

# MANUAL — OF — FERTILITY ANALYSIS

Arthur A. Campbell

Churchill Livingstone 

# Manual of Fertility Analysis

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# **Manual of Fertility Analysis**

### *Note*

The statistics which relate to the Federal Republic of Germany and the German Democratic Republic include the relevant statistics regarding Berlin, for which separate data have not been supplied. This is without prejudice to any question of status which may be involved.

Where the designation 'country or area' appears in the headings of tables, it covers countries, territories, cities or areas.

# Preface

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This volume, intended as a teaching aid for a wide spectrum of professions in the health field, statistics, and demography, has been made possible through the support of the United Nations Fund for Population Activities (UNFPA). A companion volume by Professor Hubert Campbell deals with Mortality Analysis.

This manual describes methods commonly used to measure and interpret trends and differences in the fertility of populations, assuming the availability of adequate data from birth registration systems, censuses, and sample surveys. A considerable body of literature already exists on methods of estimating measures of fertility for populations with incomplete or deficient data from registration systems and other routine sources. This field of demographic methodology is still developing as old techniques are refined and new ones are proposed.

Emerging awareness of the effects of fertility on social structure, economic well-being, and public health have given fertility and fertility-related issues a prominent place in the formulation of public policy. In some countries, this involves a concern for birth rates that continue at high levels in the presence of declining mortality, resulting in rapid population growth and consequent heavy strains on health services. In other countries, there is concern for fertility rates that are so low that populations have begun to decline or will soon do so. In either situation, it is essential that policies and programmes involving fertility or its presumed causes and consequences be based on appropriate and accurate measures of fertility, valid interpretations of trends and differentials in these measures, and reasonable conjecture about their future direction. This manual is intended to assist in attaining these objectives.

The primary purpose of this manual is to serve as a resource for training activities and refresher courses in health statistics sponsored by the World Health Organization. It is directed toward statisticians in public health programmes, health planners, health administrators, other health professionals, and government officials

who are or will be responsible for the analysis of national data on fertility. It may also be useful to students of biostatistics, epidemiology and demography as well as to others who wish to improve their understanding of techniques used to describe and analyse variations in fertility.

Bethesda, 1983

A.A.C.

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## Period measures of fertility

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### INTRODUCTION

Fertility measures describe various quantitative aspects of human reproduction. They include the volume of reproduction (as expressed by numbers or rates of live births in a given population or sub-group), the timing of reproduction (as expressed by lengths of inter-birth intervals, maternal ages at the delivery of births of different orders, etc.) and characteristics of births or of parents that aid our understanding of factors affecting trends and differentials in the volume and timing of fertility or of the health status of births in various populations (for example, marital status of the mother, birth weight of the child, proportion of multiple births, socio-economic characteristics of the parents, etc).

No single measure can express all quantitative aspects of human reproduction. Instead, there are many different measures, each suited to particular purposes, each possessing certain limitations. These various purposes and limitations must be clearly understood in order to avoid serious misinterpretations of trends and differences in various measures. The first two chapters of this manual describe these measures.

### DEFINITIONS

This manual deals primarily with the quantitative properties of live births, and only secondarily with the measurement of foetal and infant mortality. The latter topics are discussed solely in relation to their impact of numbers and characteristics of live births. A live birth, according to the definition accepted by the WHO, is a product of conception that shows any sign of life.

The term 'fertility' is used throughout this book to refer to measures associated with live births. In some contexts the word 'natality' is used in place of 'fertility,' although the meanings of the two words are identical. The term 'fecundity' is used to denote the

capacity to reproduce, rather than actual reproduction. These definitions were adopted in 1934 by the Population Association of America and have been perpetuated by the United Nations *Multilingual Demographic Dictionary*. In French, however, the term 'fecundité' refers to actual reproduction and 'fertilité' refers to potential reproduction. The cognates are also 'reversed' in Spanish.

There is a fundamental distinction between fertility measures that relate to the reproductive experience of a population in a given period of time, usually one year, called 'period' measures, and those that relate to the reproductive experience of women as they proceed through the childbearing years of life, called 'cohort' measures. The present chapter deals with period measures, and Chapter 2 describes various cohort measures.

## QUALITY OF DATA

Anyone wishing to compare fertility measures among countries, among population groups within the same country, or among various years within the same country must be aware of variations in the completeness with which births are counted, and of deficiencies in the population bases used to compute rates. In some countries the numbers of births from registration systems and populations from censuses are highly accurate — probably within 1 per cent of the actual numbers. In others, where registration systems are not yet well developed and censuses contain many inaccuracies, the number of registered births is well below the actual number of births and population bases may be either too high or too low, depending on the completeness of the count and on the extent to which ages are mis-stated. An approximate idea of the completeness of birth registration in various countries may be obtained from the United Nations *Demographic Yearbook*, which classifies countries according to the extent to which their births are registered. This source also indicates the extent to which census counts are regarded as complete.

## PERIOD MEASURES OF THE GENERAL LEVEL OF FERTILITY

### Introduction

As noted above, these measures relate to births occurring in a given population during a specified time interval, usually one year. They measure the volume of fertility during this time period only, without regard to the previous childbearing of women of reproductive age in the current population.

Rates and averages are shown variously, sometimes on a per 1000 women or per 1000 population basis and sometimes on a per woman basis. Generally, when the numerator of a rate is small in relation to the denominator, the rate is expressed on the basis of 1000 units of the denominator so that the value of the rate will be sufficiently large to show variations among different populations and different periods of time. When the numerator of a rate is a relatively large fraction of the denominator, the rate may be expressed either on the basis of 1 unit or 1000 units of the denominator, depending on customary usage.

### **Number of births**

The most elementary measure of the volume of fertility is the total number of births occurring during a specified time interval. This number may be very useful for planning purposes (e.g. to ensure the construction of adequate school facilities for future years) or for gross comparisons among various populations to indicate the probable future course of their relative population sizes. For example, in 1975 there were approximately 108 million births in economically developing countries, compared with 19 million in developed countries, a ratio of 5.7 to 1. Yet the population of the developing countries was only 2.5 times as great as that of the developed countries.<sup>1</sup> The comparison suggests that the future numerical imbalance between these two groups of countries will be considerably larger than it is now. Beyond such obvious purposes, however, the total number of births is not a useful analytical measure.

### **Birth rate**

The most frequently used measure of fertility is the birth rate; defined as the annual number of births per 1000 mid-year population. Recorded or estimated birth rates have varied from 10 to 60 births per 1000 population. Since 1960, birth rates have generally varied between 10 and 25 per 1000 in the more developed countries, and between 30 and 45 per 1000 in the less developed countries. Birth rates for a number of countries are shown in Table 1.1.

The birth rate is sometimes called the 'crude birth rate,' which indicates that it is not a refined measure of fertility. However, this measure serves one major purpose: it precisely describes the impact of fertility on population growth. Regardless of what other measures of fertility may show, it is essential to recognise that births are contributing a certain relative amount (whether 10 per 1000 or 40 per 1000) to population change in a country or population group.

The limitations of the birth rate arise from the fact that it does not relate the numerator (births) to the population 'at risk' — i.e.

**Table 1.1** Number of births, birth rates, and population: selected countries, 1973–1977. (Source: *Demographic Yearbook* 1977. United Nations, New York, 1978. Tables 3, 5, and 9.)

Country or area	Year	Number of births	Mid-year population	Birth* rate
Argentina	1973	561 500	24 720 000	22.7
Chile	1976	249 753	10 450 000	23.9
Costa Rica	1976	59 965	2 020 000	29.7
Egypt	1977	1 460 620†	38 740 000	37.7†
Germany, Federal Republic of	1977	582 944†	61 400 000	9.5†
Guatemala	1976	266 497†	6 260 000	42.6†
Japan	1976	1 832 617	112 770 000	16.3
Mauritius	1977	23 870†	909 000	26.3†
Poland	1977	663 000†	34 700 000	19.1†
Tunisia	1976	208 724	5 740 000	36.4
Union of Soviet Socialist Republics	1976	4 719 655	256 670 000	18.4
United States of America	1976	3 165 000†	215 140 000	14.7†

\* Live births per 1000 population

† Preliminary, approximate or estimated data

to the population eligible to have births — in so far as it does not measure the reproductive performance of the female population of reproductive age. Because the relative number of women of child-bearing age may vary widely among various populations, the levels of birth rates are determined, in part, by differences in age–sex distribution.

### General fertility rate

The first step toward more refined measures of fertility is represented by the general fertility rate, often known simply as the fertility rate. This is the annual number of births per 1000 women of childbearing age, that is, the ages between menarche and menopause during which conception is possible. It should be recognised that the initial and terminal ages may shift as the physiological condition of the female population changes. A decline in age at menarche (from average age 13.5 to 12.8) has been inferred from reports of women at ages 55–79 and 18–34 respectively, in the United States in 1960–62. The investigator reporting this finding and discussing other studies suggests that there is good evidence for a decline of about one year in age at menarche over a generation.<sup>2</sup> However, there is no firm evidence regarding any change in age at menopause.<sup>3</sup>

The age range chosen to define the denominator of the fertility

rate may be 10-49, as in the United Nations *Demographic Yearbook* for 1969 and earlier years, 15-44, as in the official statistics of the United States, or 15-49, as in Canada, many European countries, and the United Nations *Demographic Yearbook* for 1975. General fertility rates based on numbers of women 10-49, 15-49, and 15-44 are shown for selected countries in Table 1.2.

Even the general fertility rate is subject to the effects of different age distributions and, hence, may distort comparisons among countries. For example, relatively many women in the most fertile ages, 20-29, will tend to raise the general fertility rate.

### **Marital fertility rate**

This is the total number of births, regardless of legitimacy, per 1000 married women of reproductive age (10-49, 15-49 or 15-44, as variously defined). The marital fertility rate may help to control for the proportion of women who are married in comparisons of fertility levels for different populations or different periods of time. However, it is useful only when the populations or time periods under study have nearly equal or nearly constant proportions of illegitimate births. The legitimate fertility rate (p. 24) is a preferred measure of the reproductive performance of married women.

### **The relationship between the birth rate and the general fertility rate**

The mathematical relationship between the birth rate and the general fertility rate is simple. Where B is the number of births for a given year, P is the total population and F is the female population of reproductive age the birth rate

$$BR = \frac{B}{P} \times 1000$$

and the general fertility rate

$$GFR = \frac{B}{F} \times 1000$$

then

$$BR = GFR \times \frac{F}{P}$$

or, the birth rate is equivalent to the general fertility rate multiplied by the proportion of the total population composed of women of reproductive age. For example, if the general fertility rate is 80 and if women 15-44 years of age comprise 25 per cent of the total population, then the birth rate is  $20 = 0.25 (80)$ .



**Table 1.2** Number of births, female population aged 10-49, 15-49, and 15-44 and general fertility rates: selected countries, 1973 or 1974.  
(Source: *Demographic Yearbook 1975*. United Nations, New York, 1976. Tables 7 and 20.)

Country or area and year	Number of births	Mid-year female population aged			General fertility rate per 1000 women based on population aged		
		10-49	15-49	15-44	10-49	15-49	15-44
Costa Rica, 1973	53 455	563 733	427 823	396 073	94.8	124.9	135.0
Germany, Federal Republic of, 1973	635 633	16 843 700	14 478 900	12 446 200	37.7	43.9	51.1
Japan, 1974	2 029 989	34 247 000	30 303 000	26 701 000	59.3	67.0	76.0
Sweden, 1974	109 874	2 100 609	1 835 721	1 596 587	52.3	59.9	68.8
Tunisia, 1973	194 764	1 583 200	1 216 500	1 106 700	123.0	160.1	176.0