were very high as compared to those reported by Sudan and Census of India (1971), because they being the retired government servants formed a special group in the general population. There were 78.6 per cent married persons and rest were widower and none of the pensioners was found to be a bachelor. While Mitra reported that 72.8 per cent of the aged were married and there was no bachelor.

The members of the family of pensioners ranged between 2 to 9 and the average family size was found to be 5.4. Raj and Mitra reported the average size of the family as 5.9 and 5.8 respectively. Majority of the pensioners *i.e.* 53.5 per cent were drawn from the nuclear families and the similar observations have been made by Raj and Mitra.

The average number of living children was found to be 4.1 while there were 1.6 per cent such pensioners who did not have a child. Mitra reported 4.5 as the average number of the living children in the aged population studied by him. The dependency rate in respect of children was ascertained to be 53.8 per cent in the study population. Table 3 shows the higher the number of children more were the dependents even after the retirement which constantly worried the pensioners.

TABLE 3

TOTAL CHILDREN OF THE PENSIONERS AND THEIR ECONOMIC STATUS

No. of dependent children	No. of independent children							Total	
	None	1	2	3	4	5	& +	No.	Percentage
None	7	5	13	3	1	2	—	31	7.0
1	9	23	17	11	9	2	1	72	16.4
2	13	46	49	27	3	5	1	144	32.7
3	5	61	65	22	10	-	-	163	37.0
4	1	2	12	6	3	1	-	25	5.7
5	-	-	1	1	-	1	-	3	0.7
56+	-	1	-	-	1	-	-	2	0.4
Total	35	138	157	70	27	11	2	440	
Percentage	7.9	31.4	35.7	15.9	6.1	2.5	0.4		100.0

Service was the occupation of each unit of study but various professions pursued before retirement as given in Table 4 were supervisors clerks etc. (33.4 per cent), class IV personnel (19.3 per cent) and administrative officer (13.2 per cent).

Table 5 shows that majority of the retired persons formed 52.7 per cent who had undertaken some occupation after retirement, common being service and business. Sudani has commented that first preference of the majority of the aged is to continue to remain in their former occupation if they are required to work, but this is not applicable to those who retire from government service.

TABLE 4

PROFESSION OF PENSIONERS PURSUED BEFORE RETIREMENT

Profession	Number	Percentage
Medical specialists	14	3.2
Engineers	23	5.2
Administrative Officers	58	13.2
Teachers	37	8.4
Supervisors, Clerks, etc.	147	33.4
Technicians	76	17.3
Class IV Personnel	85	19.3
Total	440	100.0

TABLE 5

OCCUPATION UNDERTAKEN BY PENSIONERS AFTER RETIREMENT

Occupations	Number	Percentage
Service	88	20.0
Business	79	17.9
Farming	65	14.8
None	208	47.3
Total	440	100.0

The social classification before and after retirement was found to be significantly associated ($P < 0.001$). The social class of majority of the pensioners (51.1 per cent) did not change after retirement while 11.4 per cent pensioners moved to higher social class and remaining to lower social class after retirement as given in Table 6. Raj and Prasad observed that 66.9 per cent of the old people belonged to lowest socio-economic group, while Mitra and Sudani reported this figure to be 32.9 and 21.8 per cent respectively. In this study 21.1 per cent were found belonging to lowest socio-economic strata.

Gossiping and reading were the most preferred leisure time activities of the pensioners as shown in Table 7. Mitra *et al.* found that 63.4 per cent of aged passed their leisure time in prayer and 31.2 per cent in reading. Sudani concluded that looking after the grand children and reading were the main leisure time activities of the aged.

Health and vigour after the retirement was found affected in 14.3 per cent of pensioners and this phenomenon was found significantly more in those who were compulsorily retired ($P < 0.001$) as shown in Table 8. This can be attributed to the consideration that the stress arising out of the forced retirement leaves one in such dilemma, the challenge of which is very difficult to meet.

TABLE 6

SOCIAL CLASS OF PENSIONERS BEFORE AND AFTER RETIREMENT

Social class before retirement	Social class After retirement					Total	
	I	II	III	IV	V	No.	Percentage
I	62	8	25	—	—	95	21.6
II	7	55	29	18	-	109	24.8
III	4	19	38	35	21	117	26.6
IV	-	3	9	27	29	68	15.4
V	-	-	-	8	43	51	11.6
Total	73	85	101	88	93	440	
Percentage	16.6	19.3	22.9	20.0	21.1		100.0

TABLE 7
LEISURE TIME ACTIVITIES OF THE PENSIONERS

Activities	Preference Number						Total weighted number
	First		Second		Third		
	Actual	Weighted	Actual	Weighted	Actual	Weighted	
Reading	118	354	61	122	15	15	491
Gossiping	117	351	96	192	53	53	596
Social Service	26	78	35	70	17	17	165
Seeing Films	66	198	11	22	24	24	244
Listening to Radio	21	63	69	138	23	23	224
Visiting clubs	20	60	13	26	-	-	86
Indoor games	67	201	44	88	-	-	289
Outdoor games	5	15	9	18	-	-	33
No response	-	-	102	204	308	308	512

TABLE 8
AFFECT OF RETIREMENT ON HEALTH AND VIGOUR OF THE PENSIONERS

Reasons of Retirement	Health and Vigour				Total	
	Affected		Non-affected			
	No.	Percentage	No.	Percentage	No.	Percentage
Superannuation	29	8.3	319	91.7	348	100.0
Voluntary	7	26.9	19	73.1	26	100.0
Compulsory	27	40.9	39	59.1	66	100.0
Total	63	14.3	377	85.7	440	100.0

Conclusion

The dictum that 'old is gold' is not properly conceived in respect of the aged. It is true, that the retired aged do not possess much vigour and have limited physical capacities, but are capable of contributing in national development through their knowledge, expertise and experience. It would, therefore, be appropriate if their services are utilised in the community development or other programmes. This would serve dual purpose of strengthening the sense of belonging and utilisation of their free time.

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यह अध्ययन लखनऊ नगर के 440 पेंशनभोगियों से सम्बद्ध है, जिनमें से अधिकांश लोग (92.3 प्रतिशत) 55-49 वर्ष की आयु में सेवा निवृत्त हुए थे तथा अधिकांश लोग वृहद आयु के कारण रिटायर हुए थे। रिटायर लोगों में हिन्दुओं की संख्या अधिक (75.0 प्रतिशत) थी तथा उनमें से 80.0 प्रतिशत लोग शिक्षित थे, जिनका शिक्षा स्तर हाईस्कूल अथवा इससे ऊंचा था। 78.6 प्रतिशत लोग विवाहित थे तथा शेष लोग विधुर थे। पेंशनभोगियों के परिवार में सदस्यों की संख्या 2 से 9 की रेंज में थी तथा परिवार का औसतन आकार 5.4 था। परिवार में जीवित बच्चों की औसतन संख्या 4.1 थी, जबकि 1.6 प्रतिशत लोगों के पास बच्चे नहीं थे। बच्चों के संबंध में पराश्रयता दर (डिपेण्डेसी रेट) 53.8 प्रतिशत था। सेवा-निवृत्त होने से पूर्व पेंशनभोगियों का मुख्य व्यवसाय नौकरी था तथा सेवा-निवृत्ति के पश्चात अधिकांश पेंशनभोगियों (52.7 प्रतिशत) ने कोई न कोई व्यवसाय अपना लिया था। सेवा-निवृत्ति के पश्चात अधिकांश पेंशनभोगियों (51.1 प्रतिशत) के सामाजिक स्तर में कोई परिवर्तन नहीं हुआ था, जबकि दूसरी ओर सेवा-निवृत्ति के पश्चात काफी बड़ी संख्या में पेंशनभोगियों का सामाजिक स्तर नीचा हो गया था। आराम के समय की गतिविधियों में उनकी सबसे प्रमुख गतिविधि गप्पे लगाना तथा पढ़ना थी। सेवा-निवृत्ति के पश्चात 14.3 प्रतिशत पेंशनभोगियों का स्वास्थ्य ताम उत्साहप्रभावित हुआ था तथा विशेषकर उन पेंशनभोगियों का जिन्हें सेवा-निवृत्ति के लिए बाध्य किया गया था।

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