

REPRODUCTIVE EFFICIENCY AS A SOCIAL INDICATOR

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A social index is sound when the selection of the elements to be combined is based not merely on availability of certain data but on the capacity of these elements to reflect something that is really happening to people in society. The reproductive process, an important aspect of human welfare and health, is studied by using as the population women in the reproductive years and focussing on a single event - the occurrence of a pregnancy - and the variations in its outcome among individuals. The measurements that we are concerned with enlarge the detailed perception of specific events that enter into the long-run reproductive career of females.

The reproductive process has been a major focus of attention in the quest for a suitable basis for health policy decisions. Pregnancy and birth were long attended by risks to mother and child that could be reduced by various social programs. Maternal and infant mortality were unacceptable in a humanistic society and relatively easily measurable through community health records. However, in an advanced country maternal death rates dropped so low that they could no longer be used to direct resource allocation. As infant mortality reflected a number of social and environmental variables, it became a poor index of effective application of health services to reproduction, and at the same time failed to indicate other forms of pregnancy wastage and infant health deficits. The assumption that a healthy live birth was a desired outcome of pregnancy was not a stable one so long as unwanted pregnancy existed. Changed technology and vastly improved social acceptance of fertility control, along with interest in controlling unwanted births for reasons of population control, changed this situation. A number of investigators studied pregnancy wastage other than infant deaths and made such refinements as the distinction of low birth weight from temporal immaturity. What we propose is an aggregate measure of pregnancy outcomes as a guide to reproductive health policy in a developed country where infant mortality is no longer the central issue, a way of introducing the satisfaction aspects of marriage and family life into health policy goals and a way of monitoring quality aspects of population. Attention is called to fertility-related health services as a tool in optimizing reproductive experiences. These services included: maternity care and pediatric services in the first year of life, fertility control (contraception, sterilization and abortion), infertility treatment, and care of fetal loss. Virtually all women need one of these services in each year of the reproductive period (except that sterilization obviates the need for other services).

RE is defined as the percent of pregnancies that succeed in producing normal, surviving children, after taking into account the frequency of all measurable types of adverse outcomes. RE is adapted from a

loss-disability rate concept developed by Sam Shapiro and Mark Abramowicz.¹

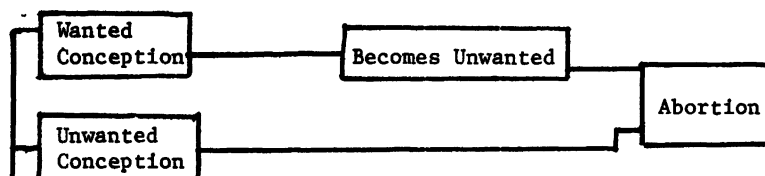
Pregnancy can be analyzed along a trajectory that contains alternatives. A pregnancy can be wanted or not at the time of conception, but later a wanted pregnancy can become unwanted if the woman or the family have reverses, and an unwanted one can be adjusted to in some favoring circumstances. Abortion, fetal loss, infant death, and survival with or without good health are further possible points or states on the trajectory. Abortion services provide a pragmatic test of "wantedness" - were the services used or not? At the same time, abortion, reflecting absence of perfect contraception, is viewed as a negative outcome even though superior to completion of an unwanted pregnancy. Subfecundity must also be considered. It is present in persons who choose to remain single or do not find marriage partners but is usually revealed and measured as couples attempt contraception. Reproductive efficiency should be measured even for unwanted pregnancies because of the possibility of handicapping conditions with monetary and non-monetary burdens to the parents.

The selection of an end point for evaluating survival is another major aspect of defining RE. Live birth is inadequate because of the heavy risks of the neonatal period. Neonatal deaths are believed to be related to genetic factors and the events of the pregnancy and post-neonatal deaths to the risks of living and the influence of environment. Although the latter type of death is less likely than the former, both should be included as adverse outcomes of pregnancy because the risk of death is high in the whole first year of life. After one year, the end point is debatable as the death rate declines and the possibility of compensating for an adverse event by a replacement birth also declines. Survival to adulthood although not an unreasonable endpoint involves a social definition of adult status and a weak connection with any replacement decisions within the individual family. We focus on events associated with pregnancy and early infancy, some of which are affected by birth timing, and include all outcomes that incur medical services and costs and do not result in a healthy surviving child; congenital conditions not manifest at birth can be handled by retrospective correction.

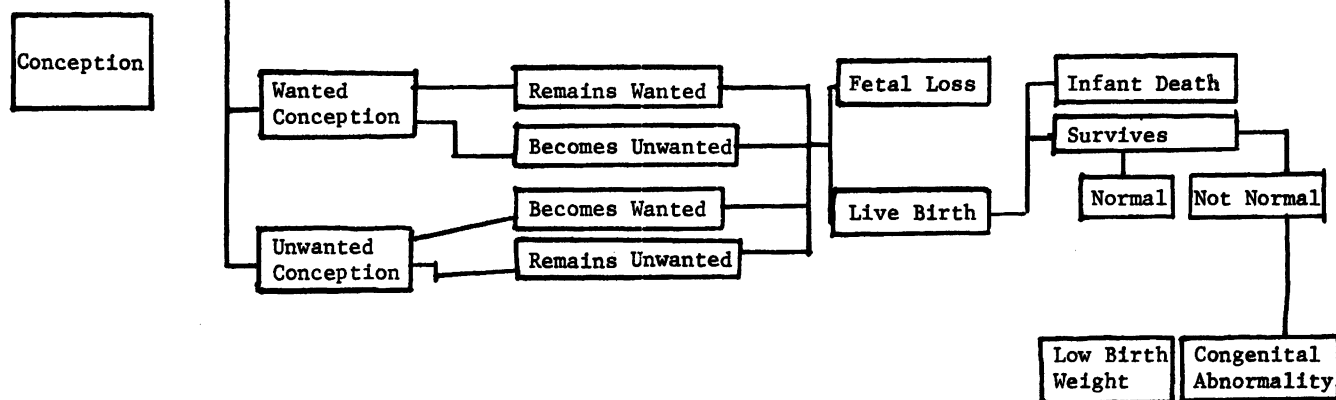
The criteria for including various events in reproductive efficiency include: 1) the possibility of being affected by social and health policy, 2) severity (reduced life expectancy and probability of optimal health) and 3) costliness, meaning both for health services and for educational and child care. Maternal morbidity should be included although inadequately measured today. Individual RE may not agree with social RE in that low aggregate fertility can stabilize population while leaving unwanted births and uncorrected disutility.

Trajectory of a Single Pregnancy

A. Pregnancy Ending in Abortion



B. Pregnancy Not Ending in Abortion



However, social concern with proper child development for the assumption of adult roles (and with reduction of poverty) brings about an interest in individual reproductive success.

Objections have been raised to an aggregate measure of RE on the grounds that adverse outcomes have heterogeneous causes, requiring varied control measures, and that they have heterogeneous consequences, some of greater seriousness for health and welfare than others. However, heterogeneous causes are implicated within such individual variables as infant deaths and low birth weight. Moreover, disagreement over program emphasis is not prevented by refusal to aggregate. In fact, various adversities share the use of health services and can be compared in terms of medical care costs (or in terms of influence on personal and community fertility).

The measurement problems in constructing an index of RE arise from data limitations. It is not possible to start with a defined sample of pregnancies and follow it prospectively through the first year after birth, correcting for overlapping incidence of adversities in one child. Dependence on retrospective studies involves: 1) population losses such as the sub-fecund, attrition within a cohort

before reproductive age, and ill-recalled or concealed fetal losses and abortions. In addition, dependence on medical care records introduces difficulties. Many fetal losses go unnoticed or unreported, and birth certificate recording of congenital abnormalities is poor - only 18.2 percent of anomalies, and only 39 percent of major ones, shown in hospital records were also found in birth certificates in an Iowa study.² Apgar³ scores are often not recorded, especially in non-teaching hospitals⁴, and entry of birth injuries is variable too. Additionally, duplications (babies with congenital defects who also have low birth weight⁵, or die) occur when separate series are used as data sources. Another measurement problem arises when actual RE is compared with some standard of desired performance: selecting the "right" group with a minimum observed rate for some given adverse outcome. Legitimate pregnancies have an advantage based on several socio-economic, age, and health care factors.⁶

One way of dealing with measurement problems is to try alternative assumptions and compare the resulting index values. Additional investment in data recording (e.g., Apgar scores) data coordination (to reduce duplications), and

special surveys could raise the level of reliable information. Input criteria of an index⁷ include, in addition to data availability, scaling characteristics and common denominality. For RE, these are largely satisfied by the unifying concept of pregnancy wastage, the fact that zero wastage is included in the scale, and the fact that numerical reckoning is possible. Heterogeneity can be dealt with by applying economic weights. RE can satisfy output criteria of an index - comprehensiveness and specificity - in that 1) it covers a broad range of significant health conditions while 2) lending itself to condition-specific analysis. It is sensitive to changes in the health of a population over time and is, in our view, relevant to allocation of resources.

The National Natality Survey conducted by the National Center for Health Statistics was used for estimating reproductive efficiency for the entire United States in the 1960's. Far from an ideal data source for the purpose, it nevertheless did give an overview of various components of reproductive loss in a large population of women - all those with legitimate live births in 1964-66. The sample consisted of 10,395 mothers. The data limitations (resulting in understatement of pregnancy wastage) revolved around omission of illegitimate births, pregnancies not terminating in a live birth, abortions, women who had completed childbearing earlier, and cases of infertility. Two known biases, an underestimate of congenital abnormalities and duplication of low birth weight and infant deaths, were corrected by using data from a Health Insurance Plan (New York) study and from the National Center for Health Statistics. Also, an estimate for omitted fetal deaths was introduced based on the fetal death rate for past pregnancies of sample mothers.

The result of the computations was that 74.5 percent of pregnancies had successful outcomes. Understatement of pregnancy wastage remains because of the data limitations that could not be corrected, in particular, on abortions, which were illegal at the time of the survey. The order of importance of the adversities was as follows: fetal deaths, congenital abnormalities, low birth weight and infant deaths.

Economic weights were applied to these adverse outcomes, based on fertility care prices in our study (C.M. and F.S.J.) in Jacksonville, Florida⁸. An infant death was priced at the cost of a pregnancy (\$850) with correction for additional hospital care for the infants who require hospital services before death. Congenital abnormalities that survive are given a cost of a typical corrective surgical operation (\$1050) plus a modest sum for extra costs in childhood for a portion of the group (prorated, this is \$1000 per case). Prematurity costs based on actual hospital utilization amount to \$850. In estimating costs of a fetal loss, probabilities and costs of early fetal loss and of stillbirths are combined to arrive at \$254 as the average cost. The economic weights result in a 128 percent increase in the

importance of congenital abnormality and a shrinkage in fetal deaths from 48 percent to 14 percent as a share of all measured adverse outcomes. In all, the negative outcomes' cost equals 30 percent of the cost of 100 "good" births (Table 2) (\$35,541 compared with \$85,000). If abortions occur at the rate of 400 per 1000 live births, 22 percent is added to the cost of adverse outcomes.

Such estimates should become far more satisfactory in the future as data from the National Survey of Family Growth provide a measure of total gravidity and associated health care. However, even this valuable survey activity still omits certain needed data, such as pregnancies terminating before marriage, experience of the unmarried, congenital abnormality detail, and a comprehensive statement of maternal morbidity.

The improvement of reproductive efficiency depends on measures to deal with teenage pregnancy and illegitimacy,⁹ high-parity births and pregnancies in women over 35, obstetrical and neonatal services in underserved areas, etc. Successive increments may be progressively more expensive to achieve. In estimating cost effectiveness of programs being considered, full resource cost for present adverse outcomes should be taken into account. Society may have to choose between policies of raising the national average of RE or reducing the variance - the contrast in performance between variously advantaged and disadvantaged groups.

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TABLE 1
Second Computation of Reproductive Efficiency

Type of Adverse Outcome and Method of Deriving Estimate	Number	Percent of Adverse Outcomes (34,332 Pregnancies)
A. Fetal Deaths		
1. Previous pregnancies (reported)-NNS tape	3515	36.1%
2. Current pregnancies (computed)-NNS tape		
Ever live born 29,637		
Fetal deaths 3,515		
Pregnancies of NNS mothers 33,152		
Rate of FD 11.9%		
Current pregnancies US 1964-66 if FD = 11.9% (10,395+FD)	1180	12.1%
Where 10,395 pregnancies make = 11.9% (11,575)		
B. Congenital abnormalities - HIP Study		
7% of all pregnancies 33,152 reported by NNS mothers	2403	24.7%
+ 1,180 assigned FD (Step A)		
34,332 total pregnancies		
C. Low birth weight-NNS tape LBW Pregnancies		
6.8% applied to live births 707 10,395 (current)		
1309 19,242 (previous)	2016	20.7%
D. Infant Deaths-MVSR, using NNS-NIMS data ¹⁰		
23/1000 live births, or 682	624	6.4%
Less overlap with LBW - 58		
Total Adverse Outcomes	9738	100.0%
Total Pregnancies 34,332		
Less adverse outcomes - 9,738		
Net "good" births 24,594		
Reproductive efficiency 74.5%		

TABLE 2
Adverse Outcomes Weighted by Health Care Costs

Type of Adverse Outcome	Percent of Adverse Outcomes	Health Care Cost Per Case	Aggregate Cost in 100 Adverse Outcomes	Percent of Aggregate Cost
Fetal Deaths	48.2%	\$ 254	\$12,243	13.6%
Congenital Abnormalities	24.7%	2,050	50,635	56.3%
Low Birth Weight	20.7%	1,000	20,700	23.0%
Infant Deaths	6.4%	1,000	6,400	7.1%
Total	100.0%		\$89,978	100.0%