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# AN APPROACH TO HEALTH PLANNING IN INDIA VIA COMPUTER SIMULATION OF EPIDEMIOLOGICAL MODELS: A CASE STUDY OF TETANUS

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*ABSTRACT*

*A computer simulation approach is considered for health planning in this paper. It can be used for evaluating the impacts, consequences over time and economic implications of alternative strategies for controlling- infectious diseases and nutritional disorders. The steps involved in the construction of such simulation models are discussed and illustrated by a case study of tetanus. These models are useful for planning in the health sector in India since they can be constructed with the limited information available. The planner does not have to wait for the outcome of expensive and time consuming intervention studies or surveys. Further, computer simulation of appropriate mathematical models, provides a 1 laboratory setting' to evaluate the effects of new policies and decisions before incurring the risk of introducing them in the real system.*

Many real life situations are complex, rendering decision making difficult. The poor health status in India is due to a large number of factors, such as, heavy infective load, inadequate services, underutilisation of existing facilities, ignorance and paucity of resources. It is necessary to have appropriate techniques to plan for health care as well as rationalise allocation of resources. This has been identified as a research priority[1]. The Planning Commission has also underlined the importance of focusing on managerial aspects of public health problems[2]. Governments may have to review the ways in which programmes are organised, services delivered, and resources and energies expended[3]. A

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scientific approach to this requires the construction of a "model" which can capture essential features of complex situations with maximum accuracy, and yet discard the irrelevant. In the model building/selection process, importance must be given to "representational adequacy" -that is, ensuring a close approximation to the matrix of interactions underlying the phenomena being investigated and its usefulness for decision making.

Models have been constructed by various persons to study epidemic processes and also to represent the epidemiological features of some diseases such as typhoid, tetanus, tuber-culosis. Several such m al models have been reviewed. Macro models have been developed for reso 139 ation and to estimate morbidity due to degenerative diseases. Exercises have also been carried out to study allocation of physicians' time, cost the structure of hospitals, determine optimal hospital size, to mention a few.

A framework for assessing the impacts, consequences over time, and economic implications of alternative strategies for controlling infectious diseases and nutritional disorders -which are important issues in health care in India - is considered. This can be done via computer simulation models and is illustrated here by a case study of tetanus. Some reasons for the choic of computer simulation models, rather than other mathematical models are given. These are not mutually exclusive: (1) computer simulation models do not require to be cast in a mathematical form for which precise analytical solutions are available. Therefore, the researcher has greater flexibility in translating complex systems in mathematical terms with minimal distortion: (2) computer simulation permits one to assess the impact of changes in important parameters on the system such as, information, organisation and environment, by making alterations in the model and observing the effects; (3) computer simulation enables the analyst to gain insight into how the variables of the system interact, as well as the relative importance of these variables; (4) computer simulaticrs of appropriate mathematical models of disease processes proyide a "laboratory" setting where "experiments" may be conducted to evaluate the effects of new policies and decision rules before incurring the risk of introducing them in the real system; (5) these simulation models can be used to anticipate

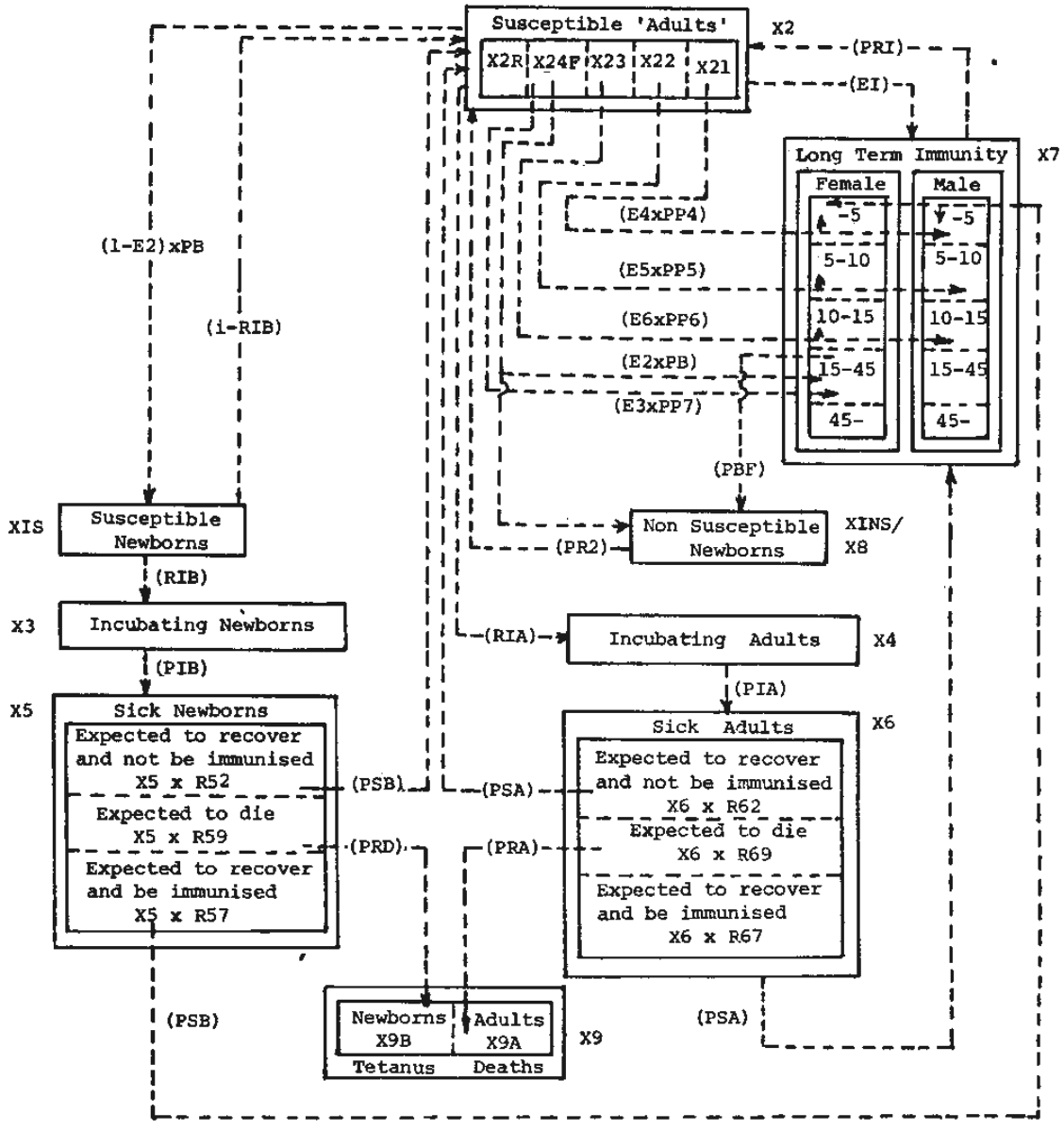
bottlenecks which may arise in the behaviour of the system; (6) large scale controlled experiments for assessing impacts of alternative strategies are costly and often operationally not feasible; and (7) the information base available in india permits the construction of simulation models for disease processes and nutritional disorders, but it precludes the use of models which require a larger information base in terms of reliable time-series or cross-section data.

Some practical problems are mentioned specification of relationships and behavioural hypotheses are often difficult selection of key variables amongst a host of explanatory variables is not easy further, validating simulation models may be troublesome sometimes due to non convergence, requiring reformulation of mathematical relations.

*Model Construction*

The natural history and dynamics of diseases in human populations have been observed to progress usually through a number of identifiable epidemiological states such as, susceptibility, immunity, incubation, illness, recovery or death for a particular disease, an individual passes from one epidemiological state to another at certain rates and in a well defined sequence such a system is not closed it is also subject to the dynamics of birth and death therefore, while constructing an epidemiological model for the control of a disease, one must incorporate: (i) the important epidemiological states, (ii) their inter-relations and interactions via rates of transition, and (iii) the possible control pathways which may be contemplated to reduce the incidence/mortality due to the disease.

The model building process is exemplified with a mathematical model which we have recently developed to describe the epidemiology of tetanus. the main objective is to provide an inexpensive and effective technique to the decision maker to evaluate the impact of on-going strategies, as well as, feasible alternative strategies, for the control of tetanus in india. the flow chart for this tetanus model is given in fig. 1.




Daily rates of transition are indicated in parentheses.

DYNAMICS OF THE EPIDEMIOLOGY AND CONTROL OF TETANUS

FIGURE 1

*Epidemiological States/Classes for Tetanus*

The epidemiological features of tetanus of newborns differs from that of tetanus in the rest of the population; which is here referred to as 'adults'. This difference is incorporated in the model in terms of varying rates of transition operating between the same epidemiological states for newborns and the rest of the population. Specification of epidemiological states is the first step in constructing the model. The main- epidemiological states/classes for tetanus in newborns and adults are summarised in Table 1.

*Inter-relations and Interactions between Epidemiological States*

To capture the inter-relations and interactions between the various epidemiological states the "rates of transition", between them have to be specified. A rate of transition is defined as the probability that a person belonging to one class will be transferred to another per unit of time, which may be an hour, a day, a week or longer. The quantification of these rates has been done on the basis of available medical evidence.

TABLE 1

EPIDEMIOLOGICAL CLASSES IN TETANUS

| Epidemiological Status | Notation | |
|---|---|---|
| | Newborns | Adults |
| Susceptibility | XIS | X2 |
| Incubation | X3 | X4 |
| Sickness | X5 | X6 |
| Death | X9B | X9A |
| Passive Immunity (Short Term) | X8 | - |
| Active Immunity (Long Term) | - | X7,X7F* |

*X7F: Immune Female

*Epidemiological Parameters and their Values*

Epidemiological parameters and their values have been quantified on the basis of available medic al evidence, which is presented below:

*The force of infection for newborns (R IB) and adults (RIA)*

The force of infection for a particular disease, in a given population, may be defined as the risk, of contracting that disease per unit of time. These values have been determined interactively by the computer. The rib value for tetanus in rural haryana is 0.0086628, and the RIA value is 0.0000005, which are the values for the force of infection in newborns and adults, respectively.

*Incubation period*

*Newborns:* studies show that six days may be considered an estimate of the incubation period for tetanus neonatorum.

*Adults*: using available data from large studies, the incubation period for tetanus in adults is estimated to be nine days.

In this model the unit of time is one day. Therefore, the reciprocal of the 'mean' incubation period for newborns *i.e.* 0.16667, gives the daily rate of exit (PIB) from the class of incubating newborns, x3 to the class of sick newborns, x5. Similarly, the reciprocal of the 'mean' incubation period for adults, namely, 0.1111 gives the daily\ rate of exit (pia) from the class of incubating adults, x4, to the,class of sick adults, x6.

*Period of clinical sickness*

*Newborns:* The period of clinical sickness in newborns who recover is estimated as 19 days, and is an average calculated from studies. For newborns who die, this is estimated as three days.

*Adults:* based on studies, the period of clinical illness in adults is estimated as 4.5 days for those who die, and 14 days for those who recover.

The daily rates of exit are reciprocals of the corresponding periods of clinical sickness. The daily rate of exit for newborns who die (PRD) and adults who die (PRA) are 0.3333 and 0.2222, respectively. For newborns who recover (PSB) and adults who recover (PSA), the values are 0.0526 and 0.0714, respectively.

*Case fatality/probability of death due to tetanus*

*Newborns:* studies support that the case fatality rate of tetanus neonatorum in rural areas is about 97 per cent.

*Adults-.* On the basis of available evidence, the case fatality rate was estimated as 50 per cent.

*Immunity*

*Short-term immunity:* Short-term immunity is referred to here as the interval during which the infant/neonate is protected through adequate maternal immunisation. The Government of India considers this to be about three months, as is reflected by the immunisation schedule. Scientific evidence supports the same.

*Long-term immunity:* This is considered to be five years for India, based on medical evidence and opinion.

*Immunisation of Recovered Cases*

It is known that an attack of tetanus does not confer immunity in those who recover, who therefore need to be immunised.

*Newborns:* The probability of a newborn recovering and then being immunised is calculated as 0.001 in rural Haryana, and is denoted as R57.

*Adults:* For adults, the probability of recovering and being immunised is calculated as 0.209, in rural Haryana, and is noted as R67.

*Non-immunisation of Recovered Cases*

The probability of recovering and not being immunised is denoted here as R52 for neonates and R62 for adults. Since

R52+R57+R59 = 1, and R62+R67+R69 = 1, the value of R52 is 0.029 and that of R62 is 0.291.

*Population Renewal*

This model is affected by the rate of population growth. The annual birth rate has been estimated as 34.8 and the annual death rate as 14.4 per 1000 population[40]. The proportion of females in Haryana is 0.4672.

Table 2 summarises the rates of transition which enter in the tetanus model. These rates cannot be varied by the decision maker – except possibly, the force of infection.

TABLE 2

KKflBS OP TRANSITION FOR TETANUS

| Rates of Transition* | Notation | Connected Epidemiological Classes |
|---|---|---|
| Force of infection for newborns | RIB | XIS → X3 |
| Force of infection for adults | RIA | X2 → X4 |
| Incubation period for newborns | PIB | X3 → X5 |
| Incubation period for adults | PIA | X4 → X6 |
| Period of clinical sickness for newborns | PSB | X5 → X2<br>X5 → X9B<br>X5 → X7 |
| Period of clinical sickness for adults | PSA | X6 → X2<br>X6 → X9A<br>X6 → X7<br>X6 → X7F |
| Crude birth rate | PB | X2 → XIS |
| Crude birth rate per female | PBP | X7F → X8 |
| Crude death rate frost ell causes other than tetanus | PDD | Results in an Outflow from classes X2,X3,x4,X5,X6,X7, to the class of deaths from causes other than tetanus |
| Duration of active immunity | PR1 | X7 → X2<br>X7P → X2 |
| Duration of passive immunity | PR2 | X8 → X2 |

*For definitions, refer to text.

*Control Pathways*

The instruments which may be used by decision makers to control the incidence/mortality, of tetanus in newborns and adults, are considered. In this model, the control mechanisms are broadly grouped into two categories:

a. those, related to better medical care of the sick;

b. those related to immunisation.

A decline in mortality rates may be achieved by improved medical care of the sick, resulting in lower case fatality rates. Further, better follow-up of those who recover results in a greater proportion of them being immunised against tetanus, and therefore, an increase in the immune class. The impact of medical care and adequate follow-up can be assessed by varying the parameters listed in Table 3.

TABLE 3

IMPACT OF MEDICAL CARE FOR TETANUS

| Parameters | Notation | Epidemiological Classes Affected |
|---|---|---|
| Proportion of sick newborns who recover and are not immunised | R52 | X5 → X2 |
| Proportion of sick newborns who recover and are inaunised | R57 | X5 → X7 |
| Proportion of sick newborns who die | R59 | X5 → X9B |
| Proportion of sick adults who recover and are not immunised | R62 | X6 → X2 |
| Proportion of sick aduits who recover and are immunised | R67 | X6 → X7 |
| Proportion of sick adults who DIE | R69 | X6 → X9A |

Immunisation programmes are important instruments of control. They have a direct impact on incidence rates. A common feature of all immunisation is that they result in a transfer from the pool of susceptibles to the immune classes. The magnitude of such transfers are functions of (a) coverage of the target group, (b) vaccine efficacy, and (c) whether continuous immunisation or mass immunisation, at specified time intervals, are contemplated. In this model we define the 'effectiveness' of an immunisation programme as a product of the proportion of the target group covered and vaccine efficacy. It may be noted that a target group is a subset of the class X2.

The impact of various immunisation strategies, singly or in combination, for different levels of coverage can be assessed. The strategies, whose impacts may be assessed by the tetanus model constructed, are given in Table 4.

TABLE 4

IMMUNISATION STRATEGIES FOR TETANUS CONTROL

| Programme | Target Group | Effectiveness Parameter |
|---|---|---|
| Mass immunisation of susceptible population at 5 yearly intervals with tetanus toxoid | X2 | El |
| Mass immunisation of females in the reproductive age group, 15-50 years, with tetanus toxoid | X2*PP7 | E3 |
| Continuous immunisation of pregnant women with tetanus toxoid | X2*PB | E2 |
| Continuous immunisation of 'under fives' with DPT | X2*PP4 | E4 |
| Continuous immunisation of the 5 to under 10, age group with DT | X2*PP5 | E5 |
| Continuous immunisation of the 10 to under 15 age group with tetanus toxoid | X2*PP6 | E6 |

*Mathematical Representation of the Tetanus Model*

The equations of the tetanus model are given below:

1. XT(t) = X2(t) + X3(t) + X4(t) X5(t) + X6(t) + X7 (t) + X8(t)
2. X9A(t+l) = X9A(t) + X6(t)xR69xPRA
3. X9B(t+l) = X9B(t) + X5(t)xR59xPRD
4. X9(t+1) = X9A(t+l) + X9B(t+l)
5. XIS(t+l) = (1.0 -E2)x X2(t) x PB
6. XINS(t+l) = X7F(t)xPBF + W3
7. X3(t+1) = X3(t)x(1.0 - PIB - PDD(t) ) + XIS(t)xRIB
8. X4(t+1) = X4(t)x( 1.0 - PIA - PDD(t) ) + X2(t)xRIA
9. X5(t+1) = X5(t)x(1.0 - (R52+R57)xPSB - R59xPRD - PDD(t) ) + X3(t)xPIB
10. X6(t+1) = X6(t)x{1.0 - (R62+R67)xPSA - R69xPRA - PDD(t) ) + X4(t)xPIA
11. X7(t+1) = X7(t)Wl(t)+W2(t) + W3(t) + W4(t) + W5(t)
12. X7P(t+l) = X7F(t) xWl(t) + W3(t) + W5(t) + PFT x (W2(t) + W4(t) )
13. X2(t+1) = X2(t)x(1.0 - RIA - PDD(t) ) + XIS(t) x (1.0 -RIB) + X7(t)xPRI- + X8{t)xPR2 + WW2 (t) - W3(t) - W4(t) - W5(t)
14. X8(t+1) = X8(t)x(1.0 - PR2 - PDD(t) ) + XINS(t)

where

15. Wl(t) = 1.0 - PRI - PDD(t)
16. W2(t) = X5(t) x R57 x x PSB + X6(t) x R67 x PSA
17. W4(t) = X2(t) x E4xPP4 + E5 x PP5 + E6 x PP6 + El)

18. W5(t) = X2(t) x PP7 x E3

19. W3(t) = E2 x PB x X2(t)

20. WW2(t) = X5(t) x R52 x PSB + X6(t x R62 x PSA

21. PDD(t) = PD - (X9(t+1) - X9(t) ) XT(t)

and

XT(t) : total population at time t;

PFT : sex ratio in the population.

*Exposition of the Mathematical Representation of the Tetanus Model*

The variables entering the model, such as, XINS(t), X2.(t) , X3(t), indicate the number of persons, at time t, in the given population who belong to the class of non-susceptible newborns - XINS{t), the class susceptible to tetanus, excluding newborns - X2(t), the class of incubating newborns - X3(t), … … . The parameters such as PB, PD, RIA ... …, represent the rates of exit, over one day from one epidemiological class to another. They may be viewed as daily transition probabilities, or, from a Bayesian point of view as a priori transition probabilities. A difference equation of this system describes the change in the number of persons in an epidemiological'- class over one day, that is, from time t to t+1. Such an equation considers the existing number in that epidemiological class at time t, adds to this entrants from other classes at time t, and subtracts those exiting from this class at time t, to obtain the value at time t+1.

Figure 1 is an aid to understanding the dynamics of the tetanus model.

*Equation (i) - Total Population*

This equation -

(i) XT(t) = X2(t) + X3(t) + X4(t)+X5(t) + X6(t) + X7(t) + X8(t), states that the total population at any point of time is the sum of the populations in the mutually exclusive

epidemiological classes on the right hand side of the equation, and are listed in the glossary.

*Equation (ii) - Adult Tetanus Deaths*

Tetanus deaths in 'adults' are considered, namely X9A. Entry to this class is from X6, who are the adults sick with tetanus. Of the sick adults at time t, the number expected to die is X6(t) x R69 (using the case - fatality for adults). The daily tetanus deaths amongst those sick are X9A(t)xR69x PRA. Therefore, the tetanus deaths in adults at t+1 is given by (ii) X9A(t+l) « X9A(t) + X6(t)xR69xPRA.

*Equation (iii) - Tetanus Neonatorum Deaths*

Deaths due to tetanus neonatorum are considered. This equation - (iii) X9B(t+l) = X9B(t) + X5(t)xR59xPRD, is analogous to equation (ii) above, cf.Figure 1.

*Equation (iv) - Total Tetanus Deaths*

Total tetanus deaths are the sum of deaths due to tetanus neonatorum and tetanus deaths in adults, cf. Figure 1. (iv) X9(t) = X9A(t) + X9B(t).

*Equation (v) - Susceptible Newborns*

Susceptible newborns are born of the susceptible 'adult' population. Usinc the daily birth rate, PB, the number of births at time t are X2(t)xPB. However, if susceptible pregnant women are being immunised, a proportion - X2(t)x PBxE2 - of these births will be non-susceptible to tetanus. (E2, the effectiveness of continuous immunisation of pregnant women, lies between 0 and 1. If E2 = 1 then all the births are non-susceptible .If E2 =0 all the births are susceptible.) Consequently, the number of susceptible births are (v) XIS(t+l) = PBxX2(t) - E2xPBxX2(t) =* (1.0 - E2) x X2(t)xPB.

*Equation (vi) - Non-Susceptible Newborns*

Non-susceptible newborns are those born of susceptible 'adults' who may have been immunised, namely, E2xPBxx2(t), plus those born of women with long-term icsaunity against tetanus, that is X7F(t). Thus, (vi) XIN5(t+l) - X7F(t)xPBF +

X2(t)xPBxE2, where PBF is the crude d&ily birth rate per female, cf. Figure 1.

*Equation (vii) - Incubating Newborns*

The class of incubating newborns \X3) is considered. The number in this class at time t+1 is obtained by adding to the existing number, X3(t), those who enter from the class of susceptible newborns, namely, XISCtJxRlB and subtracting those who exit. Those exiting from X3 go to either the class of sick newborns, or the class of deaths due to all causes other than tetanus (not shown in Figure 1). The number exiting to the former class is X3(t)xPlB (cf. Figure 1), while those going to the latter are X3 (t)xPDD(t), where PDD(t) = PD - (X9(t+l)-X9(t))/XT(t) is the daily crude death rate per person less the daily calculated tetanus deaths per person, between t and t+1. Therefore, the number of incubating newborns at t+1 is

(vii) X3(t+1) = X3Ct)-X3tt)xPDDCt)-X3(t)xPIB+XIS(t)xRIB
= X3(t)x(1.O-PDD(t)-P1B)+XIS(t)xRIB

*Equation (viii) - Incubating Adults*

The number of incubating adults, X4, at time t+1 is given by (viii) X4(t+1) = X4(t) x (1.0 - PDD(t) - PIA) + X2 (t)xRlA. The specification of this equation is analagous to equation (viii above, cf. Figure 1.

*Equation (ix) - Sick Newborns*

At time t, the entrants to the class of sick newborns, X5, from the class of incubating newborns are, X3(t)xPIB. There are four ways to exit from this class:

a. X5(t)xR57xPSB : the sick newborns who recover and are immunised,

b. X5(t)xR52xPSB : the sick newborns who recover and are not immunised,

c. X5(t)xPDD(t) : the sick newborns who die of causes other than tetanus,

d. X5(t)xR59xPRD : the sick newborns who die due to tetanus.

Subtracting those who exit and adding those who enter to X5(t) we specify the value of X5(t+U as

(ix) X5(t+1) = X5(t) x (1.0 - (R52+R57)xPSB - R59xPRD
-PDD(t) + X3(t)xPIB

*Equation (x) - Sick Adults*

Equation (x) describes how the value of X6(t+1) is obtained. The specification

(x) X6(t+1) = X6(t)x(1.0-Ol62+R67)xPSA-R69xPRA-PDD(tJ )
+X4(t)xPIA

is analogous to equation (ix), cf. Figure 1.

*Equation (xi) and (xii) - Long-term Immunity*

The susceptible population, X2(t), following immunisation, enters the class, X7, with long-term immunity, cf. Figure 1. The possible daily entrants to X7 are -

a. X2(t)xEl : consequent to mass immunisation campaigns of susceptible 'adults',

b. X2(t)xPBxE2 : consequent to continuous immunisation of susceptible pregnant women,

c. X2(t)xPP4xE4 : consequent to continuous immunisation of under five years of age with DPT,

d. X2(t)xPP5xE5 : consequent to continuous immunisation of children at school entry with TT,

e. X2(t)xPP6xE6 : consequent to continuous immunisation of children aged 10 with TT,

f. X2(t)xPP7xE3 : consequent to mass immunisations of females in the reproductive age group with TT.

The effectiveness values El, E2, E3, E4, E5, E6, lie between 0 and 1. Apart from the above entrants, those who are

immunised after recovering from tetanus also enter X7. They are -

g. X5(t)xR57xPSA : recovered newborns who are immunised,

and

h. X6(t)xR67xPSA : recovered adults who are immunised.

It may be observed that (b) and (f) also enter class x7F, that is, females with long-term immunity (a sub-set of class X7), but only a proportion of (a), (c), (d), (e), (g) and (h), enter X7F. This proportion denoted as, PFT, is determined according to the proportion of females in the total population for the study area. The exits from the immune class x7 or its sub-set X7F are -

i. X7(t)xPRI : number who lose immunity in 1 day.

and

j. X7(t)xPDD(t) : number who die due to causes other than tetanus in one day.

In light of the above we have the following specifications for the population with long-immunity and females with long-term immunity at time t+1, namely,

(xi) X7(t+1) = X7(t)x(1.0 - PRI - PDDtt) ) + X2(t)x(El + PB x E2 + PP4xE4 + PP5xE5 + PP6xE6 + PP7xE3 ) + X5CtIxR57xPSB + X6(t)xR67xPSA,

and

(xii) X7F(t+l) = X7F(t)x(1.0 - PRI-PDD(t) ) + X2(t)x(PBxE2 + PP7xE3) + X2(t)x(El+PP4xE4 + PP5XE5 + + PP6xE6) x PFT + (X5(t)xR57xPSB + X6(t)xR69 XPSA)xPFT

*Equation (xiii) - Susceptible Adult Population*

The entrants listed as (a) to (f) for equation (xi) above, constitute exits from the susceptible class, X2. Apart from these six exits we also have

X2(t)xRlA : the susceptible population which contracts tetanus,

and

X2(t)xPDD(t) : the susceptible population who die of causes other than tetanus.

The entrants into X2 are -

XISx(l.O-RIB) : the susceptible newborns who do not get tetanus,
X7(t)xPRI : those who lose long-term immunity,

X8(t)xPR2 : those who lose short-term immunity,

X5(t)xR52xPSB + x6(t)xR62xPSA : the adults and neonates who recover and are not immunised.

Thus we have the specification -

(xiii) X2(t+1) = X2(t)x(1.0-RIA - PDD(t) ) + XISx(l.Q-RIB)+
X7(tlxPRI + X8(t)xPR2 + X5(t]_xR52xPSB +
X6(t)xR62xPSA - X2(t)x(El+PBxE2 + PP4xE4 +
PP5xE5 + PP6xE6 + PP7xE3).

*Equation (xiv) - Short-term Immunity*

The equation for the neonates with short-term immunity has the following specification -

(xiv) X8(t+1) = X8(t)x(1.0-PR2-PDD(t))+XINS(t).

The entrants are (cf. Figure 1), the non-susceptible newborns, and the exits are due to loss of immunity, X8(.t)x' PR2, as well as because of deaths due to causes other than tetanus, that is, X8(t)xPDD(t).

The above 14 simultaneous (non-linear) difference equations describe the inter-relations and dynamics between the epidemiological classes entering the tetanus model. The evolution of these classes is traced per day over a planning horizon of 30 years, for various control options.

*Computer Programme*

A computer programme* for simulating this model was developed by the authors. It is written in Fortran IV and was executed on the IBM 360/44 computer system at the Delhi University. This programme evaluates the impact of thirty strategies in approximately twelve minutes.

*Validation*

Since a model is a representation of reality, it is necessary to ascertain the degree of confirmation of the model, before using it. This is termed Validation[42]. It is known that the incidence of tetanus, both in newborns and adults, displays stable levels of endemicity, when there are no interventions. This fact has been, used to validate the tetanus model. For illustration, the application of the tetanus model to depict the situation in rural Haryana is considered. (Details are beyond the scope of the present paper, and may be referred to elsewhere).

For rural Haryana, it is known that the incidence of tetanus neonatorum per 100,000 population is 30.14 and for adults is estimated to be 19.48 per 100,000 population. The results obtained by simulating the tetanus model for rural Haryana are reported in Table 5. This is done for a

TABLE 5

SIMULATION RESULTS WITH NO INTERVENTION FOR ADULT AND NEONATAL INCIDENCE OF TETANUS PER 100,000' POPULATION

| Year | Adults (a) | Newborns (b) | Year | Adults (a) | Newborns (b) |
|---|---|---|---|---|---|
| 1 | 19.48 | 30.14 | 16 | 19.58 | 30.29 |
| 2 | 19.49 | 30.15 | 17 | 19.59 | 30.30 |
| 3 | 19.50 | 30.17 | 18 | 19.60 | 30.31 |
| 4 | 19.51 | 30.17 | 19 | 19.60 | 30.32 |
| 5 | 19.51 | 30.18 | 20 | 19.61 | 30.33 |
| .6 | 19.52 | 30.19 | 21 | 19.62 | 30.34 |
| 7 | 19.53 | 30.20 | 22 | 19.62 | 30.35 |
| 8 | 19.53 | 30.21 | 23 | 19.63 | 30.36 |
| 9 | 19.54 | 30.22 | 24 | 19.64 | 30.38 |
| 10 | 19.54 | 30.23 | 25, | 19.65 | 30.39 |
| 11 | 19.55 | 30.24 | 26 | 19.65 | 30.40 |
| 12 | 19.56 | 30^25 | 27 | J9.66 | 30.41 |
| 13 | 19.56 | 30.26 | 28 | "19.67 | 30.42 |
| 14 | 19.57 | 30.27 | 29 | 19.67 | 30.43 |
| 15 | 19.58 | 30.28 | 30 | 19.68 | 30.44 |

(a): Endemic level is 19.48 per 100,000 population for adults.

(b): Endemic level is 30.13 per 100,000 population for newborns.

*Available on request.

period of thirty years during which it is assumed that there is no intervention. The maximum deviation of the incidence of tetanus in adults and the incidence of neonatal tetanus, from their respective endemic levels, is 1.03 per cent. This fact strengthens confidence in the model which has been constructed and then used to examine the impacts of alternate control strategies in rural Haryana[44].

*Results and Discussion*

Several approaches for the control of tetanus through immunisation have been examined. Two operational strategies are available for the delivery of immunisation services -continuous immunisation of specific target groups or mass immunisation campaigns. Thirty strategies were simulated, studying the impact of (a) continuous immunisation with different coverage levels; (b) mass immunisation of the total population and of females in the reproductive age group; and (c) combinations of (a) and (b). Here, the quantification of the expected decline in incidence and mortality due to 50 per cent and 80 per cent coverage of target population groups, is given in Tables 6 and 7, respectively. The annual incidence of tetanus neonatorum and tetanus in adults per 100,000 population, as well as deaths due to tetanus, progressively declines as the level of coverage is increased. The most marked reduction is observed over the initial period of intervention.

It is estimated that tetanus accounts for about 39 deaths per 100,000 population and about 836 newborn deaths per 100,000 live births in rural Haryana. Reduction in crude death rate, as well as in the infant mortality rate are desirable outcomes of the health care system. In particular, the neonatal mortality rate should be reduced. It has been suggested by health administrators and planners that the crude death rate in India be reduced from the existing 14.1 per 1000 population to 11.0 in 1985, 10.4 in 1990 and 9.0 by 2000 A.D. Also, the infant mortality rate in rural areas of India is to be reduced from 136 per 1000 live births to 122 in 1985, 80-90 in 1990 and below 60 by 2000 A.D. By adopting measures to control tetanus through immunisation, a significant decrease in mortality, particularly in newborns, may be expected. Deaths due to tetanus per 100,000 population decrease in the first five years, from the endemic level of 38.97 to 23.92 with 50 per cent coverage, and 15.53 with

TABLE 6

IMPACT OF CONTINUOUS IMMUNISATION ON TETANUS SIMULATED FOR 50% COVERAGE IN RURAL HARYANA

Strategy & coverage: DPT(50%) + DT(50%) + TT 10 to 15 years (50%) + TT Pregnant women (50%)

| Time Years | Annual Incident per 100,00 Population | | | Deaths Per 100,000 Population | Deaths in Newborns per 100,00 |
|---|---|---|---|---|---|
| | Newborns | Adults | Total | | |
| 1 | 30.13 | 19.48 | 49.61 | 38.97 | 835.88 |
| 2 | 16.68 | 18.96 | 35.64 | 26.25 | 482.36 |
| 5 | 15.97 | 17.05 | 33.02 | 23.92 | 443.11 |
| 10 | 15.66 | 15.98 | 31.64 | 23.07 | 434.47 |
| 15 | 15.58 | 15.71 | 31.29 | 22.86 | 432.07 |
| 20 | 15.55 | 15.65 | 31.20 | 22.80 | 431.37 |
| 25 | 15.54 | 15.63 | 31.17 | 22.75 | 430.05 |
| 30 | 15.54 | 15.63 | 31.17 | 22.75 | 430.10 |

TABLE 7

IMPACT OF CONTINUOUS IMMUNISATION ON TETANUS SIMULATED FOR 80% COVERAGE IN RURAL HARYANA

Strategy & Coverage: DPT (80%) + DT (80%) + TT 10 to 15 years (80%) + TT pregnant women (80%)

| | Time Years | Annual Incidence per 100,000 Population | | | Deaths per 100,000 Population | Deaths in Newborns per 100,000 Livebirths |
|---|---|---|---|---|---|---|
| | | Newborns | Adults | Total | | |
| Endemic Level | 1 | 30.13 | 19.48 | 49.61 | 38.97 | 835.88 |
| | 2 | 8.70 | 18.66 | 27.35 | 18.81 | 272.54 |
| | 5 | 7.95 | 15.75 | 23.71 | 15.53 | 220.67 |
| | 10 | 7.72 | 14.27 | 21.99 | 14.55 | 214.05 |
| | 15 | 7.66 | 13.97 | 21.62 | 14.34 | 212.31 |
| | 20 | 7.64 | 13.90 | 21.54 | 14.29 | 211.83 |
| | 25 | 7.63 | 13.88 | 21.52 | 14.28 | 211.70 |
| | 30 | 7.63 | 13.88 | 21.51 | 14.28 | 211.67 |

80 per cent coverage, respectively. Deaths due to tetanus neonatorum per 100,000 live births declines from the endemic level of 835.88 to 443.11, with 50 per cent coverage of pregnant women, and to 220.67 with 80 per cent coverage over five years. The infant mortality rate is seen to decrease by four and six per 1000 live births,with 50 per cent and 80 per cent coverage of pregnant women, respectively, with TT.

*Perspectives*

An epidemiological model has been developed for tetanus and its control. Similar models may be developed to study the control options of several diseases of public health importance - such as leprosy, tuberculosis, malaria, filaria, syphylis, etc. Not only can each disease and its control be examined, but also a group of diseases may be studied. For example, the impact of the expanded programme of immunisation on all the diseases it attempts to control - typhoid, tuberculosis, poliomyelitis, diphtheria, whooping cough and tetanus - can be studied. This would require the construction of an elaborate model based on the epidemiological features of all these diseases.

The services rendered under the expanded programme of immunisation are provided by a single agency, namely, the health infrastructure. Certain major public health problems (for examble, diarrhoeal diseases) can be controlled by the combined effort of several agencies providing health care, water supply, sanitation facilities and education. The relative contribution of the services provided by each programme/agency can be studied and compared through suitably developed epidemiological models.

Nutritional problems have their genesis in several factors, including awareness in people, adequate health services, availability of the right kind of food, food habits and cultural practices. In addition, larger issues of purchasing capacity, food production and food distribution affect the nutritional status of population groups in a definite way. Such models permit the study of these wide ramifications in a given population. For example, hypo-vitaminosis A or nutritional anaemia, which are major public health problems, can be studied by this technique, and their control strategies examined.

Simulation models , such as the one described, are highly suitable for planning in the health sector in India. The most attractive feature of this technique is that these model can be constructed with the limited information available. The decision-maker does not have to await the outcome of expensive and time consuming intervention studies or surveys. Nor is the current absence iof reliable health statistics a serious impediment for the health planner who uses this approach. Further, costing the various control strategies enables the planner to decide on cost-effective choice.


## सारांश

स्वास्थ्य योजना के लिए कम्प्यूटर सीम्यूलेशन एक सुविचारित अभिगम है। इसका प्रयोग रोगों और कुपोषण के नियंत्रण के लिए वैकल्पिक रणनीति के रूप में प्रभावों के मूल्यांकन, सामयिक अनुमान तथा आर्थिक प्रभावों का पता लगाने के लिए किया जा सकता है। ऐसे सीम्यूलेशन मॉडल के निर्माण में जो चरण निहित है। उन पर विचार विमर्श टिटनेस के एक केस अध्ययन को उदाहरण के रूप में प्रस्तुत करके किया गया है। ये मॉडल भारत में सीमित सूचना उपलब्ध होने की स्थिति में भी निर्मित किए जा सकते हैं। नियोजक को खर्चीले/अधिक समय लेने वाले सर्वेक्षणों एवं अनुसंधान अध्ययनों के परिणामों की प्रतीक्षा करने की आवश्यकता नहीं होती। नई नीतियों एवं निर्णयों को वास्तविक प्रणाली में लागू करने से पूर्व कम्प्यूटर सीम्यूलेशन का उचित गणितीय मॉडल उनके प्रभावों का मूल्यांकन करने के लिए प्रयोग–शालीय व्यवस्थापन प्रदान करता है।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GLOSSARY OP ABBREVIATIONS/NOTATIONS

DPT Triple antigen against Diphtheria, Pertussis and Tetanus

DT Diphtheria and Tetanus Toxoid

TT Tetanus Toxoid

El Effectiveness* factor in mass immunisation campaigns of the susceptible population

E2 Effectiveness factor in continuous immunisation of pregnant women

E3 Effectiveness factor in mass immunisation campaigns for females in the reproductive age group

E4 Effectiveness factor in continuous immunisation of those under five years of age

E5 Effectiveness factor in continuous immunisation of those from five to under ten years of age

E6 Effectiveness factor in continuous immunisation of those from ten to under fifteen years of age

PB Crude birth rate per person per day

PBF Crude birth rate per female per day

PD Crude death rate per person per day

PFT Proportion of females in the population

PIA Daily rate of exit from the class of incubating adults

PIB Daily rate of exit from the class of incubating newborns

PSA Daily rate of exit for adults who recover

PSB Daily rate of exit for newborns who recover

PRA Daily rate of exit for adults who die

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**Effectiveness = Coverage level x Vaccine efficacy*

PRD Daily rate of exit for newborns who die

PRl Daily rate of exit from the class with long term immunity

PR2 Daily rate of exit from the class with short term immunity

PP4 The proportion of those under five years of age in the susceptible population which can be covered with DPT immunisation per day

PP5 The proportion.of those between five to under ten years of age in the susceptible population, which can be covered with DT immunisation per day

PPG The proportion of those between ten to under fifteen year in the susceptible population, which can be covered with TT immunisation per day.

PP7 The proportion of females in the reproductive age group in the susceptible population, which can be covered in mass immunisation campaigns with TT

RIA Probability of an adult getting tetanus over one, day

RIB Probability of a newborn getting tetanus over one day

R52 Probability immunized of a sick newborn recovering and not being

R62 Probability immunized of a sick adult recovering and not being

R57 Probability immunized of sick newborn recovering and being

R67 Probability of a adult recovering and being immunised

R59 Probability of a sick newborn dying

R69 Probability of a sick adult dying

XT(t) Total population at time t

XIS(t) Number of susceptible newborns at time t

XINS*(t)* Number of non-susceptible newborns at time *t*

XI*(t)* Number of newborns at time *t*

X2 *(t)* Susceptible population at time *t*

X21*(t)* Susceptible population which is under five years of age (excluding newborns with passive immunity) at time *t*

X22 *(t)* Susceptible population in the age group 5 to under 10 years

X23*(t)* Susceptible population in the age group 10 to under 15 years

X24F*(t)* Females in the reproductive age group in the susceptible population at time *t*

X2R*(t)* The *rest* of the susceptible population at time *t* which are not members of X21 *(t*J, X22*Ct)*, X23 *(t)* , X24F*(t)*

X3*(t)* Number of incubating newborns at time *t*

X4 *(t)* Number of incubating adults at time *t*

X5*(t)* Number of sick newborns at time *t*

X6*(t)* Number of sick adults at time *t*

X7*(t)* Number of persons with long term immunity against tetanus at time *t*

X7F*(t)* Number of females with long term immunity against tetanus at time *t*

X8*{t)* Number of persons with short term immunity against tetanus at time *t*

X9*(t)* Number of deaths due to tetanus at time *t*

X9A*(t)* Number of deaths in adults due to tetanus at time *t*

X9B*(t)* Number of deaths in newborns due to tetanus at time *t*

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# AGE AT MENARCHE IN AN INDIAN POPULATION

M.M. Gandotra* and Narayan Das**

ABSTRACT

This study, based on all the pre-university female students of M.S. University of Baroda, India who have enrolled themselves in the University during the year 1972* illustrates that the age patterns of menarohe follow a Pearsonian curve of Type IV. It also suggests that the mean age at menarohe has a tendency to decline over a period of time. Further, this decline in the mean age at menarche over a period of time appears to be curvilinear in nature following thereby a pattern of polynomial of degree two.

Besides, nutrition pattern, the social status of the parents under which their daughters grow and the_ stature of the girl (weight and height) seem to be significantly associated with the age at menarche.

Menarche is the onset of menstruation and is one manifestation of puberty among the females. The knowledge of this growth phase among the girls is very important demographically as one can consider the distribution of the age at menarche as the potential starting point of reproduction. However, it is not known whether the fecundability is zero at the age at menarche or starts with a positive value and increases thereafter.

Several regional studies both in India as well as abroad have recognised the fact that the mean age at menarche may be varying from one community to the other and also within the community with varied socio-economic status, genetic factors, environmental impact etc. And even within the same community

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one may expect a certain pattern of age at menarche at a point of time and also over a period of time.

The study was thus undertaken with three objectives viz. (i) To study the age patterns of menarche; (ii) To study the mean age at menarche over a period of time; and (iii) To study the factors associated with the age at menarche.

This study covered all the pre-university female students of M.S. University of Baroda, India, who have enrolled themselves in the University during the year 1972, numbering 902 and were found to be in the age bracket 15 to 24 years.

*Mean Age at Menarche*

To have an idea about the age at onset of menstruation among the Baroda college girls simple mean could be computed directly from the frequency distribution. However, such an estimate is likely to be affected by the differences in the age distribution of the girls interviewed. For instance, among the girls aged 15 years the porportion of non-menstruating cases will naturally be less as compared to those girls who are aged 18 years and over at the point of survey. Further, the sub-groups of the sample population may also differ with respect to their age distribution. This limitation makes the estimate biased and the comparison of the crude averages for different groups unrealistic. In fact, the mean age at menarche estimated as such will be an underestimate as the age at onset of menstruation cannot exceed the present age of the girl. Chidambaram has already discussed these limitations in details while analysing the data on age at menarche of the Bombay School Girls by religion.

To overcome the difficulty in this context, estimate of age at menarche would be obtained by using life table technique used by Potter for measuring the use effectiveness of contraception. This method has also been used by Chidambaram for estimating mean age at menarche.

Since there is some time lag between the age at onset of menarche and reporting of this age at the time of survey, the respondent may not be able to recall exactly the age in years and months, and may have a tendency to report the age at

menarche in. full years. The estimates of age at menarche so obtained are therefore corrected for the estimated average recall errors of 0.5 years, as obtained by Livson and Mc Neill and Krishnan[4,5]. Standard deviation of age at menarche would also be corrected by using the following relation obtained by Krishnan^;

$M_1' = M_1'' + 1/2$ and

$M_2' = M_2'' + M_1'' + 1/6$

where, $M'_r$. and $M''_r$ stands for the true and data derived rth moments respectively.

The age distribution of the girls at the point of survey is presented in table 1. As can be seen from the table, less than 6 per cent of the girls were aged 15 years or less while about one-fourth of the girls interviewed were aged 18 years and over. The remaining 70 per cent were found in the age bracket 16 to 17 years.

To take account of the age composition of the girls at the point of survey, the mean age at menarche and its standard deviation was thus estimated by the method mentioned above. The method of estimation is shown in table 2. Explanation of the symbols used in table 2 are given below the table.

The estimated mean age at menarche was thus found to be 14.2181 with standard deviation of 1.1225. After making adjustment for the recall lapse error the corrected mean age at menarche and the corrected standard deviation would be

TABLE 1

AGE DISTRIBUTION OFTHE COLLEGE GIRLS INTERVIEWED

| | Present Age in Completed Years | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 15 | 16 | 17 | 18 | 19 | 20 | 21 & over | |
| Number | 50 | 333 | 297 | 134 | 41 | 26 | 21 | 902 |
| Percentage | 5.54 | 36.91 | 32.91 | 14.86 | 4.55 | 2.88 | 2.33 | 100 |

Mean Age at Menarche = 14.2104 years

TABLE 2

ESTIMATION OF MEAN AGE AT MENARCHE BY USING LIFE TABLE METHOD

| X | $W_X$ | $M_X$ | $d_X$ | $q_X$ | $p_X$ | $p_X$ | $M_X$ | $M_X$/10,000 |
|---|---|---|---|---|---|---|---|---|
| *10* | *902* | *3* | | *.0033* | *0.9967* | *1.0000* | *33* | *0.0033* |
| *11* | *899* | *11* | | *.0122* | *0.9878* | *0.9967* | *122* | *0.0122* |
| *12* | *888* | *36* | | *.0405* | *0.9595* | *0.9845* | *399* | *0.0399* |
| *13* | *852* | *164* | | *.1925* | *0.8075* | *0.9446* | *1818* | *0.1818* |
| *14* | *638* | *320* | | *.4651* | *0.5349* | *0.7628* | *3548* | *0.3538* |
| *15* | *368* | *278* | *1* | *.7565* | *0.2435* | *0.4080* | *3087* | *0.3087* |
| *16* | *89* | *74* | *1* | *.8362* | *0.1638* | *0.0993* | *830* | *0.0830* |
| *17* | *14* | *8* | *1* | *.5926* | *0.4074* | *0.0163* | *97* | *0.0097* |
| *18* | *5* | *5* | | *1.0000* | *0* | *0.0066* | *66+* | *0.0066* |

\+ It is assumed that $M_{18} = 66$ and $M_{19} - 0$

Mean Age at Menarche - 14.2181

Standard Deviation. - 1.1225

x - age in completed /ears

$w_x$- number of girls who have not started menstruation until exact age x and. are exposed to the risk of starting menstruation.

$M_X$ - number of girls who started menstruation between age x and x + 1.

$d_x$- number of girls who have not started menstruation and are aged x at the time of survey.

$q_x$- estimated probability of starting menstruation between age x and x -+ 1

where $q_x = m_x / w_x – d_x$

and $P_x = 1 - q_x$

$P_x$- estimated cumulative probability of not starting menstruation by age x.

$M_x$- estimated number of girls starting menstruation at age x, among an initial cohort of 10,000 girls.

$M_x = 10{,}000 (P_x - P_{x+1})$

14.7181 and 1.1074 respectively. However, before making adjustment for recall lapse error the overall mean age at menarche derived by life table method was not found to be different from the crude mean.

*Age Patterns of Menarche*

Age patterns of menarche would be useful in the demographic analysis as well as in the theoretical model building. For this purpose it would be desirable to examine the shape of the curve which the age patterns of menarche form in an Indian community.

An attempt was thus made to fit Pearsonian curve to the data on the age distribution of women at menarche. As can be seen from table 1, the size of the sample by the present age, to form a cohort to study the age pattern of menarche, is rather relatively small and hence all the girls in the age group 15-24 were taken together to fit Pearsonian curve. Since most of the girls (99.7%) had attained puberty when they were contacted, and majority of the girls were found in the age group 16-18 at the point of survey, the frequency distribution of the women by their age at menarche may not get affected. Further, the estimated mean (14.22 years) derived by life table method to overcome such limitation, is not found to be different from the crude one (14.21 years), before making adjustment for recall lapse error.

The value of $V\beta$, which is a measure of asymmetry (skewness) for this data was found to be 0.2047 indicating thereby that the value is very close to zero. This thus suggests that the age distribution of menarche though is positively skewed but is not very far from symmetry. Again the value of $\beta_2$ (kurtosis) for this data was found to be 3.9383, illustrating thereby that the form of the curve suited for this data is slightly more peaked than the normal curve of error. The value of K given by :

$$K = \beta_1 (\beta_2 = 3)^2 / 4 ( 4 \beta_2 - 3 \beta_1) ( 2 \beta_2 - 3 \beta_1 - 6 )$$

is equal to 0.0184, suggests that the form of curve which may fit to the data on the age patterns of menarche may be Pearsonian curve of type IV.

The observed frequencies and those expected on the basis of fitted Pearsonian curve of Type IV are shown in table 3.

TABLE 3

OBSERVED AND EXPECTED AGE PATTERNS OF MENARCHE

| Age in years | Observed Frequency | Expected Frequency |
|---|---|---|
| 10 | 3 ) | 2 ) |
| | ) $14^{+}$ | ) $11^{+}$ |
| 11 | 11 ) | 9 ) |
| 12 | 36 | 42 |
| 13 | 164 | 157 |
| 14 | 320 | 329 |
| 15 | 278 | 264 |
| 16 | 74 | 80 |
| 17 | 8 ) | 13 ) |
| | ) $13^{+}$ | ) $15^{+}$ |
| 18 | 5 ) | 2 ) |

+ Because of small number of cases in certain age groups it was combined with the frequency of earlier or later age group.

Pearsonian curve of Type IV gave a good fit to the data as judged by the application of Chi-square test. The value of the $X^2$ was found to be 3.6920 which is not significant at 5 per cent level. The forms of observed and fitted age distributions of menarche are given in Fig. 1.

*Trends in Mean Age at Menarohe*

Data on the age at menarche of the pre-university female students of M.S. University of Baroda, India has been available right from the years 1957 onward (Statistical Service Unit, 1957-72)[8]* It was thus decided to look at the trend of the mean age at menarche of the female students from the period 1957 to 1972. The mean age at menarche and its standard deviation, after making the requisite correction for recall lapse errors, for the years 1957-59 to 1970-72 is as shown in table 4.

The differences between the mean age at menarche for the years 1957-59, 1959-61 ……1970-72 were tested statistically by using analysis of variance technique. The value of F was found to be 10.55 which is significant even at 1 per cent level of significance. Thus, there appears to be a significant decline in the mean age at menarche of the magnitude of 0.26 years in a period of 15 years. This decline in the, mean age at menarche over a period of time appears to be curvilinear in nature. An attempt was made to fit a polynomial of degree two to a time series data on age at menarche.

TABLE 4

MEAN AGE AT MENARCHE AND ITS STANDARD DEVIATION FOR THE YEARS 1957-59 TO 1970-72

| Years* | Total Number | Mean age at menarche | STANDARD Deviation | F- Value |
|---|---|---|---|---|
| 1957-59 | 859 | 15.00 | 1.27 | |
| 1959-61 | 991 | 14.96 | 1.22 | |
| 1961-63 | 1220 | 14.80 | 1.24 | |
| 1966-68 | 1897 | 14.76 | 1.07 | 10.55** |
| 1968-70 | 1605 | 14.74 | 1.04 | |
| 1970-72 | 1634 | 14.74 | 1.06 | |

* Information on the age at menarche for the years 1963-64, 1964-65 and 1965-66 is not available.

** Significant at .01 level.

OBSERVED AND EXPECTED AGE PATTERNS OF MENARCHE

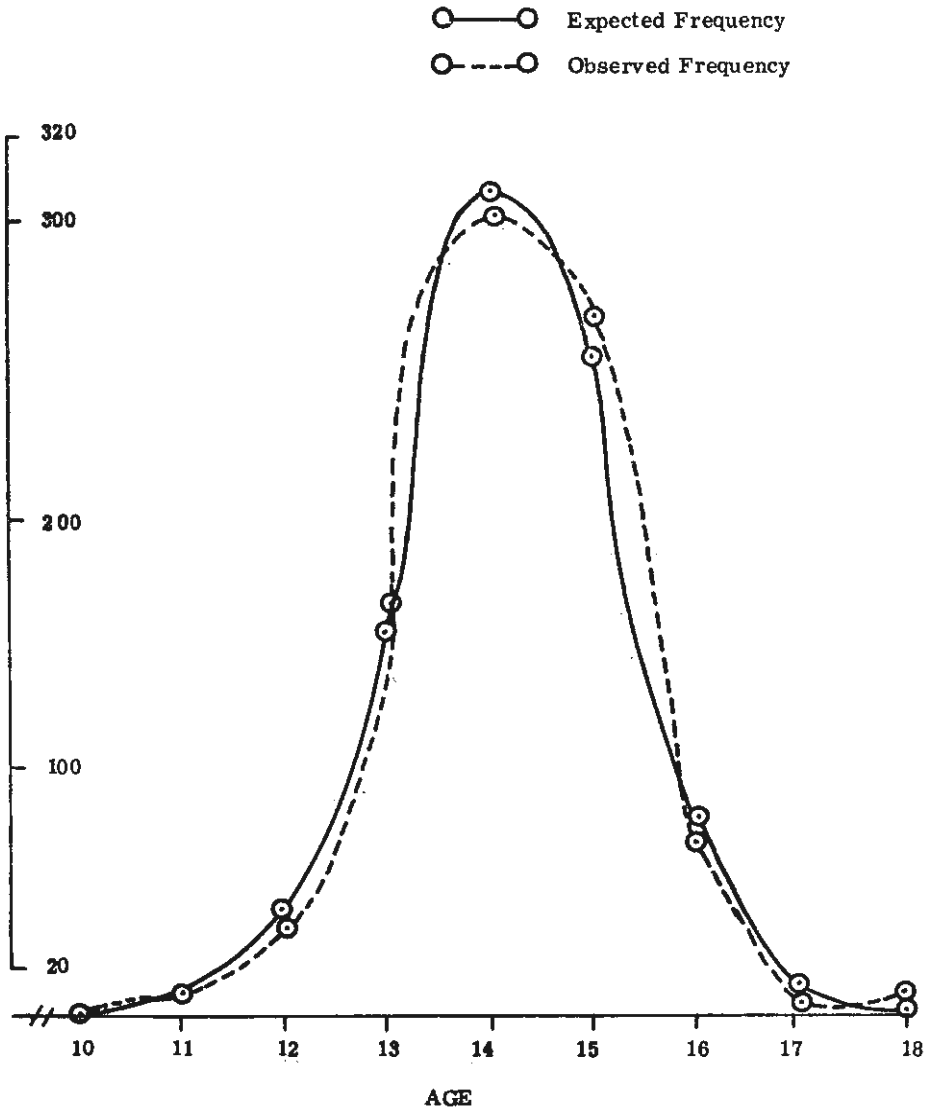


FIGURE 1

A polynomial of degree two seems to fit this time series data as judged by the application of $X^2$ test. The value of $X^2$ was found to be .00034 which is statistically not significant at 5 per cent level of significance. The forms of observed and expected distribution of mean age at menarche are given in Fig. 2.

*Factors Associated with the Age at Menarche*

Though the sample is relatively homogeneous being in the age group 15 to 24 and belonging to the pre-university class of M.S. University of Baroda, yet they may be heterogeneous with regard to their socio-economic status, dietary pattern, rural-urban exposure etc. It was thus decided to break the entire sample into some sub-groups so as to make the population as homogeneous as possible and then see if these subgroups differ in terms of their age at menarche. The total sample size was thus sub-divided into different groups by taking into consideration the following characteristics of the population under study: (i) Religion, (ii) Dietary Pattern, (iii) Education of Father, (iv) Education of Mother, (v) Urban-Rural Residence, (vi) Height, and (vii) Weight. Mean age at menarche was estimated for all these sub-groups by using Life Table Technique and these estimates were then corrected for the recall lapse errors and presented in table 5 alongwith their corrected standard deviation and the sample size. To test the significance of difference between the two means, t-test was applied, whereas to test the significance of difference between the means in more than two categories, analysis of variance test was used.

The analysis presented in table 5 suggests that the variables Religion, Dietary Pattern, Educational Status of the parents and Physical Stature of the Girl seem to be associated significantly with the age at menarche. It is, however, interesting to note that urban-rural exposure to the girl .does not seem to have any significant impact on the age at menarche.

One significant fact that emerges out of this study is that the girls who reported to be consuming non-vegetarian food, which is protein rich diet, seem to have attained menarche at a relatively younger age than those who were reported to be consuming vegetarian food with or without eggs. Further, it is observed that the education of the

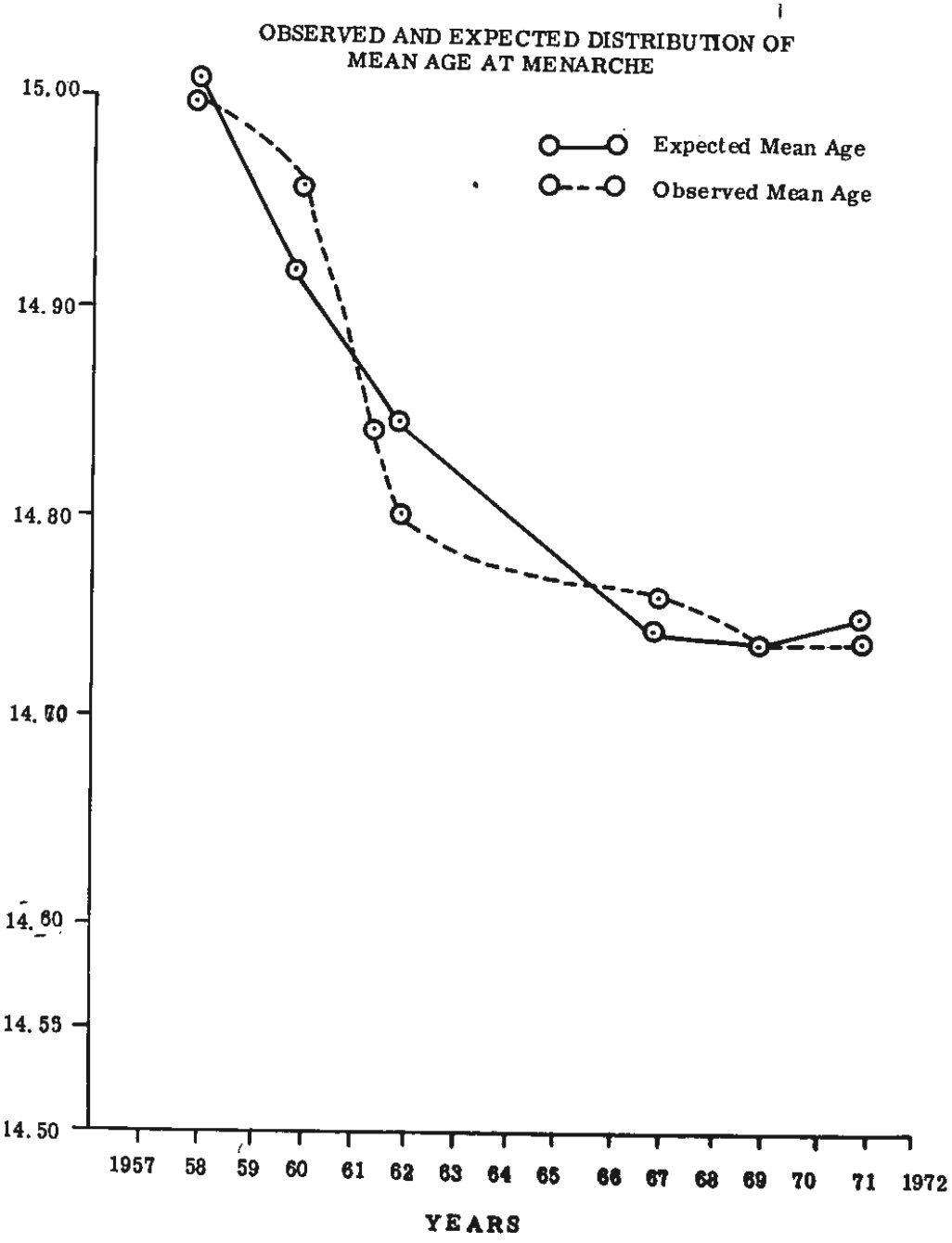
OBSERVED AND EXPECTED DISTRIBUTION OF
MEAN AGE AT MENARCHE
Expected Mean Age
Observed Mean Age
15.00
14.90
14.80
14.70
14.60
14.55
14.50
1957
58
59
60
61
62
63
64
65
66
67
68
69
70
71
1972
YEARS

FIGURE 2

TABLE 5

MEAN AGE AT MENARCHE AND ITS STANDARD DEVIATION BY DIFFERENT CHARACTERISTICS OF THE POPULATION

| *Characteristics* | *Sample size** | Haan *age at roenarche* | *Standard Deviation* | *Test of significance* |
|---|---|---|---|---|
| *Religion* | | | | |
| *Hindu* | *850* | *14.75* | *1.01* | $t = 3.03^{++}$ |
| *Non-Hindu* | *52* | *14.27* | *1.57* | |
| *Dietary Pattern* | | | | |
| *Vegetarian* | *605* | *14.87* | *0.84* | |
| *Vegetarian with eggs* | *129* | *14.61* | *1.18* | $F = 24.19^{++}$ |
| *Non-Vegetari an* | *163* | *14.20* | *1.37* | |
| *Education of Father* | | | | |
| *Primary* | *66* | *14.86* | *1.03* | |
| *Matriculation* | *365* | *15.82* | *0.98* | $F = 5.15^{++}$ |
| *Intermediate or Higher* | *400* | *14.58* | *1.08* | |
| *Education of Mother* | | | | |
| *Primary* | *450* | *14.89* | *0.96* | |
| *Matriculation* | *307* | *14.62* | *1.12* | $F = 22.44^{++}$ |
| *Intermediate or Higher* | *93* | *14.09* | *1.42* | |
| *Residence* | | | | |
| *Rural* | *154* | *14.86* | *1.05* | $t = 1.93^{NS}$ |
| *Urban* | *714* | *14.67* | *1.12* | |
| *Height (in inches)* | | | | |
| *Less than 60* | *309* | *14.88* | *0.68* | $t = 3.37^{++}$ |
| *More than 60* | *586* | *14.62* | *1.19* | |
| *Weight (in lbs.)* | | | | |
| *60- 89* | *339* | *14.93* | *0.97* | |
| *90-119* | *501* | *14.63* | *1.06* | $F = 17.96^{++}$ |
| *120-159* | *48* | *14.00* | *1.22* | |

**Sample- size is 902, it may differ under different characteristics,*

*because of non-availability of information.*

*++Significant at, .01 level.*

*NS Not significant.*

parents, especially the education of the mothers seems to be associated inversely with the mean age at menarche of their daughters. In other words, it is perhaps social status of the parents and environment, under which their daughters grow, which might be affecting the onset of menarche. Infact, education of the parents brings changes in the style of living (inclusive of nutrition) and in turn affects psychological development of the girl.

General growth of the girls (weight and height) was also found to be inversely associated with the onset of menarche. In other words, the mean age at menarche of girls would tend to be lower with the increase in the weight and/or height of the girls.

It was observed that non-Hindu girls in this study are mainly comprised of Parsi, Christian and Muslim girls who consume mostly non-vegetarian food. Thus, though the difference in the mean age at menarche of the Hindu and non-Hindu-girls was found to be statistically significant, part of this difference in the age at menarche might have arisen as a result of different dietary pattern among the different religious groups. The extent of independent effect of this variable and other variables under study could be ascertained by making use of some appropriate multi-variate analysis.

The concluding feature that emerges out of this study is that nutrition pattern, body weight, height of the girls and social status of the parents under which their daughters grow are important in explaining the variation in the age at menarche.

The present study contradicts to some extent the findings of. Baghdad study that the difference in the mean age at menarche need not necessarily be explained on the basis of socio-economic or dietary patterns[9]. But it supports the findings of another study that the socio-economic difference is the important factor and the nutrition pattern is probably the most important factor in causing differentials in the age at menarche.


**सारांश**

प्रस्तुत अध्ययन एम. एस. विश्वविद्यालय, बड़ौदा में विश्वविद्यालय–पूर्व छात्राओं पर आधारित है।, जिन्होंने विश्वविद्यालय में अपना नामांकन

वर्ष 1972 के दौरान कराया। इससे पता चलता है कि रजोदर्शन का आयुवर्ग पियरसन के चतुर्थ प्रकार के वक्र का अनुसरण करता है। इससे यह भी संकेत मिलता है कि रजोदर्शन की औसत आयु एक निश्चित समय बाद हासोन्मुखता की ओर प्रवृत्ति होती हे। रजोदर्शन की औसत आयु में यह हासोन्मुखता एक समय में वक्ररेखा में दो अंश का बहु–एक पदीय स्वभाव का अनुसरण करता है। खानपान के साथ ही माता–पिता की सामाजिक स्थिति, जिसमें उनकी लड़की बढ़ती है, तथा लड़की का स्वयं का व्यक्तित्व (वनज तथा लम्बाई) भी रजोदर्शन में सहायक होता है।

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# UTILISATION OF INSTITUTIONAL HEALTH CARE FACILITIES BY THE TARGET COUPLES IN RURAL KARNATAKA

M.V. Sholapurkar*, A.S. Chandra Mouli* and Y.S. Gopal*

ABSTRACT

Indian culture is characterised by pluralism and this extends to healing also. The rural areas contain not only Government and private doctors but a range of other persons who play healing roles. There are many situations in the developing world where excellent health care facilities are either underutilised or not utilised at all. The present investigation on a sample of 3*200 households has, therefore, made an attempt to study how far the existing institutional health services/facilities are utilised by the target couples 'in rural Karnataka. The findings have shown that a vast majority of the couples prefer to go to Government Health Institutions. Further, data have revealed that a good proportion of the respondents had visited these Government Health Institutions during the previous twelve months either on grounds of Maternal and Child Health (MCH) or for other general ailments. Only about two per cent had gone to these institutions seeking family planning services.

Much is written and spoken about the provision of Primary Health Care services and accordingly, the developing countries have been spending a great deal of money on such provision in the form of rural Primary Health Centres, deploying the Village Health Workers etc. This implies that there is an unfulfilled and unsatisfied demand from the people for such Primary Health Centre services. Of late, the objective of the Primary Health Care has been to attain "Health for All by the Year 2000 AD. To elucidate, health care includes the provision of primary, continuing and comprehensive care,

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which is based on families and communities. Further, the delivery of health care needs a well combined effort of service providers such as physicians, other health professionals Community Workers and the Community Members.

More than - any other culture, India, even Hindu India alone, is characterised by pluralism, and this extends to healing. The rural areas contain not only Government and private doctors but a range of other persons who play healing roles e.g. local authorities on healing and herbs, both paid and unpaid; priests and saints; those who cast horoscopes or have other astrological knowledge and midwives. In fact it is said that "In the lives of most villagers; clinics serve as momentary stopping places on the sick man's pilgrimage from one indigenous practitioner to another". Thus, many of the health problems although are susceptible to existing medical technologies that are safe, simple, effective and relatively inexpensive, the simplest modern health care remains an elusive goal particularly in rural areas. There are many situations in the developing world where excellent health care facilities are available and are grossly underutilised or not utilised at all. For example, in a plantation in India it was found that pregnant women did not care to visit the ante-natal clinic; children were not taken to well-baby clinics, and immunisation offered not taken. it is, therefore, argued that the picture of rural masses hungry for health care services is an erroneous one. And, the vast expenditures on supplying services for which there is so obviously no felt need may be an extravagant waste of resources. Caldwells and Reddy have held the view that villagers would traditionally know their healers who would be in some way part of their personal and family networks, recommended and known by the decision-makers within the family. Consequently, most of the household members are reluctant to go to strangers outside the area, be they modern or traditional healers, unless the cure is to be effected by a famous saint or a temple well known for its cures for the respective ailment or for its divine power for remedy.

An empirical investigation would therefore be highly relevant to know the extent of utilisation of the various primary health care facilities envisaged in rural India.

*Objectives*

This paper seeks to explore the extent of utilisation of the institutional health facilities by currently married women in the age group 15-49 and husbands of currently married women in rural areas accorded by the Government in terms of various health institutions such as the Primary Health Centre, Primary Health Unit, Local Fund Dispensary etc. Further, efforts are also made to study why the sample population prefer either Government agencies or non-government agencies, as well as reasons for such a preference. This apart, how many among the sample respondents visited the said institutions during the last one year and what was the purpose of such a visit are also investigated.

*Study Setting and Sample Design*

The data used in this paper were collected in the first round of a Longitudinal Sample Survey (LSS) conducted during May-December 1975, by the Population Centre, Bangalore. The Bangalore Revenue Division in Karnataka formed the study setting. The , said Division consists of five districts, namely, Bangalore including Bangalore Ci ty, Chi tradurga, Kolar, Shimoga and Tumkur.

The Longitudinal$_t$ Sample Survey adopted a multistage Stratified-Systematic Sample design. The sample included 5200 households, out of which 3200 were from rural and 2000 from urban areas. The rural sample was composed of the households selected from sample villages of four PHCs each in all the five districts listed above. Bangalore City and the district headquarters constituted the urban sample. The details of sampling design and sample size have been published in an earlier article by Reddy.

The interview schedule used in the LSS consisted of three sections. The first section, called ‘Household Section’, elicited information on age, sex, relationship with the head of the household, education, occupation, etc. of every member of the household. The second section, entitled 'Reproductive History and Child Mortality', sought information from all ever married women aged 15-49 in" the selected households on fertility and Child Mortality. The third section, Christened 'Structure of Demand for Family Planning Services', obtained information on knowledge, attitudes and

practice of family planning among couples with wives in the 15-49 age group. The third section was administered to all currently married women aged 15-49 in 50 per cent of the selected households and to the husbands of such women in the other 50 per cent of the selected households. The research reported in this, paper is based on part of the data Crural) obtained through the third section.

*Discussion of Findings*

Data pertaining to the proportion of respondents[1] choice of place of services are discussed in the following paragraphs. The choice regarding the place of services whenever the respondents need medical help, is examined in the light of some socio-economic variables.

*i. Sex of the Respondent*

Data on the respondents by sex on their choice about the type of medical institution they visit, when he/she needs medical attention is given in Table 1. It can be seen that a vast majority of both male and female respondents go to the government institution for treatment when they are ill. The relative percentages being 70.0 and 69.0 respectively. Sex of the respondent-has not yielded wide variation as far as the place of service is concerned. It is also interesting to note that nearly 19 per cent of males and 15 per cent of females go to the private clinics or to the private practitioners. And, 2.7 per cent of males and 7 per cent of females would not visit any kind of medical institution.

TABLE 1

THE DISTRIBUTION OF RESPONDENTS BY SEX AND THE PLACE OF SERVICE THEY VISITED

| Sex of the Respondents | Not Visited at all | PHC/PHU/LFD/SC other Govt. clinic or doctor | Private clinic or doctor (Non-Govt.) | Govt./Private clinics/ doctors | No response | Total |
|---|---|---|---|---|---|---|
| Male | 2.69 | 70.06 | 18.55 | 7.85 | 0.85 | 100.00 (1299) |
| Female | 7.21 | 68.97 | 15.03 | 7.36 | 1.43 | 100.00 (1331) |
| Total | 4.98 | 69.51 | 16.77 | 7.60 | 1.14 | 100.00 (2630) |

This may be either for reasons of not being ill or having no faith in Allopathy or Ayurveda. On the other hand, they might try their own Homoeopathic medicine. Out of the total sample, about 8 per cent have reported that they go to both government institutions and private clinic depending upon the nature of illness and need of the hour.

*ii. Age of the Respondent*

Information provided in Table 2 shows that people in majority, belonging to different age groups visit government institutions when they are in need of some medical aid. More than 65 per cent of male and female respondents have reported that they visited the government institution when there was illness in the family. Relatively, more respondents in the age group 30-44 are found to avail the private clinic services for treatment. About 6 to 8 per cent are said to visit both government and private clinics.

TABLE 2

DISTRIBUTION OF RESPONDENTS BY AGE AND THE PLACE OF SERVICE THEY VISITED

| *Age* | *Not visited at all* | *PHC/PHU/LFD/SC other Govt. clinic or doctor* | *Private clinic or doctor (Non-Govt.)* | *Govt./Pri-vate clinics/ doctors* | *No res-ponse* | *Total* |
|---|---|---|---|---|---|---|
| *15-29* | | | | | | |
| *Male* | *3.08* | *69.23* | *18.08* | *8.46* | *1.15* | *100.00 (260)* |
| *Female* | *7.21* | *70.30* | *14.29* | *6.22* | *1.98* | *100.00 (707)* |
| *30-44* | | | | | | |
| *Male* | *2.07* | *69.54* | *20.10* | *7.34* | *0.95* | *100.00 (627)* |
| *Female* | *7.45* | *66.55* | *16.18* | *8.91* | *0.91* | *100.00 (550)* |
| *45+* | | | | | | |
| *Male* | *3.40* | *71.36* | *16.50* | *8.25* | *-0.49* | *100.00 (412)* |
| *Female* | *5.41* | *74.32* | *13.51* | *6.76* | _ | *100.00 (74)* |
| *Total* | | | | | | |
| *Male* | *2.69* | *70.06* | *18.55-* | *7.85* | *0.85 "* | *100.00 (1299)* |
| *Female* | *7.21* | *68.97* | *15.03* | *7.36* | *1.43* | *100.00 (1331)* |

*iii. Literacy level of the Respondent*

The respondents' choice of the place of service by the literacy level is shown in Table 3. The choice regarding the place of service does not vary much with the level of literacy. For, more than 65 per cent of male and female respondents have been found to be in favour of availing government health services during illness. However, it is noteworthy that comparatively a slightly lower proportion of people with higher education avail government health services. On the contrary, a relatively higher proportion of respondents with middle school level of education go to private doctor or clinics for treatment. The advent of education might probably make these persons look for special or

TABLE 3

DISTRIBUTION OF RESPONDENTS BY EDUCATION AND PLACE OF SERVICE THEY VISITED

| *Education* | *Not visited at all* | *PHC/PHU/LFD/ SC other Govt. clinic or doctor* | *Private clinic or doctor (Non-Govt.)* | *Govt./Pri-vate clinics/ doctors* | *No res-ponse* | *Total* |
|---|---|---|---|---|---|---|
| *Illiterate* | | | | | | |
| *Male* | *4.04* | *70.22* | *16.16* | *8.36* | *1.21* | *100.00 (742)* |
| *Female* | *7.66* | *69.70* | *13.89* | *7.30* | *1.45* | *100.00 (1109)* |
| *Primary* | | | | | | |
| *Male* | *1.56* | *71.76* | *17.65* | *9.03* | – | *100.00 (255)* |
| *Female* | *4.08* | *66.34* | *19.38* | *8.16* | *2.04* | *100.00 (98)* |
| *Middle* | | | | | | |
| *Male* | – | *65.99* | *26.53* | *6.80* | *0.68* | *100.00 (147)* |
| *Female* | *3.85* | *67,95* | *20.51* | *7.69* | – | *100.00 (78)* |
| *High School and above* | | | | | | |
| *Male* | *0.65* | *70.32* | *23.87* | *4.51* | *0.65* | *100.00 (155)* |
| *Female* | *6.52* | *58.70* | *23.91* | *6.52* | *4.35* | *100.00 (46)* |
| *Total* | | | | | | |
| *Male* | *2.69* | *70.06* | *18.55* | *7.85* | *0.85* | *100.00 (1299)* |
| *Female* | *7.21* | *68.97* | *15.03* | *7.36* | *1.43* | *100.00 (1331)* |

extra care; or they might not like to wait in the queue in the government hospital. Relatively more illiterates are found to have not visited any health institution. This complies with the established notion that even today in the rural areas, some do not beseech any medical aid despite being ill. Though sex differential has not been wide, the proportion of males availing the health measures is more compared to that of females.

*iv. Per Capita Income*

By and large, per capita income of the family has not affected the respondents' choice for government health institutions. Nearly 70 per cent or more of male and female respondents irrespective of per capita income are reported to have visited the government institutions for treatment (Table 4). However, amongst those who have reported

TABLE 4

DISTRIBUTION OF RESPONDENTS BY PER CAPITA INCOME AND THE PLACE OF SERVICE THEY VISITED

| Per Capita Income | Not visited at all | PHC/PHO/LFD/ SC other Govt. clinic or doctor | Private clinic or doctor (Non- Govt.) | Govt./Pri- vate clinics/ doctors | No res- ponse | Total |
|---|---|---|---|---|---|---|
| *300* | | | | | | |
| Male | 2.95 | 70. 46 | *18.14* | *7*.74 | 0.*70* | *100*.00 *(711)* |
| Female | 7.*77* | 68.51 | *14*.98 | 7.*49* | *1.25* | *100*.00 *(721)* |
| 400-700 | | | | | | |
| Male | 3.00 | 74.38 | 16.*08* | 5.*72* | *0.82* | *100*.00 *(367)* |
| Female | 7.71 | *70*.48 | 14.36 | *5.85* | 1.*60* | *100.00 (376)* |
| 800+ | | | | | | |
| Male | 1.*53* | *60*.71 | 23.*47* | 12.76 | *1.53* | *100*.00 *(196)* |
| Female | 3.54 | 68.68 | *16.67* | 10.10 | 1.*01* | *100.00 C198)* |
| Total | | | | | | |
| Male | 2.*75* | 70.09 | *18*.37 | 7.*93* | 0.*86* | *100.00 (1274)* |
| Female | 7.*10* | *69.12* | *15.06* | 7.*41* | *1.31* | *100.00 (1295)* |

that they would avail the non-government services, respondents belonging to higher per capita group are more in number. It is noteworthy that people in the per capita income group 400-700 are the ones who go to private clinics in less number. A relatively higher proportion of respondents in the per capita income group Rs.800 and above avail both government and private health facilities. This might be the consequence of their affluence to afford a choice in the type of medical care they need.

*v. Religion*

Seventy per cent of Hindus and Muslims have been found to avail the government health services during illness {Table 5). However, the variation between these two religious groups is very small. Nearly 8 per cent of Hindu and Muslim respondents go to both government and private clinics.

TABLE 5

DISTRIBUTION OP RESPONDENTS BY RELIGION AND PLACE OF SERVICE THEY VISITED

| Religion | Hot visited at all | PHC/PHU/LFD/ SC other Govt. clinic or doctor | Private clinic or doctor (Non-Govt.) | Govt./Pri-vate clinics/ doctors | No res-ponse | Total |
|---|---|---|---|---|---|---|
| Hindu | | | | | | |
| Male | 2.81 | 69.96 | 18.47 | 7.88 | 0.88 | 100.00 (1245) |
| Female | 7.31 | 69.10 | 14.77 | 7.39 | 1.43 | 100.00 (1259) |
| Muslim | | | | | | |
| Male | · | 70.83 | 20.83 | 8.34 | - | 100.00 (48) |
| Female | 6.06 | 66.67 | 18.18 | 7.57 | 1.52 | 100.00 (66) |
| Total | | | | | | |
| Male | 2.70 | 69.99 | 18.56 | 7.89 | 0.86 | 100.00* (1293) |
| Female | 7.24 | 69.98 | 14.95 | 7.40 | 1.43 | 100.00* (1325) |

*6 Male and 1 7 female respondents were Christians. The totals therefore vary from those of other tables.

*vi. Number of Living Children*

It is interesting to note that respondents with no living children are the ones who would visit government institution during illness in more numbers and the respondents with one to three living children are the ones who would visit the private clinic in relatively higher proportion (Table 6). However, the variation among the various groups is very small and the proportion of respondents preferring the government hospitals is as high as 70 per cent, while that of private clinic 18.7 per cent.

*vii. Type of Family*

While a lower proportion of male respondents in stem and stem-joint family prefer government doctor or an institution, a higher proportion of females in the said families prefer a

TABLE 6

DISTRIBUTION OF RESPONDENTS BY THE NUMBER OF LIVING CHILDREN AND THE PLACE OF SERVICE THEY VISITED

| No. of Living Children | Not visited at all | PHC/PHU/LFD/ SC other Govt, clinic or doctor | Private clinic or doctor (Non-Govt.) | Govt./Pri-vate clinics/ doctors | NO res-ponse | Total |
|---|---|---|---|---|---|---|
| 0 Male | 3.95 | 74.73 | 17.03 | 3.30 | 1.10 | 100.00 (182) |
| Female | 10.96 | 70.32 | 11,61 | 14.53 | 2.58 | 100.00 (155) |
| 1-3 Male | 3.44 | 67.48 | 19.62 | 8.26 | 1.20 | 100.00 (581) |
| Female | 6.85 | 69.78 | 14.64 | 7.17 | 1.56 | 100.00 1642) |
| 4+ Male | 1.54 | 70.66 | 18.15 | 9.27 | 0.38 | 100.00 (578) |
| Female | 6.38 | 67.73 | 16.51 | 8.44 | 0.94 | 100.00 (533) |
| Total | | | | | | |
| Male | 2.73 | 69.79 | 18.66 | 7.96 | 0.86 | 100.00 (1281) |
| Female | 7.14 | 69.02 | 15.04 | 7.37 | 1.28 | 100.00 (1330) |

Note: 18 cases have been omitted for the analysis as data on the number of living children were not available.

government institution or a government doctor as shown in Table 7. The proportion amongst not visiting any clinic or institution for any medical help is more in stem-joint for males and for females in Nuclear-A family. Males in Nuclear-B and Stem-joint families prefer private clinics in relatively higher proportion compared to females in Nuclear-B families only, who, in higher proportion prefer private clinics. A possible reason for preferring private clinics

TABLE 7

DISTRIBUTION OF RESPONDENTS BY TYPE OF FAMILY AND THE PLACE OF SERVICE THEY VISITED

| Type of Family | Not visited at all | PHC/PHU/LFD SC other Govt, clinic or doctor | Private clinic or doctor (Non-Govt.) | Govt./Pri-vate clinics doctros | No res-ponse | Total |
|---|---|---|---|---|---|---|
| Nuclear-A | | | | | | |
| Male | 3.50 | 71.12 | 17.02 | 7.75 | 0.61 | 100.00 (658) |
| Female | 8.18 | 69.03 | 15.40 | 6.29 | 1.10 | 100.00 (636) |
| Nuclear-B | | | | | | |
| Male | - | 65.00 | 25.00 | 10.00 | - | 100.00 (20) |
| Female | 5.71 | 68.57 | 22.86 | 2.86 | - | 100.00 (35) |
| Joint | | | | | | |
| Hale | 1.30 | 70.63 | 19.44 | 7.77 | 0.86 | 100.00 (463) |
| Female | 7.90 | 67.04 | 14.68 | 8.80 | 1.58 | 100.00 (443) |
| Stem | | | | | | |
| Male | 6.49 | 67.54 | 15.58 | 7.79 | 2.60 | 100.00 (77) |
| Female | 6.13 | 69.39 | 10.20 | 10.20 | 4.08 | 100.00 (98) |
| Stem-Joint | | | | | | |
| Male | 1.23 | 61.74 | 27.16 | 8.64 | 1.23 | 100.00 (81) |
| Female | 0.84 | 75.63 | 15.97 | 6.72 | 0.84 | 100.00 (119) |
| Total | | | | | | |
| Male | 2.69 | 70.06 | 18.55 | 7.85 | 0.85 | 100.00 (1299) |
| Female | 7.21 | 68.97 | 15.03 | 7.36 | 1.43 | 100.00 (1331) |

PHC/PHU/LFD Vate Clinics

by the respondents of Nuclear-B families Could be an account of relatively more freedom the head of the household enjoys. There is probably no one to impose upon his influence on the decision-making.

*Utilisation of Institutional Health Services During the Last one Year*

Respondents were questioned to find out whether they had availed the institutional health services during the last twelve months. It was found that 37.3 per cent of respondents had availed these services while 10.7 per cent had gone to the private clinics and about 49 per cent had not visited any institution/clinic at all as shown in Table 8. When the percentages for male and female respondents were looked at, it was evident that a higher proportion of males had availed health services both at the government and private institutions. As a natural corollary, amongst those who had not visited any institution, the proportion of females is more than that of males.

In a study conducted by the Indian Institute of Management, Ahmedabad, it was found that women seeking medical treatment at a PHC was about five to one. This is because of their household responsibilities, and out of ignorance, tend to neglect their illness, until they become too sick to move around and attend to their normal chores. They were also dependent on others in the family to get medical treatment which might cause delay in visiting the health centres.

TABLE 8
SHOWING THE PROPORTION OP MALE AND FEMALE THE VARIOUS HEALTH INSTITUTIONS DURING THE RESPONDENTS PREVIOUS 12 WHO VISITED MONTHS

| Sex | Not visited at all | PHC/PHU/LFD/ SC other Govt, clinic or doctor | Private clinic or doctor (Non-Govt.) | Govt./Pri-clinics/ doctors | No vate res-ponse | Total |
|---|---|---|---|---|---|---|
| Male | 43.80 | 40.26 | 12.86 | 1.31 | 1.77 | 100.00 (1299) |
| Female | 54.55 | 34.41 | 8.64 | 0.60 | 1.80 | 100.00 (1331) |
| Total | 49.24 | 37.30 | 10.72 | 0.95 | 1.79 | 100.00 (2630) |

In addition to asking whether the respondents had visited any health institution during the last one year, the purpose of visit, if paid, was also asked. It was observed that as high as 95 per cent had visited the institutions on grounds of the maternal and child and other health problems. Only about 2 per cent had gone for receiving family planning services. What is evident from this is that people seek to get maternal and child health as well as other health services from the peripheral health institutions. Many might not go in pursuit of family planning as motivation and follow-up care as it was provided at home itself by the paramedical staff or at the weekly sub-centre clinic.

*Reasons for not Visiting Government Institutions*

Efforts were also made to know the various reasons as to why a section of the rural population would not like to avail the government health services. Data pertaining to this aspect is furnished in Table 9. According to the table, nearly 50 per cent of those who had resented to visit the

TABLE 9
REASONS FOR NOT VISITING EITHER GOVERNMENT INSTITUTION OR DOCTOR

| Reasons | Male | Female |
|---|---|---|
| For off | 7.47 | 7.00 |
| Quality of service is not good | 47.72 | 37.50 |
| Have to wait for long time | 4.98 | 2.50 |
| Medicines are not available | 0.83 | - |
| Personnel take money | 13.69 | 9.00 |
| People advice to go private doctors clinic | - | - |
| Any other | 9.96 | 23.50 |
| More than one reasons | 9.54 | 11.00 |
| Not available | - | - |
| No response | 5.81 | 9.50 |
| Total | 100.00 (241) | 100.00 (200) |

government institution for reasons of poor quality of service. Other reasons for not preferring any government institution for treatment were the distance, waiting at the hospital for a very long duration, non-availability of medicines and the personnel at the hospital demanding money. However, the most cited reason was the poor quality of service.

*Summary and Conclusions*

It has been debated very often that inspite of several significant achievements, the health care system envisaged in the country suffers from some weaknesses and deficiencies. In other words, infrastructure of sub-centres, primary health centres and rural hospitals built up in -the rural areas touches only a fraction of the rural population and the concept of health in its totality with preventive and promotive health care services, besides curative, is yet to be made operational. Further, doctors and para-medicals are reluctant to serve in the rural areas in the field of preventive and promotive health. And, the involvement of the people in solving their health problems has been almost nonexistent[9]. However, the above argument is not veritable for the findings of the present study have refurnished people's faith in and effectiveness of the government health care and delivery system. The very fact that nearly 70 per cent of the rural population avail the government health care services is adequate to vouch safe their trust in the said system. A transition has come off in terms of seeking medical aid in the rural areas. This change from the traditional medicine to western type of medicine is in itself is the evidence. It is only a very small proportion who have said that they would not indent for any kind of medical help. This concurrs with a popular belief that "the period of transition in life demands a change in values and inventing a new orientation to life geared towards making a contribution to the family, community of society".

The socio-economic as well as demographic variables have not ceded significant variations in the couples' choice. A vast majority on the other hand, have reposted their faith in the health care and delivery system managed by the government. The evidence is that a large proportion did avail the health services in the government institutions during the previous 12 months. Further, people sought MCH

and General Health Care mostly at the government health institutions. However, a section of the sample which does not avail the government services has made its stance clear that such a resentment is due to the poor quality of service. So, if the quality of service is improved besides locating the medical sub-centres at easily accessible points, thence probably one hundred per cent of rural people would go to the government health institutions'. It has been established that distance is sometimes a deterrent for availing the government health facilities and also people have no preference for hemophilous characteristics to avail services from health personnelll/12. Therefore, a good and an efficient health care system coupled with a sense of commitment for providing a highly qualitative service will make the health planners dream "Health for All by 2000 AD" come true.

*Acknowledgement*

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## सारांश

भारतीय संस्कृति एक बहुवादी लक्षणयुक्त संस्कृति है तथा इसका विस्तार रोग संधान तक है। ग्रामीण क्षेत्रों में केवल सरकारी या गैर–सरकारी डाक्टर ही नहीं है, अपितु कुछ ऐसे व्यक्ति भी हैं जो रोगसंधान की भूमिका निभाते है। विश्व के विकासशील देशों में अनेकानेक ऐसी स्थितियां हैं, जहां विशिष्ट स्वास्थ्य देखरेख सुविधाओं का या तो अल्प उपयोग किया गया है या इनका बिल्कुल उपयोग नहीं किया गया। 3200 परिवार–सैम्पलों पर की गई जांच का उद्वेश्य यह अध्ययन करना था कि कर्नाटक राज्य के ग्रामीण क्षेत्रों में उपलब्ध संस्थानिक स्वास्थ्य सेवाओं/सुविधाओं का उपयोग लक्षित दम्पत्तियों द्वारा किस सीमा तक किया जा रहा है। परिणामों से स्पष्ट होता है कि दम्पत्तियों में अधिकांश लोग सरकारी स्वास्थ्य संस्थानों में जाने को प्राथमिकता देते हैं। इसके साथ–साथ आंकड़ों से यह भी पता चलता है कि प्रत्यर्थियों की एक बहुल संख्या ने गत 12 महीनों में या तो मातृ–शिशु

स्वास्थ्य के लिए या सामान्य बीमारियों में इन सरकारी स्वास्थ्य संस्थानों की सेवाएं ली हैं। केवल लगभग दो प्रतिशत ही परिवार नियोजन सेवाओं की प्राप्ति हेतु इन संस्थानों में गए थे।

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# NATURE AND SCOPE OF HEALTH ECONOMICS: AN EXPOSITORY NOTE

T. Krishna Kumar*

ABSTRACT

Broad overview of health economics is presented in this paper. It defines the health status of individuals and of the community. It also identifies broadly the factors that influence the health status. Further, it describes basic health care policy, issues that deal with resource cost of alternate health care delivery systems,their effect on the health status, and the economic benefit of improvement in health status. The paper also notes the public good and merit good aspects of health care and it gives simple exposition of demand, supply, and market equilibrium. It distinguishes the terms health care needs and demand for health care. The paper also shows how health policy issues must consider the trade-off between efficiency and equity in providing health services.

Presuming that almost all the readers are health scientists and health administrators with medical and public health and family welfare background, an overall introduction to the nature and scope of economic analysis and a demonstration as to how it can be harnessed to provide useful analysis of health policy issues is presented in the paper.

## *Health Status of a Community: Some Conceptual and Methodological Issues*

The two most important issues which should confront a health administrator or a health policy maker are: (i) how

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to define and operationally measure the state of health of an individual and of a community; and (ii) how to value the importance of improvement in health which can be achieved only at the expense of utilising some scarce human and non-human resources that have alternative uses. From the point of view of health policy at the community level at first it seems not very useful to define the health status of an individual. But conceptually health status of a community can be defined only in terms of how many members of *the*-community are in various categories of health status. Thus, any operational definition of the status of health of a community requires an associated definition of state of health of individuals forming that community.

The health status of an individual can perhaps be defined and measured in terms of his/her ability to perform and endure a set of mental and physical tasks, especially chosen for his/her age and occupation. What kind of tasks are chosen for each age/sex/occupation and how the performance and endurance are to be measured are also two very important technical issues. The performance and endurance on the physical tasks can be taken as indicators of the physical health, while the performance and endurance on mental tasks can be taken as indicators of the mental health.

The functioning of human body, whose health status is being measured, is very complex. There could be certain defects in the system which cannot be detected through a preselected battery of tasks. Thus, certain clinical tests are also needed to define and measure the health status of an in-dividual. Certain defects, so detected through clinical tests may not have any effect on the performance and endurance associated with a battery of tasks administered at that point in time, but they do have an effect on the same at a future date. It may be noted that there can be no standard battery of tasks for all persons. The physical and mental health "requirements" would vary from individual to individual and community to community.

Once health status of individuals is measured using a multi-dimensional scale involving scores on various physi-cal and mental tasks and clinical tests it becomes necessary to comprehend such complex information into a. single index of health status. This can be done employing some

of the statistical techniques on multi-dimensional scaling that use multi-variate statistical methods.

The status of health of a community can be described by describing the health status of each individual member of the community. But this is too mucii information, too difficult to comprehend and too detailed to be of use. Therefore, one might wish to describe the health of the community in terms of the distribution of such members by different age and sex classifications and by different categories of health status, such categories being determined by classifying the health status index into different intervals.

What was described above is a conceptual scheme for defining and measuring health status of an individual and the community. However, we all see indices of health status with jaundiced eyes, the statistical artifacts provided by the hospital records and public health records being responsible for such a view. It is well-known that these statistics give a biased view of the health status. The bias is invariably of such a nature as to over-state the community health status. This is so because several individuals do not utilise the services of Primary Health Care Units (PHC), Public Health Services, and Hospital Services.

Before we can examine the second issue, viz. the value one assigns to improvement in health status, we have to deal with a few ethical and technical issues. Some health economists attempted to examine the question of value of life and relate it to such practical problems as the benefits and costs associated with research and curative programmes aimed at saving lives of persons suffering from catastrophic ill-nesses such as heart diseases and cancer. Both the medical profession and the general public were quite, quick to grasp the ill-effects of such an approach. One might use such an approach to advocate that certain expensive treatments should not be administered to the elderly and the, mentally retarded etc. The approach thus raises some ethical questions. However, as long as health programmes require resources that have alternative uses, that is when health planning competes for plan resources, it "is necessary to assess both the improvements in health status of the community and the value of such improvements that are attributable to particular health care programmes. And such returns must be measured in nominal money units for easy comparison.

Changes in health status can take place due to any one or more of several reasons such as:

i. natural physiological changes?

ii. natural changes in the environment;

iii. changes in dietary and other habits (not prescribed);

iv. changes in environment created through public health services. (One practical example that has been extensively debated in our country is the role of nutrition and energy intake on health status and the related issues of measurement of malnutrition and poverty[7]»8.)

v. changes in dietary and other habits including drug therapy, physical therapy etc. prescribed by doctors (medical treatment);

vi. surgical corrections (surgical treatment).

The extent of changes in health status that can be brought about by these, vary due to variations in the initial health status, the genetic or anthropological factors. The actual changes in health status that would result also depend on the medical technology.

The basic questions put forward are: (i) how much of the changes in the health status of the community is attributable to health care delivery systems; (ii) what are the benefits to the community of achieving a given amount of improvement in its health status; and what are the resource costs associated with alternate health care delivery systems?

Health economics is a branch of economic analysis that attempts to answer these questions using the methods of economic analysis. A brief overview of the nature and scope of economic analysis is required before it can be seen how economic analysis can answer these questions. For a more detailed discussion on basic economic principles, the reader can refer.

One famous economist once said that government comes into the picture when the market mechanism fails to provide the society the goods and services it needs, and that a nonprofit sector emerges when both the market and the government fail to provide the goods and services needed by the society. Since health is a prominent field in which the private practice, the government, and the non-profit sector operate it is useful to elaborate this theme. Economics deals with consumer behaviour, producer behaviour and how institutional mechanisms bring these two groups together and determines a price at which transactions take place.

*Individual Demand Curve*

The amount of a particular commodity (either a physical good or a service) an individual consumer is willing to buy at alternative (hypothetical) prices, all other factors remaining constant, is referred to as the consumer's individual demand schedule, demand curve, or demand function. This is shown in Figure 1.

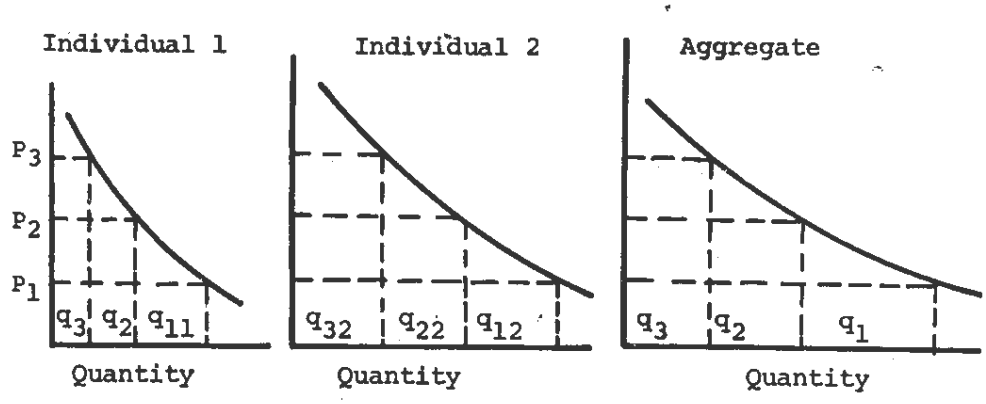

INDIVIDUAL DEMAND CURVE

FIGURE 1

Usually the lower the price the larger is the quantity of the commodity the consumer is willing to buy. The-quantity demanded (i.e. one is willing to buy) depends on factors other than its price. It depends for example on the consumer's tastes, his income, and the prices of other goods. In Figure 1, all other factors, except the price, are assumed to remain constant while price is varied.

*Market Demand Curve*

Different individuals have different tastes and different incomes and hence different demand curves. As illustrated in Figure 2, the relation between individual demand curves and the aggregate market demand curve. In general, the market demand curve also is downward sloping, i.e. the lower the price the larger is the aggregate quantity demanded.




MARKET DEMAND CURVE

FIGURE 2

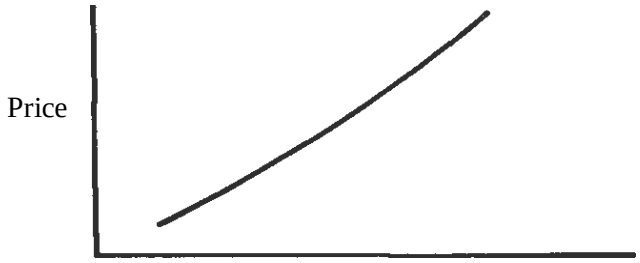
$$q_1 = q_{11} + q_{12} + \cdots\cdots$$

$$q_2 = q_{21} + q_{22} + \cdots\cdots$$

$$q_3 = q_{31} + q_{32} + \cdots\cdots$$

*Individual Supply Curve*

The quantity of a commodity an individual producer is willing to sell at alternate (hypothetical) prices, all other factors remaining constant, is referred to as the producer's individual supply schedule, supply curve, or supply function, as is shown in Figure 3.



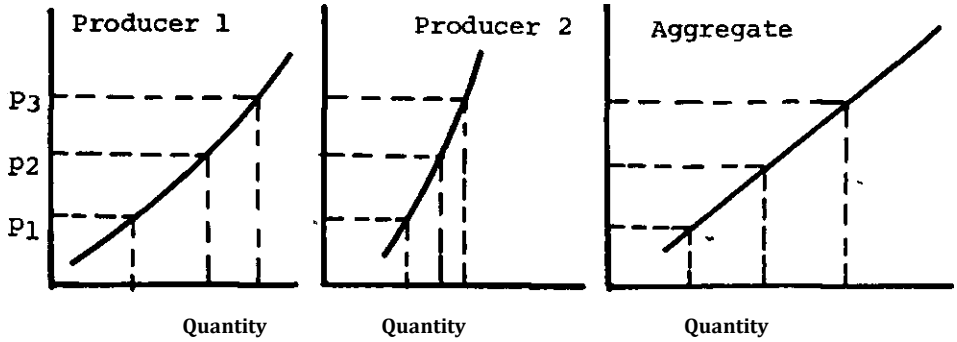

INDIVIDUAL SUPPLY CURVE

FIGURE 3

Usually the higher the price the larger is the quantity supplied (i.e. the quantity the supplier is willing to supply). The quantity supplied depends on factors other than its own price. For example it depends on the technical relation between the inputs and outputs of production, on the prices of these inputs, etc. These other factors are assumed to remain constant-while drawing the individual supply curve.

*Market Supply Curve*

Different producers operate at different scales and use different methods of production. Thus, there will be different individual supply curves. The relation between individual supply curve and the aggregate market supply curve are shown in Figure 4. In general the market supply curve is upward sloping.

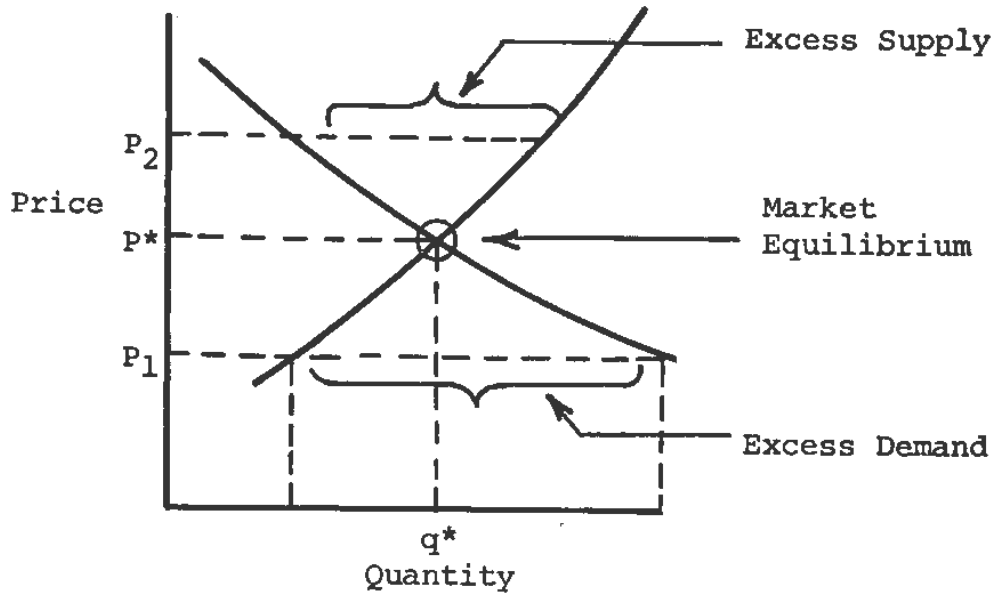



**MARKET SUPPLY CURVE**

**FIGURE 4**

*Market Equilibrium*

Figure 5 depicts both the market demand and market supply




MARKET EQUILIBRIUM

FIGURE 5

At price $P_1$ there is an excess demand, whereas at price $P_2$ there is an excess supply. At price P* the quantity the consuming community is willing to buy at that price equals the quantity the producing community is willing to supply. This is called the Market Equilibrium price.

*When Does the Market Fail?*

Take the case of mosquito-control. Most residents of a community" would' like to get rid of mosquitoes in their houses. Households can buy an insecticide and spray it in their houses. But, it is an unpleasant method of controlling mosquitoes. Every resident realises that it is better to control the mosquito population at their breeding grounds -in ponds, tanks, canals, sewer lines, etc. Would any private entrepreneur come forward to render this service? The questions he would ask are: (i) how much it would cost him to do the job, (ii) how much the residents are willing to pay for it, and (iii) how much profit margin there is for him?

There is very little problem with the first question. But let us examine the answer to the second question. Each resident would feel that he is only one of several beneficiaries and hence everyone should share the cost. Some critical and miserly residents would even argue that the residents who are closer to these breeding places should pay more than the others who are farther away. There would definitely be a disagreement on how such differential rates are to be fixed because no one has a record of the visiting habits of mosquitoes. Finally, there is that clever resident who feels that if he does not pay but a majority do so to meet the expense then the project would be undertaken and he would get the benefit. He may be called a "free rider". What happens if there are several free riders and several others quarrel about payment differentials depending on different visitation schedules of the mosquitoes? The re^_ ceipts would be less than the costs and no businessman would come forward to render this service. The market mechanism fails as there will be no private entrepreneurs to produce, the service while there are some residents who are willing to pay for controlling the mosquitoes in their breeding places. It is, in cases such, as this that the market fails and the government (it could be local government, State government, or the Central government) comes into action.

Consider next the medical and surgical services. Suppose that there are only a few trained medical personnel and they offer the services, at relatively high prices through private nursing homes. The situation would be such that the demand and supply of medical and surgical services will give rise to relatively high equilibrium price. This will have the consequence of leaving out a large portion of the community that cannot afford such a high price for medical and surgical services. The society would consider such services to be essential and/or constitute the basic needs of all sections of the society. Such goods and services are called merit goods. Another example of a merit good is education. Whentjthe market mechanism fails to provide the poorer sections of the society the merit goods it becomes the responsibility of the government to provide the same.

Since Government resources have alternate uses the share of government expenditure that goes to health may be quite small. When both the private health care service units and government health care service units cannot satisfy the

health care needs of the society, then private non-profit and philanthropic organisations can emerge to set up hospitals, clinics, and dispensaries. Some religious institutions, such as Catholic Churches, would like to consider the merit good nature of such services as education and health for rendering such services at low cost to the poor. This may be done as a social service function and also possibly as a means of propogating their religion through such services.

The last three paragraphs explain how private nursing homes, polyclinics, government hospitals, and missionary hospitals, and other non-profit hospitals are co-exist. Behind all these there is demand for service, supply of service, and equilibrium price. It may be noted that there can be quality differentials in the services offered by different types of institutions that render health care service. One important question that can be posed in this connection is whether the type of\ management has any perceptible effect or notion the efficiency of delivering the health care and on its quality. Some economic research has been done on this topic3.

*Equity and Efficiency in Health Care Delivery*

Two basic issues related to health policy viz. definition and measurement of health status and valuation of benefits associated with improvement in health status have been discussed. Now attention be focussed on the benefits and costs associated with health care delivery systems or projects.

The first question we shall address ourselves is - what is meant by productive efficiency of a health care delivery institution? Consider, for example, the productive efficiency of a hospital. A hospital can be viewed as an institution engaged in producing a variety of health care services employing certain scarce resources such as the services of trained medical and para-medical personnel,medical equipment, drugs and other raw material and so on. Thus a hospital shares certain similarities with productive business enterprises that attracted the attention of economists for several decades. Only during the last two and half decades the productive efficiency of hospitals has been investigated by the economists.

Several problems arise in grappling with this issue. First, the health services rendered are outputs of the hospital but the ultimate output of the health care delivery system is a change in the health status of the society. Should one measure efficiency in terms of services rendered .or in terms of changes in the health status achieved? Hospital care is only a part of an entire system of health care, the other components being home care (including nutrition), preventive care, community health, etc. It is quite possible to reduce the output of hospital services and increase the other health care services with no change in the extent of improvement in health status.

If one, chooses to define and measure productive efficiency only in terms of the health services rendered by the hospital the following questions arise: (i) how does one combine' various hospital inputs into a single measure of input and (ii) how does one combine different hospital outputs into a single measure of output? The ratio of output to input can be taken as the productive efficiency. Health economists have come up with some suggestions as answers to these questions. For example, it is assumed that the unit cost of the inputs (or prices) can be taken as weights for combining different inputs and similarly the unit costs of producing different health services can be taken as the weights for combining them into a single output measure. While there are no serious problems associated with the input weighting there are certain serious problems with the weights recommended for weighting the outputs. One particular problem is that the output prices are regulated. Since there are some common resources the unit costs depend on how one allocates the joint costs.

From the entire health systems point of view we must know the contribution that each health care service makes to the improvement of health status. This requires a systematic examination of the cause and effect relations between health status and the factors (identified earlier) that influence it. The weightage to be assigned to each health service can be regarded as a product of two factors. The first factor which remains the same for all health services, is the economic value (in rupees) of improving the health status index by one unit. The second factor is the change in health status index attributable to a unit change in that particular health service.

Economists examined the issue regarding the economic value of an improvement in health status. They did so, of course using the readily available indices of health status such as number of sick days of labour. This examination was done using aggregate data. There is much scope to do further work in this area, particularly in the context of developing countries. And our country offers the best possible data to do applied research in this field.

As pointed out earlier the economic value of improvement in health status depends on the nature of tasks people perform and the physical and mental skills required to perform these tasks. We can assign an economic value (in rupees) to each task and examine the contribution of health status to the performance of these tasks. It is important to note here that the choice of tasks (determined by the occupational choices made by people) which is normally taken as given, is itself influenced by their health status.

So far we examined the issue of defining and measuring productive efficiency of the health care delivery system. This concept, as you could have already realised, is a market concept. The value attached to each task is a market value. The value of working for an hour on the shop floor by a factory worker over a period of his working life requires a particular health status. This hour of work has a market value. If one were to be guided by productive efficiency of health care delivery system along the lines described above -particularly in allocating resources to various health care related activities - it might turn out that the health system will improve the health status of those persons who are more productive at the expense of not improving the health status of those who are less productive. Such a system would perpetuate the misery of the poor, the elderly, the tribals, the backward classes and the like. It is, therefore, necessary to focus the attention on the equity, or lack of it, in improving the health status of various segments of the society. The benefit-cost evaluation of health care projects - the standard approach used by the planners - thus must take into account both the productive efficiency and equity. The tradeoff between efficiency and equity or the relative weights for the two must come as a broad national policy guideline.

*Demand for Health Care and Health Care Needs*

One of the most important topics in health economics is to study the demand and supply behaviour of the consumers and producers of health care services. As discussed, an individual's demand (willingness to obtain health services) for health care service would depend on his personal tastes (preferences between different goods and services), the price of health services, prices of related goods and services, and his income. It may so happen that some individuals demand much less of health care services than what they need. While some others demand much more than what they need.

It is, therefore, necessary to distinguish demand for health care services and health care needs. We already mentioned what demand is. The need for health care service is the amount of that service required to meet and maintain a minimum level of health status. This requirement has to be determined on the basis of the occupation of the persons, the public health norms, and other technical considerations. The nutritional needs have already been specified by WHO and various countries.

For the low income community the demand for health care is usually less than the need for it as determined by the community. In such instances where the demand is less than the need the government is called upon to narrow the gap between the two by offering subsidies to consumers of health services. The health benefit schemes of several industries and the governments are of this type.

There is a great need to examine the gap between demand and need for health care services and also the roles played by various health assistance schemes. In particular one may identify the gap for different segments of the society and suggest policies that are aimed at reducing the gap.

Most frequently, the demand for health services is determined not by the consumer of the service but by the provider of the service. The attending physician decides what care the patient requires. It is possible that there can be unnecessary prescriptions given by physicians to patients who visit them. It is also possible that there are a lot of individuals who do not have access to trained medical personnel and who do not have periodic medical check-

ups. Thus, while there is a scope for an over-statement of demand for health services, there is a greater possibility of an under-statement of demand for health services. For some detailed treatment of topics described, the reader can refer to. Blue Cross and Blue Shield organisation of U.S.A. brings out a journal. Inquiry, which is devoted entirely to health economics.

While community health schemes and family welfare schemes have so far concentrated their efforts on public health and family planning there is a great need in our country for consumer education on health and for increasing the health manpower, at the governments' expense, in order to carry out periodic health screening exercises for the general public.


## सारांश

इस लेख में स्वास्थ्य अर्थ–व्यवस्था पर विस्तृत सिंहावलोकन प्रस्तुत किया गया है। यह व्यक्ति एवं समुदाय के स्वास्थ्य स्तर को परिभाशित करता है। इसमें प्रमुख रूप से उन पहलुओं की पहचान की गई है जो स्वास्थ्य स्तर को प्रभावित करते हैं। इसके साथ–साथ इसमें आधार–भूत स्वास्थ्य देखरेख नीति, वैकल्पिक स्वास्थ्य देखरेख वितरण प्रणाली के लागत–स्रोतो से सम्बद्ध समस्याओं, स्वास्थ्य स्तर पर उनके प्रभावों तथा स्वास्थ्य स्तर में सुधार के परिणामस्वरूप आर्थिक लाभों आदि के बारे में विवेचन किया गया हैं। इस लेख में स्वास्थ्य देखरेख के बहुजन हिताय, बहुजन सुखाय रूपों पर भी प्रकाश डाला गया है। इसमें स्वास्थ्य परिचया की आवश्यकताओं और मांगों के संदर्भ में अन्तर भी स्पश्ट किया गया है। लेख में यह भी बताया गया है कि स्वास्थ्य नीति कैसे स्वास्थ्य सेवाओं को उपलब्ध कराने में आधिक्य और साम्य के अन्तराल को तय करती है।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# TETANUS NEONATORUM - THE NEXT GOAL FOR WORLD WIDE SUCCESS

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ABSTRACT

Te tonus neonatorum remains a major killer inspite of a very effective immunisation available. The main problem appears in making this immunisation available to the pregnant women. Another factor is the unhygienic intra natal care which most of these women receive.

The study was conducted in field practice areas of Christian Medical College, Ludhiana. It has been shown that mortality from tetanus neonatorum can be dramatically reduced by immunising the pregnant women and ensuring a safe delivery.

The methodology of such services is described and data are presented on 2990 deliveries from the years 1976-1980. The results show that tetanus neonatorum may well be the next goal for world wide eradication.

Tetanus neonatorum remains a major killer in this country inspite of a very effective immunisation available against this disease. The reasons for this tragedy are that a majority of pregnant women receive no ante-natal care and this lack of ante-natal care is reflected in many of these women being unprotected against tetanus and their deliveries being conducted by untrained dais.

According to a WHO report tetanus may account for upto 10 per cent of all new born mortality[3]-. In Bangladesh tetanus was the leading cause of death in the children under one year, accounting for 27 per cent of all infant deaths[2].

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There are varying estimates of incidence of tetanus neonatorum in India, in Punjab, 30 out of 103 neo-natal deaths were due to tetanus - an incidence of 29 per cent. According to a report of the Registrar General of India (1972) Tetanus was responsible for 5.86 per cent of infant deaths.

Active immunisation of women during pregnancy has for long been recognised as a safe and effective measure for prevention of neo-natal tetanus. Two doses of absorbed tetanus toxoid (TT) are considered protective. This has been advocated by many wokrers and is also recommended under the National Immunisation Scheduled6. According to a WHO report neo-natal tetanus could be controlled in all societies and immunisation of the women twice before the birth of the baby is sufficient to prevent neo-natal tetanus and this could well become the 'next world-wide success following eradication of smallpox. The results of this study also lend support to such a view.

About 80 per cent of the babies born in our country are delivered by traditional birth attendants many of whom have learned their skills by apprenticeship and experience rather than formal education. Even though the Government of India has focussed its attention to dais since 1950's many areas continue to be serviced by untrained dais and even where there are so called "untrained dais" there is practically no support or supervision of these women by the local health functionary. Attendance during delivery by a trained person is an important factor in ensuring that the pregnancy ends in a healthy mother and child.

This has also been shown in another study conducted in Delhi where the authors have stated that the unhygienic circumstances under which most of the deliveries are conducted in our country expose the babies to a much high quantum of infection that the proclaimed protective level of 0.01 per ml of anti-toxin is not sufficient to protect .the baby against clinical disease. These authors further state that for prevention of tetanus neonatorum strict asepsis during delivery and subsequent cord care is as important as immunisation of mother during pregnancy.

*Methodology*

The department of Community Health .of Christian Medical College, Ludhiana, Punjab provides Comprehensive Health Care through its three rural and one urban centre. The family folder methodology is used. Each family is registered and those in need of 'services are entered in comprehensive health services register and services are provided by regular home visiting.

Pregnancies are detected by keeping the married women in the reproductive age group under surveillance by regular home visits and recording of their last menstrual period. Once a pregnancy is detected the woman becomes entitled for special care and her name is entered in the maternal services section. Ante-natal care is provided by regular home visits and advice is given on nutrition, ante-natal clinic attendance, arrangement for delivery and family planning. The women who fail to avail of the services of ante-natal clinic are given at least two doses of absorbed tetanus toxoid at home and these protected earlier within the last three years are given a booster dose.

A very close rapport is maintained with the dais and the centre staff provides both support and supervision. Further, most of the dais are trained and have mainly received training by the centre staff.

Data from the three main rural centres is presented for the last five years i.e. from 1976 to 198Q on tetanus toxoid protection, birth attendant and infant deaths, with a view to show that it is possible on a community basis to control neo-natal tetanus.

TABLE 1

COMBINED POPULATION OF THE AREAS SERVICED BY THE THREE RURAL CENTRES

| Year | Population served |
|---|---|
| 1976 | 20,154 |
| 1977 | 24,043 |
| 1978 | 25,175 |
| 1979 | 23,202 |
| 1980 | 23,657 |

The difference in population over the years is because some new areas were taken up for service and old areas were discontinued for administrative or logistic reasons.

It is evident from Table 2 that every year nearly 80 per cent or more mothers were protected by two or three doses or booster of tetanus toxoid, except in 1977 when additional new areas were taken up for service.

The total deliveries in "A" in Table 3 differs from the total in table 2 because it is a custom in rural Punjab that some women (mainly primigravida) go to their maternal home for delivery. Table 3 gives details of birth attendants of the women who delivered in area served by us. It will be seen that nearly 2/3 of the deliveries were by trained dais and a very small proportion (6.6% on the whole) were delivered by untrained dais.

It is evident from Table 4 that area of action tetanus neonatorum was responsible for a very small proportion of neo-natal and infant deaths and on the whole for the years 1976-1980 it accounted for 2.2 per cent and 1.2 per cent of neo-natal and infant deaths respectively.

*Conclusions*

It is evident from the data presented in this paper that it is possible to control tetanus neonatorum on a community basis, and, if proper strategy is adopted it has the potential of becoming the next world wide success after eradication of smallpox.

TABLE 2

| | 1976 | 1977 | 1978 | 1979 | 1980 | Total |
|---|---|---|---|---|---|---|
| Number of mother delivered | 513 | 638 | 635 | 644 | 542 | 2990 |
| Protected against tetanus | 419 | 429 | 534 | 580 | 443 | 2405 |
| Percentage Protection | 78.9 | 67.2 | 94.0 | 90.0 | 81.7 | 80.4 |

TABLE 3

BIRTH ATTENDANT AT THE TIKE OF DELIVERY

| | 1976 | 1977 | 1978 | 1979 | 1980 | Total |
|---|---|---|---|---|---|---|
| Total deliveries in 'Area' (A) | 485 | 601 | 604 | 594 | 521 | 2805 |
| Delivered by traditional dais | 312 | 393 | 395 | 418 | 342 | 1861 |
| Percentage | 64.5 | 65.5 | 65.3 | 70.3 | 65.6 | 66.3 |
| Delivered by untrained dais | 25 | 65 | 39 | 22 | 34 | 185 |
| Percentage | 5.1 | 10.8 | 6.4 | 3.8 | 6.5 | 6.6 |
| Delivered by centre staff, hospital etc. | 147 | 143 | 170 | 154 | 145 | 759 |
| Percentage | 34.4 | 23.7 | 28.3 | 25.9 | 27.9 | 27.1 |

TABLE 4

INFANT DEATHS, NEO-NATAL DEATHS AND NUMBER OF DEATHS DUE TO TETANUS NEONATORUM

| | 1976 | 1977 | 1978 | 1979 | 1980 | Total |
|---|---|---|---|---|---|---|
| Total infant deaths | 55 | 75 | 78 | 68 | 53 | 329 |
| Total neo-natal deaths | 34 | 35 | 37 | 39 | 32 | 177 |
| Number of deaths due to tetanus | 0 | 1 | 0 | 2 | 1 | 4 |
| Percentage of neo-natal deaths due to tetanus | 0 | 2.8 | 0 | 5.1 | 3.1 | 2.2 |
| Percentage of infant deaths due to tetanus | 0 | 1.3 | 0 | 2.9 | 1.8 | 1.2 |

With the government plan to provide one set of male and female multipurpose workers for every unit of 5000 population is a realistic goal if the following strategy is adopted.

1. Detect all pregnancies as early as possible constantly monitoring the married women in the reproductive age group,

2. Protecting these women by two doses or booster dose of absorbed tetanus toxoid as the need may be,

3. Having the delivery attended by a trained dai, and

4. Providing the dais with training and following it with a constant supportive supervision.


## सारांश

अत्याधिक प्रभावकारी प्रतिरक्षण सेवायें उपलब्ध होने पर भी टिटनेस अभी तक अपने संहारक रूप में बनी हुई है। गर्भवती महिलाओं को प्रतिरक्षण सेवायें उपलब्ध किस प्रकार कराई जायें, यही सबसे प्रमुख समस्या प्रतीत होती है। इस समस्या का दूसरा पहलू है इन महिलाओं को प्रसव–पूर्व अवधि में प्राप्त गलत ढंग की देखरेख।

इस अध्ययन का संचालन क्रिश्चियन मेडिकल कालेज, लुधियाना के क्षेत्राभ्यास क्षेत्र में किया गया था। इस अध्ययन में यह बताया गया हैं कि गर्भवती महिलाओं को प्रतिरक्षण सेवायें प्रदान करके तथा सुरक्षापूर्ण–प्रसव के माध्यम से नवजात शिशुओं में टिटनेस के कारण होने वाले मृत्युदर को बड़ीनाटकीयता से घटाया जा सकता है।

इस लेख में इन सेवाओं की प्रक्रिया का विवेचन किया गया है तथा वर्ष 1976–1980 तक 2290 प्रसूति केसों से सम्बद्ध आंकड़े प्रस्तुत किये गये हैं। प्राप्त परिणाम प्रदर्शित करते हैं कि हमारा अगला लक्ष्य विश्व स्तर पर नवजात शिशुओं में टिटनेस उन्मूलन का हा सकता है।


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