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# **An Epidemiologic Approach to Reproductive Health**

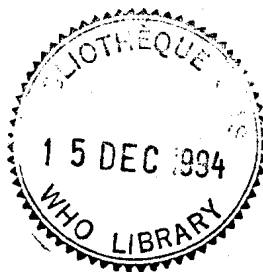
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**Editors**

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**James E. Higgins, PhD**, Director of Biostatistics and Quality Assurance, Clinical Research International, Research Triangle Park, North Carolina. Dr. Higgins collaborated with Dr. George Rubin to plan the present version of the manual. Using published reports, he developed many of the examples that are used in the present text and workshop. His extensive contributions and revisions produced the reference-like format and the self-help approach to learning epidemiologic research design and methodology. Dr. Higgins provided technical review of the present materials.

**George L. Rubin, MBBS, FRACP**, Director, Epidemiology and Health Services, Evaluation Branch, Department of Health, New South Wales, Sydney, Australia. Dr. Rubin was instrumental in developing and contributing to the first versions of the manual. Together with Christine Zahniser and Dr. Roger Rochat, he developed the manual and workshop for the first regional workshops. He collaborated with Dr. Higgins to plan the present version of the manual. Many of the examples incorporated in the present text and workshop were developed by Dr. Rubin from published reports.

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## Preface

This manual has been prepared for clinicians, researchers, public health professionals, and other personnel who wish to conduct epidemiologic studies of reproductive health issues. It is intended to be used in a two-week workshop that includes an introduction to epidemiologic methods, the unique applications of these methods to reproductive health research, and the development of research proposals. The manual is not intended to replace the many excellent resources and texts presently available on these subjects. Course participants use the teaching materials to develop research proposals about reproductive health problems that are of interest to them or to the organizations they represent. Representatives from funding agencies attend the final session of the workshop to observe presentations of the research proposals prepared during the workshop and to make recommendations about further development of the projects and possible funding.

The evolution of this workshop and manual has been extensive. Many organizations and individuals have contributed to this project over a long period of time. In November 1980 while working in Asia, Drs. Linda Atkinson and Oscar (Bud) Harkavy, Program Officers at the Ford Foundation, and Dr. Roger Rochat from the Centers for Disease Control (CDC) discussed the need to support capacity-building in epidemiologic research in developing countries, particularly in the area of contraceptive safety (broadly defined to include the health consequences of not contracepting as well as maternal mortality). Discussions with health personnel at The United States Agency for International Development (USAID) (Jim Shelton, Tony Boni), the Ford Foundation (Lincoln Chen, Tony Measham), the Population Council (Jarrett Clinton), and the International Development Research Council (Marjorie Koblinsky) provided the impetus to increase the number and quality of contraceptive safety studies being implemented internationally. Training in epidemiology, research methodology, and proposal development were used to accomplish this objective. As a result, five contraceptive safety workshops were developed for presentation in Southeast Asia.

These first workshops were a collaborative effort by the Division of Reproductive Health at CDC, the Population Council, and the Ford Foundation. The objectives for these first workshops included the following:

- To increase the knowledge of health professionals in Southeast Asia about the principles of epidemiology.
- To assist workshop participants in developing research proposals for conducting contraceptive safety studies.
- To increase the number and quality of epidemiologic studies on contraceptive safety conducted in Southeast Asia.

Each of the first five workshops was scheduled to last one week. Didactic sessions and group exercises were the primary approaches used for the

presentation of materials. To supplement the lecture materials, a training manual was developed and included information on the principles of epidemiology and research design, examples of epidemiologic studies from the literature (from Southeast Asia whenever possible), case studies, and practice exercises. Other teaching materials included epidemiology textbooks, statistical monographs, and publications from the medical and epidemiologic literature on contraceptive safety. Participants worked in groups of 4 to 8 persons to develop research proposals on studies of contraceptive safety. The research proposals were presented on the last day of the workshop to a panel of health professionals familiar with contraceptive safety concerns in the region. Feedback was provided by the panel regarding the relevance of the problem selected, the suitability of the selected study design, and the feasibility of implementing the study. These presentations helped to formalize the learning experiences of the participants from the workshop and to publicize to potential funding agencies the research hypotheses and methodologies for contraceptive safety studies that the participants hoped to eventually conduct.

To evaluate the success of the workshop and to help the workshop participants assess their progress during the workshop, tests on the principles of epidemiology were administered on the first day and last days of the workshop. The same test was administered on both days. In general, test scores at the conclusion of the workshop were approximately twice as high as test scores on the pretest.

The first workshop was planned and developed during the summer of 1981 by George Rubin (CDC) and Christine Zahniser (CDC) and conducted on September 21-28, 1981, in Bangkok, Thailand. Andrew Fisher (The Population Council) managed the logistics, including the selection of the workshop participants. David Brandling-Bennett from the World Health Organization (WHO), Andrew Fisher, George Rubin, and Christine Zahniser were workshop instructors. The first workshop trained 12 workshop participants from four countries in Southeast Asia. Three additional workshops were conducted in Bangkok during February 1982, October 1982, and March 1983; additional instructors from CDC included Carlos Huevo and Peter Layde.

After the first Bangkok workshop, CDC received a request for a national workshop in Bangladesh. This workshop was a collaborative effort by CDC, the Program for the Introduction and Adaptation of Contraceptive Technology (PIACT), and The Population Council/International Center for Diarrhoeal Disease Research. David Grimes and Christine Zahniser conducted the first national workshop in Dhaka, Bangladesh, in March 1982. Atiqur Rahman Khan (PIACT), a regional resource person for the September 1981 workshop in Thailand, and Yusef Choudhury (PIACT) arranged the Bangladesh workshop. PIACT received grant monies from the Ford Foundation for contraceptive safety research in Bangladesh that ultimately were used to support research initiated during the workshop.

The series of national workshops in Bangkok stimulated substantial interest among the participants, private organizations, and government organizations such as USAID, WHO, the Ford Foundation, the Population Council, and the

Johns Hopkins Program for International Education in Gynecology and Obstetrics (JHPIEGO) for conducting additional workshops. Furthermore, the newly developed technical expertise of selected participants proved useful for implementing research and future workshops.

Beginning in 1983, Family Health International (FHI) provided technical assistance to an epidemiologic training program implemented by the Instituto de Investigacion Cientifica of the Universidad Juarez, Durango, Mexico. With support from FHI and the United Nations Family Planning Assistance (UNFPA), the Instituto trained and funded investigators from Mexico and other countries in Latin America to conduct epidemiologic studies of reproductive health issues. The training was provided annually to approximately 10 students during a three-week workshop in Durango. Materials used in the workshop evolved from those developed by the Division of Reproductive Health at CDC and were prepared in a self-instructional format in both English and Spanish.

As an outgrowth of the epidemiology training program supported by FHI and UNFPA at the Instituto, the Mexican Interuniversity Group for Epidemiologic Research in Reproductive Health (GIMIESAR) was formed in 1984. GIMIESAR is based in Durango and includes representatives from Mexican universities and medical schools who received training in the Durango workshops. GIMIESAR has embellished the training materials originally developed in collaboration with FHI and has been responsible for organizing and presenting the annual workshop since 1985. Later workshops were coordinated by the Mexican Institute of Social Security (IMSS), WHO, and CDC and were conducted during March and November 1990. Jose Becerra, Daniel Hernandez, Octavio Mojarro, Holly Shulman, and Phyllis Wingo from CDC were workshop instructors.

The first regional workshop in Africa was conducted in Mombassa, Kenya, in 1983 by Ronald Burkman, Michael Dalmat, David Grimes, Peter Lampthey, Japheth Mati, Hamid Rushwan, and Kenneth Schulz. For this workshop, the instructional materials were expanded to include randomized clinical trials, surveys, and sample size and power estimation. The length of the workshop was extended to two weeks, a recommendation that had been made during the Southeast Asia workshops. JHPIEGO managed the administrative functions for this workshop and paid all participant costs. Representatives from potential funding agencies participated in a grant application review process during the last two days of the workshop, and three research projects were funded. The results of a randomized clinical trial of the efficacy of prophylactic antibiotics administered when an intrauterine device was inserted were recently published. The need to train additional reproductive health professionals resulted in a national workshop conducted in 1985 by Barbara Janowitz, John Repke, George Rubin, Kenneth Schulz, and Charles Warren.

Another regional workshop in Africa was sponsored by the Special Programme on Human Reproduction (WHO) and was conducted in Yaounde, Cameroon, in September 1987 by Robert Anda, Nancy Binkin, Barbara Maciak, and Phyllis Wingo. Boniface Nasah (Centre Universitaire pour la Science et la Sante and Centre Hospitalier Universitaire) facilitated the presentation of the workshop.

The collaboration among CDC, FHI, and WHO that resulted in the preparation of the present version of the manual evolved from this workshop. Carol Hogue supported the completion of this project through steady encouragement and the provision of program resources and protected time.

The first national workshop in China, a collaborative effort between the CDC and the Beijing Medical College, was conducted in October 1983 by Charles Chen, Carol Hogue, George Rubin, and Roger Rochat. A participant at the fourth regional workshop in Thailand, Qiao Geng-Mei (Beijing Medical University), was instrumental in arranging the first China workshop. The second workshop in China was requested through WHO and conducted by Jonathan Liff, Wong-Ho Chow, Raymond Bain, and Roger Rochat from Emory University, Atlanta, Georgia, in 1986. For both workshops, the manual was translated into Chinese. All lectures were conducted in English and simultaneously were translated into Chinese.

The first national workshop in Indonesia was coordinated by the Indonesian National Family Planning Board (BKKBN), Yayasan Kusuma Buana (YKB), the Ford Foundation of Indonesia, and the CDC. The workshop was conducted in January 1987 by Nancy Lee, Edmond Maes, and Phyllis Wingo. An Indonesian researcher, Joedo Prihartono (YKB), a participant at the first regional workshop in Thailand, arranged for the participants to attend the workshop and managed the administrative functions of the workshop. The manual was translated into Bahasa Indonesian. The proposal to conduct a case-control study of the possible association between hepatocellular adenoma and the use of oral contraceptives received funding for further development. Although participants ultimately established a surveillance system for identifying biopsy-proven cases of hepatocellular adenoma, the case-control study has not yet been implemented.

A total of 14 workshops have been conducted in eight countries during 1981-1990, including six regional and eight national workshops. More than 300 clinicians, researchers, and public health professionals have participated. CDC continues to receive requests for regional and national workshops on epidemiologic approaches to reproductive health. This training program should complement the Field Epidemiology Training Program supported by CDC and WHO as well as the training program for clinicians that is supported by The Rockefeller Foundation. The paucity of medical and epidemiologic literature on reproductive health issues in developing countries indicate that this training program is unique in at least three aspects:

- This program lasts two weeks while most epidemiology training programs last 6 months to 2 years.
- This program provides the training in the developing countries whereas most other programs provide training at institutions in developed countries. Conducting short-term workshops in reproductive health epidemiology at regional or national levels may allow a greater number of individuals to benefit from this training.

- When representatives from funding agencies attend the presentations of the proposals developed during the workshop, workshop participants have the opportunity to obtain funding to conduct their research.

Roger Rochat  
Phyllis Wingo  
Christine Zahniser

April 30, 1991



# 1 Reproductive Health Epidemiology

## Introduction

This workbook is designed to train public health professionals to use epidemiologic methods to answer questions about reproductive health. It serves as the text for the Centers for Disease Control, Family Health International, and the World Health Organization's Reproductive Health Epidemiology Workshop and should provide the user with the necessary skills to develop a protocol for conducting epidemiologic research. Specific skills include basic quantitative measures used in reproductive health epidemiology, epidemiologic study design (descriptive and analytic), sample size and power estimation, survey sample design, and scientific statements of research questions and hypotheses.

Epidemiology can be defined as the study of patterns of human diseases, health, and behaviors. Epidemiologists answer research questions by classifying individuals into one or more discrete groups and assessing the differences between these groups.

Reproductive health epidemiology applies this system of study to questions about maximizing the reproductive health of men and women. Human reproductive health begins with sexual growth and development that is manifest at puberty, continues throughout life for men, and ends at menopause for women. Reproductive health is influenced by fertility and by decisions related to sexual activity, pregnancy, and contraception.

## History

### Origins of Reproductive Epidemiology

Reproductive epidemiology dates back to 19th century Vienna when Ignaz Semmelweis discovered that deaths from puerperal (childbed) fever were higher among women whose babies were

*Scope of Study*

*Epidemiology defined*

*Reproductive health epidemiology*

*Early Advances*

delivered in the hospital by medical students than among women whose babies were delivered by midwives. He correctly attributed this difference to the midwives' practice of washing their hands between deliveries (MacMahon and Pugh, 1970).

Modern reproductive epidemiology has evolved substantially during the 20th century. The advent of birth and death registries, which were established in the United States during the early part of this century and in Europe during the 18th and 19th centuries, gave health officials a means of identifying risk factors for maternal and infant mortality. Public health measures could then be designed to reduce these factors. For example, milk stations, which provided milk to nursing mothers, were established when a relationship was found between infant mortality, sanitation, and nutrition (Holland et al., 1984). This and similar measures led to a 95% decrease in maternal mortality in the United States from 1915 to 1965 (Hogue CJR, personal communication). In Sweden, the infant mortality rate declined from 200 deaths per 1,000 live births in the 1750s to less than 20 per 1,000 in the 1950s (United Nations, 1963).

### **Influence of Demography and Epidemiology**

*Stages of demographic transition*

Reproductive epidemiology also has origins in demography, a discipline that evolved during the 19th century from studies of parish registries in England. Historical changes in the population (demographic transitions) and related changes in the patterns of health and disease (epidemiologic transitions) directly affect mortality, fertility, birthrates, and other measures of reproductive health. These changes also affect the health and status of women, children, and the family.

The original theory of demographic transition (Notestein, 1945) describes three stages of population growth that accompanied economic development in Western countries.

***High growth potential.*** During this stage, rates for births and deaths, although high, are at similar levels, so population growth is minimal. If mortality were to decline at this stage without a concurrent decline in fertility, the size of the population would increase rapidly.

**Transition.** This stage begins with a decline in mortality while fertility remains high, and shifts to a decline in fertility until both rates are at similarly low levels. During the first part of this stage, the high growth potential is realized; during the latter part, population growth declines.

**Incipient decline.** During this final stage, rates for births and deaths are at low and relatively stable levels. Sometimes, however, fertility rates decrease to levels lower than death rates and produce a decline in population.

Although demographic transition provides a perspective for interpreting historical changes in Western populations, the theory does not completely describe or explain patterns of population change in non-Western societies or those in developing countries where external factors have affected a dramatic decline in the mortality rate without a concomitant decline in the birthrate (Hauser and Duncan, 1959; Notestein and Segal, 1963).

Epidemiologic transition theory describes changes in patterns of health and disease by focusing on mortality and fertility rates and on the interaction of social, economic, demographic, and health variables (Omran, 1974). The three stages of epidemiologic transition parallel and influence the three stages of demographic transition.

**Age of pestilence and famine.** During this stage, the prevalence of endemic diseases is high, nutrition is poor, and infectious diseases and famine are rampant. The rates for births and deaths are high, and population growth minimal. Extended family structures with large family size, multiple-generation households, and home-centered lifestyles are dominant. Women function as mothers with no rights or responsibilities outside the home (Omran, 1974).

**Age of receding pandemics.** At this stage, disease and famine decrease, mortality rates decline, birthrates increase, and populations grow. Large extended families are predominant, especially in rural areas, but nuclear family units become more common in urban centers. Women begin to become involved in activities outside the home (Omran, 1974).

*Stages of  
epidemiologic  
transition*

*Age of degenerative and man-made diseases.* During this period, social, economic, and environmental conditions improve; infectious diseases and conditions related to poor nutrition decline. Birth and death rates are low, and population size is stable. Chronic diseases (e.g., cardiovascular disease, cancer, stroke, diseases caused by occupational exposures, etc.) are the primary causes of death. Small nuclear families become the norm. *Women are increasingly emancipated from traditional roles and become better educated and more career-oriented* (Omran, 1974).

## Status Of Reproductive Health

Substantial variation in maternal and infant mortality rates exist throughout the world today. Among the ten most populous countries, maternal mortality rates vary from 1,500/100,000 live births to less than 15/100,000 live births, a 100-fold range. Infant mortality varies from 140 to 5 per 1,000 live births (Table 1.1).

In the United States, epidemiologists are seeking explanations for the diminishing decline in U.S. maternal and infant mortality rates, while these rates continue to decrease in other developed countries. They are also concerned about the excess mortality among minorities in the United States. For example, infant mortality is twice as high among blacks as among whites, and maternal mortality is more than two times higher among black women than among white women (Hogue et al., 1987; Rochat et al., 1988).

Population growth rates also vary considerably. At the current rate of growth, three of the ten most populous countries—Bangladesh, Nigeria, and Pakistan—will double in population in less than 30 years (Hatcher et al., 1989). By comparison, the two most populous countries with the lowest growth rates—Japan and the United States—will double in 133 and 99 years, respectively. In Nigeria and Bangladesh, the two countries with the highest total fertility rates, births per 1,000 females aged 15 to 19 years exceed 200.

In the ten most populous countries, the prevalence of contraceptive use among married women aged 15 to 44 years varies from less than 10% to more than 80% (Hatcher et al., 1989). In all but one of these countries, 10% or fewer of the couples of reproductive age use condoms, which provide both contraception and protection from HIV and other sexually transmitted infections.

**Table 1.1**  
**Reproductive Health Around the World**

	Population Estimate Mid-1988 (in millions)	Crude Birth Rate (births per 1000 population)	Crude Death Rate (deaths per 1000 population)	Natural Increase (births minus deaths per 1000 population)	Years for Population to Double (at current rate of increase)	Total Fertility Rate (TFR) (if children per woman by age 15)	% Decline in TFR 1970-75 to 1985-90	Infant Mortality Rate (per 1000 live births)	Maternal Mortality Rate (deaths in maternal deaths per 100,000 live births)	Life Expectancy at Birth - 1988 (in years)	Human Suffering Index <sup>1</sup> (maximum score = 100)	Status of Women <sup>2</sup> (maximum score = 100)
China	1087	21	7	1.4	49	2.1	55	44	44	66	50	58.5
India	817	33	13	2.0	35	3.7	31	101	400-500	54	61	43.5
U.S.S.R	286	20	10	1.0	68	2.4	0	25	..	69	19	77.0
United States	246	16	9	0.7	99	1.9	5	11	14	75	8	82.5
Indonesia	177	27	10	1.7	40	3.5	36	88	357-800	58	62	46.5
Brazil	144	28	8	2.0	34	3.5	26	63	87-154	65	50	54.5
Japan	123	11	6	0.5	133	1.8	14	5	16	78	11	68.5
Nigeria	112	46	17	2.9	24	7.1	0	124	1500	47	80	29.0
Bangladesh	110	43	17	2.7	26	5.5	21	140	623	50	79	21.5
Pakistan	108	43	15	2.9	24	5.3	18	125	400-600	54	73	28.0
Mexico	84	30	6	2.4	29	4.0	38	50	92	66	47	61.5
United Kingdom	57	13	12	0.2	408	1.8	14	9	12	75	12	74.5
Egypt	53	38	9	2.8	24	4.3	22	93	269	59	55	38.0
Turkey	53	31	9	2.2	32	3.7	33	92	207	63	55	52.5
World	5128	28	10	1.7	40	3.3	25	81	390	63	55	..

(Source: Hatcher et al., 1989)

Table 1.1 (continued)

	Percent Couples of Reproductive Age Using												
	% Married Women Ages 15-44 Using Any Method of Birth Control	Pills	IUDs	Female Sterilization	Male Sterilization	Condoms	Injectables	Withdrawal	Natural Family Planning	Vaginal Methods	Other Traditional	Access to Birth Control (maximum score = 100)	
<b>China</b>	81	5	32	30	9	3	—	—	—	1	1	84	
<b>India</b>	39	5	4	26 (combined)		4	—	—	—	—	..	64	
<b>U.S.S.R</b>	75	..	..	..	..	..	..	..	..	..	..	..	
<b>United States</b>	68	14	5	17	11	10	—	1	3	7	..	83	
<b>Indonesia</b>	46	14	13	3	—	2	10	..	..	4	..	67	
<b>Brazil</b>	65	25	1	27	1	2	—	5	4	1	..	56	
<b>Japan</b>	64	1	4	8	3	43	—	1	4	..	1	63	
<b>Nigeria</b>	5	1	1	—	—	—	—	—	—	—	3	21	
<b>Bangladesh</b>	25	5	1	8	2	2	1	1	4	—	1	64	
<b>Pakistan</b>	8	1	1	2	—	2	1	1	—	—	—	29	
<b>Mexico</b>	53	10	11	19	1	2	3	..	..	..	8	72	
<b>United Kingdom</b>	83 <sup>3</sup>	24	7	14	14	17	—	6	2	3	—	97	
<b>Egypt</b>	30	17	8	2	—	1	—	—	1	1	1	37	
<b>Turkey</b>	62	9	9	1	—	5	—	30	1	3	3	39	
<b>World</b>	51	7	10	13	5	5	1	4	4	1	1	..	

Table 1.1 (continued)

	Status of Abortion I - V	Abortion		Breastfeeding			Adolescent Pregnancy & Determinants			
		# of Abortions per 1000 Live Births	% Children Ever Breastfed	% Breastfeeding at 3 Months	% Breastfeeding at 6 Months	Births per 1000 Females Ages 15-19	Singulate Mean Age at Marriage for Females	% Females Marrying Before Age 20	% Females Ages 15 and Over Enrolled in Secondary School	% Females Illiterate Ages 15 and Older
<b>China</b>	I	490	..	56	55	12	23	4	35	34
<b>India</b>	II	247	98	90	79	41	19	57	20	25
<b>U.S.S.R.</b>	I	2080	..	..	..	16	..	27	77	2
<b>United States</b>	I	422	58	36	22	53	22	8	92	1
<b>Indonesia</b>	IV	..	97	93	92	31	16	37	24	42
<b>Brazil</b>	IV	250- 1200 <sup>s</sup>	91	56	31	81	22	18	35	28
<b>Japan</b>	II	382- 1492	75	..	..	3	25	1	93	1
<b>Nigeria</b>	III	..	100	100	89	213	19	44	16	77
<b>Bangladesh</b>	III	45	99	98	97	237	16	63	6	87
<b>Pakistan</b>	III	..	97	..	91	141	21	38	7	87
<b>Mexico</b>	IV	..	87	78	52	80	18	19	49	..
<b>United Kingdom</b>	II	223	51	15	9	28	23	5	84	..
<b>Egypt</b>	III	..	95	91	86	99	21	22	45	75
<b>Turkey</b>	I	256	90	83	53	67	18	16	28	..
<b>World</b>		300- 500	..	..	..	..	..	..	..	..

These data highlight the urgent need worldwide for improved family planning and maternal and child health services. The availability of existing contraceptives should also be improved, and new methods should be developed and tested. Epidemiologic research has an important role in improving each of these areas.

## Uses of Epidemiologic Methods in Reproductive Health Practice

*Testing, intervention, and evaluation*

Epidemiologic methods are used to define reproductive health problems, to elucidate the causes of these problems, to test interventions, and to evaluate programs (Table 1.2). Problem definition involves describing the population affected, the etiology of the health problem, identifying the alterable risk factors, and conducting ongoing surveillance to detect trends in the problem. Reduction of risk factors through intervention depends on accurate assessment of the comparative safety and efficacy of proposed interventions and treatments. Analytic epidemiology is used to test such interventions. Epidemiologic methods and results are used to assess whether a program is based on the appropriate interventions and treatments and whether the interventions and treatments are being properly used. Cost-benefit analysis is applied to determine whether interventions make the best use of available resources.

### Example 1

*Shunyi Risk Approach Project in Perinatal Health*

The Shunyi Risk Approach Project in Perinatal Health (Yan et al., 1989), which was conducted in Shunyi County, People's Republic of China, shows how epidemiologic methods are applied to problem definition, intervention and testing, and program evaluation. The project used the *risk approach* in an attempt to improve perinatal health services. It began in 1983 and continued for five years.

**Problem definition.** Investigators collected data on 1,914 pregnant women and their 1,928 infants, and on 50 cases of perinatal mortality. Among other problems, the investigators found that 151 per 1,000 women suffered from hypertensive disorders during pregnancy, and 1 per 1,000 suffered from eclampsia. The perinatal mortality rate for

the infants born to these women was elevated. For example, the perinatal mortality rate for infants born to women who experienced mild to severe hypertension that improved during pregnancy was 4.6 per 1,000 deliveries, or more than twice the rate for pregnancies uncomplicated by these disorders. The rate for infants born to women with hypertensive disorders that worsened or remained severe throughout pregnancy was 10.8 per 1,000 deliveries.

Table 1.2

## Uses of Epidemiologic Methods in Reproductive Health Practice

<u>Uses</u>	<u>Problems Addressed</u>
Problem definition	Population affected Risk factor identification Surveillance
Intervention and testing	Comparative safety of treatments Comparative efficacy of treatments
Program evaluation	Risk approach Cost-effectiveness

**Intervention and testing.** To reduce the incidence of pre-eclampsia, eclampsia, and perinatal mortality associated with hypertensive disorders of pregnancy, the investigators initiated a number of interventions in 1985. They educated patients about the need for rest, proper nutrition, and the signs and symptoms of eclampsia. High-risk women were informed about the need for weekly or biweekly blood pressure measurements. The investigators also provided training to health care providers and taught village doctors to measure blood pressure and to check their equipment. Practitioners in the township hospital were taught how to diagnose and treat hypertensive disorders, to make proper referrals to the county hospital, and to follow a set protocol for monitoring all pregnant women.

**Program evaluation.** The investigators conducted epidemiologic surveillance to assess the impact of these interventions. From

1984 to 1986, the incidence of preeclampsia and eclampsia decreased from 1.8% to 0.4%, and the perinatal mortality rate for pregnancies complicated by these disorders declined from 10.8 per 1,000 deliveries to 0. The team of investigators concluded that the interventions had been highly successful in reducing maternal and infant morbidity and mortality related to hypertensive disorders of pregnancy.

### Example 2

*Surveillance  
of maternal  
smoking  
and  
pregnancy  
outcome*

Another example of epidemiologic problem definition and intervention is the surveillance of maternal smoking and pregnancy outcome and the study of effective smoking cessation programs.

**Problem definition.** Over the last three decades, a relationship between maternal smoking and pregnancy outcome has been established through numerous analytic epidemiologic studies. For example, MacMahon et al. (1966) reported that infants born to women who smoked were approximately 200 g lighter than infants born to nonsmoking women. Since then, virtually all studies of maternal smoking and birthweight have confirmed this finding. A dose-response relationship also exists between the number of cigarettes smoked and infant birthweight, regardless of gestational age at birth (Hogue et al., 1987). Descriptive epidemiologic studies have revealed that one in three women in the United States are smokers when they conceive, and one in four women continue to smoke throughout pregnancy (Prager et al., 1984). Worldwide, the prevalence of smoking among women varies considerably. In general, the prevalence of smoking increases with economic development. Using analytic epidemiology, Kleinman et al. (1988) estimated that 10% of infant mortality in the United States could be eliminated if maternal smoking were no longer a risk factor. In the United States, epidemiologic surveillance of maternal smoking has been conducted through the analysis of birth certificates in Missouri since 1979, through the Pregnancy Risk Assessment Monitoring System in six states since 1988, and in the future for all states adopting the revised birth certificate of 1989.

**Intervention and testing.** Experimental epidemiology has been used to test the effectiveness of smoking cessation counseling to help women who want to stop smoking and to assess the impact on

improved pregnancy outcome for women who do stop smoking. Well-conducted clinical trials have found that some women can stop smoking with counseling assistance. The results of these trials show that the birthweights of the infants born to women who stop smoking by the fifth month of pregnancy are similar to the birthweights of the infants born to women who never smoked during their pregnancy (Sexton and Hebel, 1984; Windsor et al., 1985).

*Program Evaluation.* Using analytic epidemiologic studies as the data source, Marks et al. (1990) estimated that a national smoking cessation program could save over \$5 in care for low-birthweight infants for every \$1 spent on the intervention, and that program costs would amount to \$69,542 for each of the 338 deaths prevented.

## **Scope of Epidemiologic Research in Reproductive Health**

Epidemiologists have conducted investigations into virtually every aspect of reproductive health, including sexual development, sexual activity, contraception, contraceptive methods, fertility, unintended pregnancy, induced abortion, maternal and infant morbidity and mortality, male and female problems with the reproductive tract, and the delivery of maternal and child health and family planning services. In this workbook, we have selected examples from epidemiologic studies that have been conducted in many countries to illustrate the usefulness of epidemiology in answering important public health questions on reproductive health issues. During the workshop, we will discuss this research to provide a framework for developing research protocols. The examples we provide should not be considered comprehensive or exhaustive because epidemiologic methods can be applied to many areas of human reproductive health.

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