

The Quality of Infant Mortality Data in Eight East Asian and Latin American Societies, 1900-2000

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Web Appendix A1 to:

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Table of Contents

1. The Quality of Infant Mortality Data: General Considerations	1
2. Costa Rica	8
3. Chile.....	10
4. Argentina.....	13
5. Brazil.....	16
6. Taiwan.....	19
7. South Korea.....	27
8. Thailand	30
9. Indonesia	34
Works Cited	37

Most of the infant mortality data in Wealth, Health, and Democracy in East Asia and Latin America come from Kenneth Hill et al., Trends in Child Mortality in the Developing World (1999), or the World Bank's World Development Indicators (accessed August 2, 2008). The main exception is Taiwan, which at the time of this writing was not a member of the United Nations (the agency that sponsored the Hill et al. publication) or the World Bank. The Taiwanese infant mortality data in Wealth, Health, and Democracy in East Asia and Latin America come from island-specific sources.

The first part of this document describes how Hill et al. and the World Bank arrived at their infant mortality estimates. The second part explores the general strengths and weaknesses of three main types of data sources -- vital registration statistics, national census data, and sample surveys -- from which these compendia derived their estimates. The third part of the document picks up where the Sections 1 of Chapters 3-10 left off, providing a more thorough assessment of alternative infant mortality estimates for each of the eight societies. An associated web appendix (McGuireA2IMREstim.doc) compiles alternative estimates of the infant mortality rate in each society from 1960 to about 2000. The tables referred to below are in that associated web appendix.

1. The Quality of Infant Mortality Data: General Considerations

The United Nations in the early 1990s launched a systematic effort to compile and evaluate for 94 developing countries all sources of data from which national infant or child

mortality rates could be calculated or estimated.¹ The data came from three sources: vital registration statistics, national census data, or sample surveys. A "knotted" regression line was fitted to the disparate sources of data (giving less weight to sources deemed less reliable, and no weight to sources deemed unreliable), and projections were made for 1960 and 1995, as well as for every fifth intervening year. In 2004, researchers at UNICEF, the World Health Organization, the World Bank, and the United Populations Division formed the Inter-Agency Group for the Estimation of Child Mortality to combine the data collection resources of each agency and to coordinate and harmonize estimation methodologies, which were modeled closely on those used by the initial United Nations project of the 1990s. The estimates appear in the 2007 or later editions of UNICEF's State of the World's Children and the World Bank's World Development Indicators.² These estimates are used in most of the cross-national analyses in this book, as well as in the over-time analyses of infant mortality rates in Brazil, Indonesia, South Korea, and Thailand, where vital registration systems were incomplete during most or all of the years from 1960 to 2005.

In Argentina, Chile, and Costa Rica, where infant death registration was nearly complete for most of the years analyzed, vital registration statistics, rather than the Inter-Agency Group estimates published in the World Bank's World Development indicators, were preferred for over-time analyses because they are likely to track the actual trajectory of infant mortality decline better than the Inter-Agency Group figures, which are statistical reconciliations of alternative estimates from a variety of data sources for several different years. No such infant mortality estimates are available for Taiwan, which is not a member of any of the institutions whose

¹ Hill et al. 1999; United Nations 1990; United Nations 1992.

² UNICEF et al. 2007; World Bank 2008e. For an application of this methodology to infant mortality estimates in Thailand from 1980 to 2000, see Hill, Vapattanawong et al. 2007.

researchers formed the Inter-Agency group. Unfortunately, Taiwanese vital registration statistics were notorious for most of the period analyzed for underreporting infant deaths. Taiwan is therefore analyzed using infant mortality estimates derived from census data, corrected vital registration statistics, and surveys.

Registration is a passive method of collecting vital statistics, in that government registrars wait for citizens, medical authorities, or local government officials to notify them of births, marriages, and deaths. Such notification may be needed to inherit property; to collect life insurance payouts; or to acquire documents like birth certificates, marriage licenses, or burial permits. When complete (recording at least 90 percent of births and deaths, according to the UN) and accurate (producing infant mortality rates similar to those estimated from census and survey data), vital registration statistics provide more direct, timely, comprehensive, and information-rich estimates of infant mortality than do census or survey data. According to United Nations studies, however, vital registration statistics from 1960 to 1995 were both complete and accurate in only eight developing countries (Argentina, Chile, Cuba, Israel, Mauritius, Singapore, Uruguay, and Venezuela) and two territories (Hong Kong and Puerto Rico). Costa Rica and Kuwait met the completeness and accuracy criteria as of 1970, and Sri Lanka met them as of 1974.³ Because it is not a member of the United Nations, Taiwan was not included in the UN studies, but throughout the twentieth century, as will be noted in Chapter 7, its vital statistics were among the most complete and accurate in the developing world -- with the single exception

³ Hill et al. 1999; United Nations 1992.

of its infant mortality statistics, which produced much lower estimates of infant deaths than did census and survey data.⁴

Contributing to the incompleteness of vital registration statistics is that parents often fail to register the deaths of infants whose births were not reported.⁵ Because in any society with an infant mortality rate below 500 per 1000 there will be fewer cases of infant death than of infant survival, the omission of a death will reduce the numerator of the infant mortality rate proportionately more than the omission of a birth will reduce the denominator. Hence, omitting both the birth and the death will lead to an understatement of the true infant mortality rate.⁶ Even when reported, moreover, deaths in the first 24 hours of life, which can comprise up to forty percent of infant deaths where infant mortality rates are low, are classified in some countries as late fetal deaths.⁷ In other countries, for cultural reasons or because of misunderstandings, deaths below the age of one may be recorded as deaths at the age of one. Errors creep in not only at the registration stage, but also during the compilation of locally-registered events by the central government.⁸ Hence, despite their timeliness and information-richness, good vital registration statistics are not always available.

Whereas registration is a passive method of collecting vital statistics, censuses and sample surveys are active methods, in that administrators ask people to answer questions about

⁴ Chen et al. 1998; Mirzaee 1979. Egypt, Guatemala, Jamaica, and Trinidad and Tobago resemble Taiwan in that their vital registration statistics met the United Nations criterion for completeness, but understated infant mortality rates derived by well-tested procedures from census and survey data.

⁵ Hill 1991: 369. A study of a district in rural Thailand showed that 14 of 16 couples whose infants had died within 15 days of birth, which was the legal cut-off for birth registration, had reported neither the birth nor the death (Lumbiganon et al. 1990).

⁶ Omitting both the death and the birth doesn't balance out unless the true infant mortality rate is 500 per 1000. Below that level, the dual omission makes the infant mortality rate look lower than it really is.

⁷ Liu et al. 1992: 106-107; Velkoff and Miller 1995. France, Japan, and the former Soviet Union were among the countries that counted deaths in the first 24 hours of life as late fetal deaths during the years from 1960 to 1995.

⁸ Chamie 1994: 137; United Nations 1992: 3-4.

vital events, rather than waiting for people to come to them. These "active" methods may be further subdivided into "prospective" methods, in which a specific set of people is interviewed repeatedly over a certain span of time, and "retrospective" methods, in which a specific set of people is asked in a single interview about past vital events.⁹ Retrospective methods are used in all censuses and in most sample surveys. One such method is to ask each woman of childbearing age to state the age or date of birth of each child she has ever borne and, if the child has died, the date of the child's death or the age of the child at death. The "birth histories" so collected provide the information needed to make "direct" estimates of the infant mortality rate. The main problem with birth history technique is that it places relatively high demands on both respondents and interviewers.¹⁰ To deal with this problem, the demographer William Brass devised in the early 1960s a set of "survivorship" questions that were simpler to ask and easier to answer accurately. In the Brass method, each woman of childbearing age (or, in some cultures, each woman who has ever been married) is asked her age, how many children she has borne, and how many of those children are still living. (Survivorship questions can also be asked about parents, siblings, and spouses; indeed, the "sisterhood" method is often used to estimate maternal mortality rates). No questions are asked about the dates of the births or deaths, but by making assumptions about the fertility rates of mothers in different age groups, demographers can use the answers to such

⁹ One prospective method is a surveillance system, in which data collectors make periodic visits to all households in a given area to ask questions about vital events. Taiwan had such a system during Japanese colonial rule prior to 1945, as well as under the Nationalist government in the 1950s (Taeuber 1961: 103, 106). A related prospective method is a multi-round sample survey, in which researchers select a cohort of women of childbearing age for an initial interview (which may include questions about past vital events), and then follow this panel for a period of years, asking each participant periodically what vital events have occurred in her household since the last interview. Because surveillance systems and panel studies are costly, they tend to be restricted in numerical, geographical, and temporal scope. They also do not work well in urban slums or in other areas of high migration. By calling attention to those who need treatment, moreover, both surveillance systems and panel studies understandably influence the outcomes they purport to measure (Hill 1991: 370-371)

¹⁰ One scholar concluded that "the amount of underreporting of deaths and misreporting of ages makes the results [of estimates based on retrospective mortality questions] almost useless" (Murray 1987: 774).

survivorship questions to make "indirect" estimates of the infant mortality rate.¹¹ These indirect estimates based on survivorship questions thus depend on assumptions about the fertility rates of mothers in various age groups, but they are less demanding of respondents and interviewers than are the birth histories that form the basis of direct estimates of infant mortality rates.

Of 82 countries examined by the United Nations (1992), 43 had censuses and 48 had sample surveys that included survivorship questions. Although such questions demand less of respondents and interviewers than do the birth histories that form the basis of direct estimates of infant mortality rates, they still require the respondent to give accurate information about her own age and about the numbers of her living and dead children.¹² Respondents, however, sometimes fail to mention children who have died or have been given up for adoption, and sometimes characterize fetal deaths as infant deaths.¹³ Also, the deaths of infants whose mothers have died, migrated, or disappeared from the records of surveyors or census-takers will not be recorded. Moreover, the most recent estimates of child mortality are derived from the reports of the youngest women surveyed, and thus tend to be biased upward, because the infants of teenage mothers run higher mortality risks than the infants of mothers in their 20s and early 30s. As noted earlier, moreover, indirect estimates of infant mortality based on responses to survivorship questions depend on assumptions about past fertility and mortality rates. If such responses are to be used to project mortality rates at older ages, demographers must use life tables that relate patterns of mortality at certain ages to patterns of mortality at other ages.¹⁴ Several model life

¹¹ When a source reports both "direct" and "indirect" estimates from the same census or survey, the direct estimates are derived from birth histories, whereas the indirect estimates are derived from answers to survivorship questions.

¹² Murray 1987: 774.

¹³ Chackiel and Gough (1997) report encountering these problems in Argentina and in the Dominican Republic.

¹⁴ United Nations 1992: 7-11.

tables are available, and projections of mortality rates at older ages can differ significantly according to which model life table is chosen.¹⁵

Age-specific mortality rates can also be estimated by the intercensal survivor technique. This method simply involves subtracting the number of persons of a given age in one census from the number aged ten years younger in a census ten years earlier. The difference, adjusted for migration, is stipulated to be the number of persons in the age group who have died. This technique is straightforward, but it is also demanding: it requires accurate data on the number and ages of migrants, supposes that each census covers the same population, and assumes that ages are reported correctly.¹⁶

Other methods have been used to estimate infant mortality,¹⁷ but those summarized here are the ones used to generate the vast majority of the infant mortality data employed in Wealth, Health, and Democracy in East Asia and Latin America. Each method has typical defects, and none is invariably superior to all of the others. Equally severe problems, however, affect data on income-related indicators. If quantitative data are to illuminate policies, institutions, and circumstances conducive to expanding human capabilities, the best that can be done is to collect and analyze them as carefully as possible, to be forthright about their inadequacies, and to regard the conclusions derived from their use as guidelines rather than blueprints. The alternatives to drawing lessons from the systematic analysis of imperfect empirical data are random selection or deduction from first principles.

¹⁵ Murray 1987: 774-775.

¹⁶ Murray 1987: 774.

¹⁷ Hill 1991.

2. Costa Rica

The United Nations in the mid-1990s considered Costa Rica to be one of eleven developing countries whose vital registries were both complete (recording at least 90 percent of births and deaths) and accurate (producing estimates of infant mortality rates not too dissimilar from those estimated on the basis of census and survey data).¹⁸ A large country-specific literature confirms that Costa Rica's vital registries have been more complete and accurate than those of most other developing countries.¹⁹ Underregistration of total deaths, according to one estimate, was in the 12-14 percent range from 1960 to the late 1970s, before falling to 8 percent in the early 1980s.²⁰ These figures were well below the Latin American average throughout this period (Table 1). The Pan American Health Organization estimated that only 5 percent of total deaths were unreported in Costa Rica in 1990, and that reporting was complete by 1995.²¹

Scholars have been skeptical, however, about the quality of pre-1970 vital-registration based estimates of infant mortality in Costa Rica. In 1960, the vital registries produced an infant mortality rate of 74 per 1000, whereas Hill et al., relying mainly on estimates calculated indirectly from survivorship questions in the 1973 census,²² estimated a rate of 87 per 1000 (Table 2), implying underregistration of about 22 percent. According to one comparison of vital registration to census data, infant death underregistration fell from 18 percent in 1958 to 6 percent in 1964.²³ Nevertheless, a study in 1963-64 found that the national death registry omitted about 16 percent of under-two deaths in hospitals. No estimate was made of omissions of infant

¹⁸ Hill et al. 1999.

¹⁹ Alvarez 1968: 12, 38; Haines and Avery 1982: 35; Porras 1976: 2.

²⁰ Jaspers-Faijer and Orellana 1996: 46.

²¹ PAHO 1994: 433; PAHO 2000.

²² Hill et al. 1999: 66.

²³ Arriaga 1968: 92.

and child deaths outside hospitals, which is likely to have been even higher, and no information was provided on the omission of under-one deaths, but the study galvanized the government into taking action to improve death registration.²⁴ This action seems to have been successful. One study found that between 1964 and 1968 infant death underregistration fell from 15 to 5 percent.²⁵ By 1970, infant death recording in the vital registries was sufficiently complete that Hill et al. (1999) weighted vital registration data equally with census and survey-based estimates. In 1970, the infant mortality rate in Costa Rica according to Hill et al. (1999), relying on a variety of sources, was 62 per 1000, the same as the rate calculated from vital registration statistics (Table 2).

Comparisons of vital registration statistics to projections based on census and survey data suggest that infant death underreporting may have remained at the 5-10 percent level throughout the 1970s,²⁶ but additional improvement took place in the 1980s. A five-year multi-round sample survey of births and deaths in the rural region of Puriscal in the mid-1980s turned up 50 infant deaths, of which only one had not been registered. On the basis of this survey and others, Luis Rosero-Bixby concluded that registration of infant deaths in Costa Rica has been virtually complete since the early 1980s.²⁷ In 1995, the Hill et al. (1999) estimate of Costa Rica's infant mortality rate, 12 per 1000, was actually lower than the rate of 13 per 1000 calculated from vital registration statistics (Table 2). Costa Rican vital registration statistics seem therefore to be a reliable source of infant mortality data after about 1970.

²⁴ Rosero-Bixby 2000b.

²⁵ Behm 1976: 3.

²⁶ Rosero-Bixby 2000b.

²⁷ Rosero-Bixby 2000a, Rosero-Bixby 2000b.

3. Chile

According to the Interamerican Development Bank, Chile's Civil Registry in the mid-1990s was "in a shambles," having been "largely neglected during the Pinochet regime." Computers were "obsolete," offices were "crumbling," training was "almost nonexistent," salaries were "very low," and morale was "dismal" until participatory reforms emphasizing training and quality control were adopted in 1997.²⁸ This description makes one wonder about similar institutions in other countries, because Chile from 1960 to 1995 had, overall, the lowest level of death underregistration in Latin America. In 1993 and again in 1996, indeed, the Pan American Health Organization judged death underregistration to be lower in Chile than in the United States (Table 1).

Chile through the end of the 1970s had two vital registration series, each compiled from the same set of birth and death certificates and reports. One series was compiled by the National Statistical Institute (INE), the other by the National Health Service (SNS). In no year during the 1970s did the number of infant deaths in each series differ by more than one percent, and in most years the difference was a small fraction of that amount.²⁹ Comparisons with census data show that the Chilean vital registries in the 1990s missed very few deaths of persons over five years of age.³⁰ Hill et al. (1999) express confidence in Chilean vital registration figures all the way back to 1960, the initial year of their analysis.³¹ Other assessments of the quality of Chilean mortality data confirm the evaluations of these international organizations.³² The quality of Chilean vital registration statistics may even have been high early in the twentieth century. One scholar

²⁸ IADB 2000c.

²⁹ Raczynski and Oyarzo 1981: 69.

³⁰ Chile. INE 2002: 26)

³¹ Hill et al. 1999: 56, 66.

³² Gallegos Ulloa et al. 1997; Raczynski 1994: 33; Taucher 1984: 3-5.

estimated that 5-20 percent of infant deaths went unreported in the Petarca Valley after vital registration began in 1909, but concluded that "either omissions were few, random, or disguised by birth omissions."³³ Hill et al.'s (1999) estimate of infant mortality in 1960, 118 per 1000, is almost identical to the official rate of 119.5 per 1000, and their estimate for 1995, 10 per 1000, is actually below the official rate of 11 per 1000 (Table 3).

Some studies have uncovered evidence suggesting that Chile's vital registries may not be quite as complete as the above-cited studies suggest. One area of concern is birth underregistration. Since 1952 published Chilean birth statistics have been adjusted upward to correct for underreporting, due mostly to late registration rather than non-registration.³⁴ Until 1966 the upward adjustment was between 8.9 and 10.6 percent. After 1967 the National Statistical Institute used an upward adjustment of 5 percent; the National Health Service used one of 8.9 percent.³⁵

Another area of concern involves the registration of infant deaths. One study found that 25 percent of infant deaths in Chile in the early 1970s were unaccompanied by a medical certificate, and that the figure approached 50 percent in parts of the rural south.³⁶ An analysis during a later period found a higher proportion of deaths without medical certification in rural than in urban areas.³⁷ In an analysis of Costa Rica's 81 cantons in 1984, one demographer estimated that for every 100 deaths without a medical certificate, 30 go unregistered.³⁸ If the

³³ McCaa 1983: 181.

³⁴ Chile. INE 2002: 25, 52.

³⁵ Raczynski and Oyarzo 1981: 69.

³⁶ De Kadt 1974: 149.

³⁷ Taucher, Albala, and Icaza 1996: 255.

³⁸ Rosero-Bixby 2000b.

same relation held for Chile in the early 1970s, infant death underregistration would have been about 7 percent.

A particular area of concern in Chile, as in Taiwan (see below) and elsewhere, involves possible underreporting of the deaths of neonates (infants under 28 days), especially of those with very low birthweights who die within the first hours or days of life. A 1968-69 survey of maternity wards in Santiago showed that more than fifty percent of very low-birthweight babies who died within the first few hours or days did not have their deaths registered.³⁹ A 1973 survey of Santiago and four nearby rural communities found that 56 percent of neonatal deaths were unreported, and that the rate was 78 percent for neonates who survived only a few minutes.⁴⁰ Underreporting of the births (and, often, deaths) of very low-birthweight neonates is also very common in many advanced industrial countries, however.⁴¹ There is no reason to suppose that the problem has been worse in Chile than elsewhere.

Infant death registration reportedly deteriorated from 1972 to 1980.⁴² After 1968, the civil registry began closing on weekends, a law requiring death registration prior to burial was suspended, and political turmoil impeded the functioning of the reporting process.⁴³ Vital registration statistics give no evidence of such underreporting, however. The number of neonatal and infant deaths rose in 1972 as compared to 1971, rather than falling sharply as would likely have occurred had underregistration spiked in 1972. The number of neonatal and infant deaths also plunged in 1981 as compared to 1980, rather than rising or staying constant, as would be

³⁹ Chile. INE 2002: 26.

⁴⁰ Mamalakis 1980: 45.

⁴¹ Heck, Schoendorf, and Parker 1999; Howell and Blondel 1994; Kramer et al. 2002; United States Congress 1994: 34-35.

⁴² Taucher 1984: 4.

⁴³ Behm and Correa 1977: 4; Mamalakis 1980: 45.

expected if registration had suddenly improved in 1980 (absolute numbers of deaths from Chile. INE 2002: 52; rates per 1000 from Table 3).

Chilean governments have recognized the problems of birth and infant death underreporting and have taken action to ameliorate them. In 1975, the government began to adjust infant mortality statistics for underreporting.⁴⁴ By the early 1990s the rule requiring death registration before burial had been reinstated.⁴⁵ Even scholars who believe that the Chilean vital registries have omitted some infant (especially neonatal) deaths have written that omissions have been infrequent or acceptably constant across regions and over time.⁴⁶ On the whole, it seems reasonable to proceed as if infant mortality estimates derived from Chilean vital registration records were complete and accurate from 1960 to 1995.

4. Argentina

Vital registration-based infant mortality data are available for Argentina as a whole, including the (then) territories of Chaco, Formosa, Misiones, and Patagonia, only from 1938 onward. Data for individual provinces go back to 1914, however, and data for the territories go back to 1933.⁴⁷ Aggregating the vital registration data from the provinces and using census data as a benchmark, Collver estimated that birth registration around 1914 was 92 percent complete and that death registration was 100 percent complete (he found similar levels of completeness in Chile, Costa Rica, and Panama).⁴⁸ Indeed, because birth underregistration exceeded death underregistration from 1914 to 1947 (the date of the next census), Collver suggested that vital

⁴⁴ Mamalakis 1980: 45.

⁴⁵ Taucher and Jofré 1997: 1226-1227.

⁴⁶ Hojman 1993: 208 fn. 9; Raczynski and Oyarzo 1981: 70; Taucher, Albalá, and Icaza 1996: 255; Taucher and Jofré 1997: 1226-1227.

⁴⁷ Somoza, Dehollain, and Salvia 1962.

⁴⁸ Collver 1965: 39.

registration statistics may have overstated infant mortality rate during much of the first half of the twentieth century. In 1915-1919, for example, the average annual infant mortality rate based on vital registration statistics was 122 per 1000. Correcting for estimated underregistration of births, Collver estimated that the true rate was only 113 per 1000.⁴⁹ Not all demographers agree, however, that Argentine death registration was virtually complete in the first half of the twentieth century. Somoza found that vital registration-based estimates of overall mortality understated census-based estimates by 10 percent in 1914, 9 percent in 1947, and 3 percent in 1960.⁵⁰

Even if Collver is correct that birth underregistration exceeded death underregistration in Argentina as a whole during the first half of the twentieth century, infant mortality seems to have been persistently understated in some very poor provinces. In 1920-1923, reported infant mortality in impoverished Santiago del Estero was only 100 per 1000, much lower than the 143 per 1000 reported in the far more developed province of Córdoba.⁵¹ Infant mortality underregistration in Santiago del Estero seems to have persisted for several decades. In 1942, according to vital registration statistics, infant mortality in Santiago del Estero was 88 per 1000, not much higher than Córdoba's 83 per 1000,⁵² and vastly lower than the rates in equally poor Salta (205 per 1000) and Jujuy (227 per 1000). Likewise, according to vital registration data, infant mortality in the impoverished territory of Formosa was only 67 per 1000 in 1941,⁵³ lower than the rate in the fairly affluent province of Córdoba in 1942 (83 per 1000). As late as 1960, census-based estimates of infant mortality in four very poor provinces -- Chaco, Formosa, Misiones, and Santiago del Estero -- were two to three times higher than vital registration-based

⁴⁹ Collver 1965: 65.

⁵⁰ Somoza 1971: 170.

⁵¹ Argentina. DGE 1926: 37.

⁵² Argentina. DGEC 1944: 53.

⁵³ Argentina. DGE 1942: 22.

estimates.⁵⁴ The provinces and territories in which infant mortality seems to have been seriously understated all had small populations, however, so underregistration in these jurisdictions did not imply significant underestimation in the country as a whole.

Using census data as a benchmark, Collver found that birth and death registration had become complete by 1945,⁵⁵ and available time series for infant mortality have tracked one another closely since 1960. In particular, direct estimates based on vital registration statistics have been similar to indirect estimates based on census survivorship questions (Table 4). The only highly discrepant estimates (yielding much lower infant mortality estimates than other sources) are those based on the 1980 census, which was taken under the 1976-1983 military regime, during which thousands of people "disappeared." Unlike the censuses of 1960 or 1970, which used enumeration exclusively,⁵⁶ the 1980 census used sampling rather than enumeration in areas containing 94 percent of the population: cities with more than 100,000 inhabitants and the entire provinces of Buenos Aires, Córdoba, Entre Ríos, and Santa Fé. The government's rationale for sampling rather than enumerating these areas was to cut costs, permit timely publication, reduce paperwork, and "facilitate quality control of the information collected."⁵⁷ According to a United Nations study, "data from the 1980 census appear to be flawed, possibly because of high levels of non-response combined with computerized imputation."⁵⁸

Except in the case of the 1980 census, then, vital registration statistics and census data have produced similar infant mortality estimates since 1960. Other evidence also suggests that Argentina's vital registration statistics are probably fairly complete and accurate. In the late

⁵⁴ Arruñada, Hamilton, and Ambrosi 1971: 19, 34.

⁵⁵ Collver 1965: 39.

⁵⁶ Argentina. INDEC 1983: 75-79.

⁵⁷ Argentina. INDEC 1985: 5 (quotation), 8.

⁵⁸ United Nations 1992: 34.

1990s, age-specific mortality rates based on vital registration data were consistent with provincial cause-of-death profiles, except in the provinces of Santiago del Estero and Catamarca.⁵⁹ In 1990 and again in 1995, trained personnel reportedly attended 95 percent of births in Argentina (Book Table A16), facilitating the initial recording of vital events. Stillwaggon argues that Argentine vital registration worsened under the 1976-1983 military regime; remained in disarray in the early 1990s (despite the best efforts of many health professionals); and was especially deficient in registering infant deaths among the poor.⁶⁰ Stillwaggon also found that the government may have manufactured some of the statistics it reported to international agencies, including a 95 percent figure for measles vaccination coverage in 1990, a year when Argentina was the only country in the world to purchase no vaccines. A measles epidemic erupted in 1991.⁶¹ One study found, however, that overall mortality underregistration in Argentina from 1960 to 1998 ranged from 2.1 to 5.8 percent, with the lowest figure coming from 1975 to 1980 during the most repressive phase of the military regime.⁶² In short, the relatively high quality of Argentine vital registration statistics, coupled with the richness of the information they provide, seem to warrant their use in the depiction of infant mortality trends and patterns.

5. Brazil

Vital registration statistics from the mid-1980s to the mid-1990s were less complete in Brazil than in Argentina, Chile, or Costa Rica (Table 1). Birth registration became mandatory in

⁵⁹ Verdejo 1998: 56.

⁶⁰ Stillwaggon 1998: 162; Stillwaggon 2000.

⁶¹ Stillwaggon 1998: 14.

⁶² Jaspers-Fajier and Orellana 1996: 48.

Brazil only in the mid-1970s,⁶³ and although death registration has long been necessary to obtain a burial permit, unofficial burials are widespread.⁶⁴ In the 1980s, official agencies registered 20 to 30 percent fewer births and 25 to 45 percent fewer deaths than were estimated from census and survey data.⁶⁵ In the mid-1990s, however, vital statistics began to improve. By 1997, according to the Health Ministry, birth underregistration had fallen to 13 percent and death underregistration had dropped to 20 percent. In the impoverished Northeast, however, the figures were 27 and 44 percent respectively.⁶⁶

In Brazil as in other Latin American countries, death registration tends to be less complete for infants than for older persons.⁶⁷ Rather than register the deaths of unbaptized children or of infants who have lived only a few days, parents often prefer clandestine burials.⁶⁸ Becker and Lechtig estimated that only 66 percent of infant deaths were registered in 1980,⁶⁹ and the Pan American Health Organization (PAHO) estimated that only 50 to 80 percent of infant deaths were registered in 1985-90 (Table 1). Death registration improved less in the 1990s for infants than for older persons. According to the Health Ministry, only 57 percent of infant deaths were registered in Brazil in 1998, with the proportion varying from 81 percent in the Southeast to 39 percent in the Northeast. State-by-state estimates of infant death registration ranged from 99 percent in Mato Grosso do Sul (Center-West) to 20 percent in Maranhão and Piauí (Northeast).⁷⁰

⁶³ Scheper-Hughes 1992: 296.

⁶⁴ Azevedo 1981: 60-61; Scheper-Hughes 1992: 291; Szwarcwald et al. 1997: 505.

⁶⁵ Becker and Lechtig 1986: 47; PAHO 1990: 37; Simões et al. 1989: 23-24; Szwarcwald et al. 1997: 505.

⁶⁶ Brasil. Ministério da Saúde 2001: Tables F-10 and F-11.

⁶⁷ PAHO 1998: 4; Szwarcwald et al. 1997: 505.

⁶⁸ Scheper-Hughes 1992: 291.

⁶⁹ Becker and Lechtig 1986: 47.

⁷⁰ Brasil. Ministério da Saúde 2001: Table F-11.

Because vital statistics are incomplete, most researchers have used census and survey data to estimate Brazilian mortality levels and trends.⁷¹ Censuses since 1950 have asked each adult female respondent to report the number of children she had ever born and the number of such children who were still surviving.⁷² Since 1972, a government-sponsored national household survey, the Pesquisa Nacional por Amostra de Domicílios (PNAD), has asked similar questions. Such survivorship questions in censuses and surveys can be used to produce indirect estimates of infant mortality rates. Table 5 compares infant mortality estimates based on vital registration, census, and survey data from 1960 to 2000.

Census and survey data are not immune to reporting errors, and seldom satisfy all of the assumptions needed to produce valid infant mortality estimates from answers to survivorship questions.⁷³ The PNAD surveys do not cover the rural areas of the Amazon, which are sparsely populated but may have high infant mortality rates. The 1986 and 1996 Demographic and Health surveys differed in sample size and methodology,⁷⁴ such that for the 1976-81 period, the 1986 survey produced an infant mortality estimate of 96 per 1000, whereas the 1996 survey produced an estimate of 75 per 1000.⁷⁵ Hence, census and survey estimates of infant mortality, although better than vital registration estimates in Brazil, have their own imperfections. Unlike vital registration statistics, moreover, they include no information on causes of death, and produce estimates for five-year periods rather than for individual years.

⁷¹ Becker and Lechtig 1986: 43-47; Hill et al. 1999; Simões et al. 1989; Wood and Carvalho 1988: 117.

⁷² CELADE 1998: 159; Goyer and Domschke 1983: 86-87; United Nations 1992: 57; Wood and Carvalho 1988: 262.

⁷³ Chackiel and Gough 1997; Murray 1987: 774; Simões and Oliveira 1986: 30; United Nations 1992.

⁷⁴ Rutstein 2001.

⁷⁵ Macro International 2001.

These data deficiencies make it hard to estimate infant mortality levels and trends. In 1980, estimates of infant mortality in Brazil ranged from 81 to 64 per 1000. After about 1985, however, with the exception of those based on vital registration, estimates of infant mortality began to converge (Table 5). Moreover, the Cardoso government worked hard in the late 1990s to improve the quality and availability of health data. According to an official of the Pan American Health Organization, Brazil during this period spent more than a million dollars a year to improve the completeness and accuracy of the health data it reported to this international agency.⁷⁶

6. Taiwan

Taiwan is a province of China, not a country. Since 1971 it has belonged neither to the United Nations nor to the World Bank, whose agencies produce the most readily available development statistics. Moreover, a key turning point in Taiwanese mortality decline may have occurred during the late 1940s, when regime change, political violence, and the aftermath of war wreaked havoc with the island's statistical systems.

The Japanese colonial rulers carried out regular population censuses during their occupation of the island from 1895 to 1945. They also collected vital registration statistics, requiring families to report all vital events to the police, who visited each household every three, six, or twelve months, depending on its "reputability."⁷⁷ The colonizers held an entire neighborhood or village accountable if registries were out of order, so peer pressure and individual prudence worked together in favor of nearly complete registration of vital events.⁷⁸ As

⁷⁶ Castillo-Salgado 2001.

⁷⁷ Taeuber 1944: 103, 147

⁷⁸ Barclay 1954a: 139-145, 159.

a result, Taiwan "from 1905 to 1943...had an outstanding set of demographic records. They were unique in quality among all agrarian countries, and compared favorably with those of most industrial countries of the world."⁷⁹ The main deficiency in the colonial vital statistics is that they seriously understated infant mortality, particularly neonatal (0-27 day) mortality.⁸⁰

Serious underregistration of infant deaths continued after World War II. The reasons for the problem included underreporting of neonatal mortality, classification of infant deaths as one year-old deaths (and perhaps as fetal deaths), and delays in birth and death reporting.⁸¹ Recognizing that infant deaths were underregistered, one scholar has used census data to estimate infant deaths per 1000 live births during the colonial era.⁸² These estimates can be compared to vital registration figures. For 1920 the estimates are 236 (census) and 176 (vital registration); for 1930 they are 199 (census) and 151 (vital registration); for 1940 they are 129 (census) and 135 (vital registration).⁸³ The convergence between the estimates (to the point that the vital registration estimate by 1940 was higher than the census estimate) may have been due to an improvement of infant death reporting over time.

Taiwan's mortality statistics during World War II and from 1945 to the mid-1950s (Table 6a) must be treated with particular caution. Taiwanese during this period were legally required to register deaths in order to obtain a burial permit, but the law was not strictly enforced, particularly in the case of infant deaths.⁸⁴ Accordingly, population records deteriorated "from 1944, when the major statistical activities of the Japanese ceased, to 1956, when the major

⁷⁹ Barclay 1954b: 3

⁸⁰ Barclay 1954a: 158-164.

⁸¹ Anderton and Barrett 1990: 399; Barclay 1954b: 24-27, 110; Freedman, Peng, Takeshita, and Sun 1963: 219; Knöbel, Yang, and Ho 1994: 815; Mirzaee 1979: 15, 24-28, 31; Sullivan 1972: 39; Taeuber 1961: 103.

⁸² Mirzaee 1979: 224-228.

⁸³ Vital registration figures from Barclay 1954a: 161-162.

⁸⁴ Barclay 1954b: 23.

statistical activities of the Chinese began." As a result, "the continuities and the regularities of the late colonial period were replaced by the discontinuities and the reorientations of a period in which statistical offices were less competently staffed and efficiently organized, discipline in reporting less rigid, and publication more limited."⁸⁵

A major problem confronting the vital registration system in the late 1940s was the flight of many city dwellers to the countryside. In February 1947 the Kuomintang (KMT) army, retreating from the mainland, massacred thousands of Taiwanese after a token gesture of resistance. After this episode, the "KMT government stopped recording population statistics for the next eight years."⁸⁶ Meanwhile, an influx of soldiers and civilians after the Communist victory on the mainland disrupted the household registration system established by the Japanese. "The situation was especially confused around the period 1948-1950 when mass migration from mainland China took place. The proportion of mainland Chinese became rather large, especially in the cities. However, in rural areas where the proportion of mainland Chinese [was] low, the quality of the system still seem[ed] high."⁸⁷

Underreporting of neonatal (0-27 day) mortality, which was already severe during the Japanese colonial era, became even worse after 1945 owing to wartime disruption, regime change, flight to the countryside, and the arrival of 1.5 million mainlanders in a population under 10 million. The period of poor registration lasted either from 1944 to 1956 or from 1947 to 1955.⁸⁸ In 1940 the number of infant deaths picked up by the vital registration system had actually exceeded the number estimated from census data. By 1955, however, the vital

⁸⁵ Taeuber 1961: 102, 115-116.

⁸⁶ Kuo 2002: 4 fn. 2.

⁸⁷ Tuan 1958: 40.

⁸⁸ 1944-1956: Taeuber 1961: 102; 1947-1955: Kuo 2002: 4 fn 2.

registration records produced an infant mortality rate of only 34-37 per 1000 (Table 6a), barely higher than the rate in the United States (30 per 1000). That seems impossibly low. Taiwan's child (1-4) mortality rate, which according to the same vital registration system that produced the infant (0-1) mortality estimate of 34-37 per 1000, was 13.4 per 1000, more than ten times as high as the US rate of 1.1 per 1000.⁸⁹ In 1955, moreover, the United States was 10 times richer than Taiwan, with a GDP per capita of \$11,964 vs. \$1,224.⁹⁰

Using a method developed by Jeremiah Sullivan to correct vital registration statistics for the underestimation of neonatal mortality, Mohammed Mirzaee produced an infant mortality estimate of 60 per 1000 for 1950, much higher than the vital registration estimate of 35-40 per 1000 (Table 6a). Sullivan assumed that vital registration figures were accurate for post-neonatal mortality (28-365 days), but that they seriously understated neonatal mortality (0-27 days). Using the government's post-neonatal mortality statistics and a correction factor based on the German ratio of neonatal to post-neonatal mortality, Sullivan used bivariate regression to generate an adjusted (higher) estimate of neonatal mortality, and then added this figure to the government's figure for post-neonatal mortality to estimate the corrected infant mortality rate. The 60 per 1000 infant mortality rate produced by this technique for 1950 may itself be too low, however. Sullivan's formula was derived from infant mortality rates that were lower than those prevailing in Taiwan in the late 1940s, and may not be applicable to the higher rates of the earlier era. Moreover, Sullivan's method applied to Taiwan around 1950 produces an infant mortality estimate far below that calculated from model life tables, using as a baseline life expectancy

⁸⁹ Chow and Hsu 1960: 15.

⁹⁰ Heston, Summers, and Aten 2002, variable RGDPCH.

figures derived from registered deaths in Taiwan at all ages in 1950.⁹¹ These life table estimates for 1950 or thereabouts range from 91 to 110 per 1000 (Table 6a).

Barclay provides higher and more plausible estimates of infant mortality from 1947 to 1951 (Table 6a). Barclay's estimates are calculated from (1) registered births in each calendar year; (2) the number of under-one infants alive at the end of that calendar year; and (3) the proportion of under-one deaths expected (on the basis of data from the Japanese colonial era) to occur in the succeeding calendar year, but before the infant's first birthday.⁹² According to Barclay's estimates, infant mortality in Taiwan in 1947 was at least 179 per 1000. It then fell sharply to 115 per 1000 in 1948, winding up at 100 per 1000 in 1951 (Table 6a). Using a different formula to correct for late registration of infant deaths, other scholars produced an estimate of 105 per 1000 for 1949.⁹³ These estimates of 105-115 per 1000 for the period around 1950 seem more realistic than either the vital registration estimates of 35-40 per 1000 or Mirzaee's estimate of 60 per 1000 based on Sullivan's formula.

A child (1-4) mortality estimate for 1948 can shed additional light on what the true infant mortality rate may have been in Taiwan in the late 1940s. Taiwanese vital registration statistics for 1948 produced a child mortality rate of 32 per 1000.⁹⁴ A UNICEF study produced 724 paired observations for infant and under-5 mortality covering 95 developing countries at eight five-year intervals from 1960 to 1995.⁹⁵ The researchers involved in the study calculated each infant mortality estimate from the paired under-5 mortality estimate (or vice versa, the under-5 from the infant) using model life tables. Child mortality estimates can be produced from these 724 pairs

⁹¹ Mirzaee 1979: 34-35.

⁹² Barclay 1954b: 24-27.

⁹³ Chow and Hsu 1960: 23.

⁹⁴ Chow and Hsu 1960: 13.

⁹⁵ Hill et al. 1999.

by subtracting infant from under-5 mortality in each case. The effect of this operation is essentially to average infant/child mortality ratios in five life tables, thereby providing a rough idea of what infant mortality rate we should expect to find in a society, like Taiwan in 1948, with a registered child (age 1-4) mortality rate of 32 per 1000, and for which the appropriate life table is uncertain. Twelve estimates of child mortality in the Hill et al. study fall between 31 and 33 per 1000. Their mean associated infant mortality rate is 75 per 1000, with a range from 59 to 86 per 1000. To the extent that child mortality was underregistered in Taiwan in 1948, infant mortality would be higher than 75 per 1000.

More consensus exists on the infant mortality rate around 1960 than around 1950. "Field studies" by the Sino-American Joint Commission on Rural Reconstruction (JCRR) in three townships in the late 1950s produced infant mortality estimates averaging 51 per 1000.⁹⁶ This 51 per 1000 figure was still higher than the vital registration estimates for the country as a whole for 1958, which were in the neighborhood of 33-38 per 1000 (Table 6a). Using the Sullivan method, Mirzaee produced an estimate of 54 per 1000 for 1960,⁹⁷ not too different from the JCRR survey estimates reported by Chow and Hsu and close to those calculated by Mirzaee himself from model life tables, using as a baseline life expectancy figures derived from registered deaths at all ages. Using the formula described earlier, Sullivan produced a similar estimate of 55 per 1000 for 1961 (Table 7).

Given the strengths and weaknesses of the various Taiwanese infant mortality estimates for 1940 to 1960, it seems most defensible to accept that the rate was 128-136 per 1000 in 1940, 91-110 per 1000 in 1950, and 53-56 per 1000 in 1960. The convergence of estimates around

⁹⁶ Chow and Hsu 1960: 23.

⁹⁷ Mirzaee 1979: 34.

1960 reflects recovery from the disruption of the postwar era. By the mid-1950s the Kuomintang had regularized the collection of information on vital events, although infant deaths continued to be underregistered. This problem persisted for the next forty years. Estimated underreporting of infant mortality in vital registration records in the 1980s ranges from 70 to 100 percent.⁹⁸ A third study of infant mortality underregistration in the 1980s produced an estimate of 46 to 96 percent.⁹⁹ Table 7 presents available estimates of infant mortality in Taiwan from 1960 to 2000; Table A1 in the book presents the figures chosen to represent the true rate. The 1960, 1965, 1970, and 1975 figures are taken from Mirzaee's estimates, which are based on corrected vital registration statistics. The 1980 and 1985 estimates are derived using the Sullivan formula¹⁰⁰ from the vital registration estimates in Table 7 (11.0 and 7.4 per 1000 respectively). Sullivan developed his formula for registered rates of 19-31 per 1000,¹⁰¹ but no alternative is available.

For a year close to 1990, the best data were collected in an island-wide survey in 1989¹⁰² that produced an estimate of 10.2 per 1000, much higher than the 6.1 per 1000 rate calculated from vital registration statistics (Table 6b). Applied to this vital registration rate of 6.1 per 1000, the Sullivan method, it should be noted, produces an infant mortality estimate of 13.6 per 1000, much higher than the 10.2 per 1000 estimated in the survey. Because the Sullivan method was derived for higher registered infant mortality rates, because the survey was comprehensive and rigorous, and because the survey estimate splits the difference between the uncorrected and corrected vital registration rates, the survey estimate of 10.2 is used in preference to both the recorded vital registration rate and the vital registration rate adjusted using the Sullivan formula.

⁹⁸ 70 percent estimate: Chen et al. 1998: 291. 100 percent estimate: Knöbel, Yang, and Ho 1994.

⁹⁹ Wen, Tsai, and Tsai 1992: 223.

¹⁰⁰ The Sullivan formula is reproduced in Mirzaee 1979: 34.

¹⁰¹ Sullivan 1972.

¹⁰² Chen et al. 1998: 291; Wen et al. 2002: 149.

The Taiwanese government acknowledged in 2000 that infant deaths had been underreported up to 1994 and attributed a spike in the registered infant mortality rate from 5.66 in 1994 to 7.40 in 1995 to "the implementation of a more efficient and accurate birth registration system," announcing that "the discrepancy [between the registered and the actual infant mortality rate] has now been corrected."¹⁰³ The 1996 infant mortality rate according to vital registration statistics, 7.5 per 1000,¹⁰⁴ was very close to the rate of 8.0 calculated from a survey of 3,623 women giving birth throughout Taiwan from February 12-16, 1996.¹⁰⁵ The survey was carried out by the same team that undertook the 1989 survey, and was at least as comprehensive and rigorous as the earlier study. Because of this corroborating evidence, the 2000 and 2005 figures in Table A1 are taken from uncorrected government vital registration statistics.

Another deficiency of death registration, by no means unique to Taiwan, involves the omission or misclassification of maternal deaths. A careful survey of deaths of women aged 10-49 in 1984-1988, involving both the perusal of the death certificates of all 27,171 such women and interviews with family members of 81 percent of those women, produced a maternal mortality ratio estimate of 17.2 per 100,000, 70 percent higher than the 10.1 per 100,000 ratio calculated from vital registration statistics.¹⁰⁶

¹⁰³ Taiwan. GIO 2000.

¹⁰⁴ Taiwan. DGBAS 2007: 28.

¹⁰⁵ Wen et al. 2002: 147-148.

¹⁰⁶ Kao et al. 1997: 34-35.

7. South Korea

Estimates of infant mortality in South Korea around 1960 range from 108 per 1000 to 58 per 1000.¹⁰⁷ In two rural townships not far from Seoul, infant mortality in 1961-62 was estimated to be about 60 per 1000.¹⁰⁸ The estimates for 30-35 years later are not much more consistent. For 1989 they range from 22 to 12 per 1000; for 1990 from 13 to 8 per 1000; and for 1995 from 10 to 6 per 1000.¹⁰⁹ In percentage terms, the discrepancy between the lowest and highest estimate was only slightly smaller in 1995 than in 1960. These discrepancies present a serious problem for analysis. Table 7 gives an idea of the range of infant mortality estimates that exist for South Korea from 1960 to 2000.

Korean vital statistics have long-standing deficiencies. At least through the early 1980s, responsibility for the vital registration system was divided among several government agencies; fines for late registration of births and deaths deterred people from registering vital events at all; registration facilities were inconveniently located in both rural and urban areas; and registration required the use of Chinese characters, making the process difficult for Koreans with low levels of education.¹¹⁰ The government began around 1970 to improve the coverage and quality of vital statistics, but fifteen years later it remained hard to place much confidence in official registries of births and deaths.¹¹¹ Infant mortality rates must therefore be estimated either from population censuses, which have been taken every five years or so since 1925, or from sample surveys. In

¹⁰⁷ 108 per 1000: Kwon 1986: 12. 90 per 1000: UNICEF 1998; Hill et al. 1999: 114. 85 per 1000: UNDP 1993; Bos, Hon, Maeda, Chellaraj, and Parker 1999. 82 per 1000: World Bank 2001. 78 per 1000: Mason et al 1980: 398. 71 per 1000: Koo 1998: 244; 69 per 1000: Mehrotra, Park, and Baek 1997; UNDP-Korea 1998. 60 per 1000: census data in Coale, Cho, and Goldman 1980: 22. 58 per 1000: Korean National Fertility Study in Kwon 1986: 12.

¹⁰⁸ Yang et al. 1965: 242.

¹⁰⁹ 1989: 22 per 1000: United Nations 1990; 12 per 1000: United Nations 1998. 1990: 13 per 1000: UNDP-Korea 1998; 8 per 1000: Hill et al. 1999. 1995: 10 per 1000: World Bank 2001; 6 per 1000 Hill et al. 1999

¹¹⁰ Choo 1980: 200; UNFPA 1982: 19.

¹¹¹ Kwon 1986: 76.

both surveys and censuses respondents are often reluctant to report child deaths, and projections based on adult mortality rates suggest that census and survey data alike understate infant mortality in South Korea.¹¹² Tai-Hwon Kwon argued that the 1974 Korean National Fertility Survey seriously underestimated infant mortality, and provided much higher estimates for several years covered by the survey.¹¹³ Checks using census data suggest that the government's estimate of life expectancy for 1965-70 (61 years) may have overstated the figure by 11 years, and that the crude death rate in 1970, 8 per 1000 according to official statistics, may actually have been as high as 13 per thousand.¹¹⁴

Estimates based on census and survey data in the standard statistical compendia are also apparently flawed. The figures for South Korea in Hill et al. (1999), a systematic compendium of transparently-derived infant mortality estimates for a large number of developing countries over a long period of time, are highly problematic. The Hill et al. (1999) estimate for 1960, 90 per 1000, is considerably higher than most of the other estimates in Table 7, which range from 58 to 82 per 1000. It is also much higher than alternative estimates of 67 to 68 per 1000 produced by three sample surveys in 1959, 1960, and 1961 respectively.¹¹⁵ These surveys covered only rural areas, which may be presumed to have suffered higher infant mortality rates than the nation as a whole. If anything, then, they should have yielded higher rather than lower estimates than the Hill et al. (1999) study.

The problematic character of the Hill et al. estimate for 1960 derives not only from its inconsistency with alternative estimates, but also from its empirical basis. The 1960 figure is

¹¹² Coale, Cho, and Goldman 1980: 21-22.

¹¹³ Kwon 1986: 13; the results of the survey are summarized in Korea 1977.

¹¹⁴ Kwon, Lee, Chang, and Yu 1975: 24.

¹¹⁵ Ban, Moon, and Perkins 1980: 313.

based on (1) indirect estimates from the 1970 census; (2) an indirect estimate from the 1974 Korean National Fertility Survey (KNFS); and (3) a direct estimate from the 1974 KNFS. The indirect estimates are based on responses to child survivorship questions; the direct estimate is based on birth histories. The indirect estimates from the 1970 census are calculated from responses by women aged 40-44 (with a reference date of 1962) and 45-49 (with a reference date of 1959). The indirect estimate from the 1974 KNFS is based on responses from women aged 45-49 (with a reference date of 1962).¹¹⁶ The direct estimate (for the period 1959-1964) in the 1974 KNFS must also have been based primarily on birth histories from older women. All direct and indirect estimates are prone to error, but those based on reports from older women are especially problematic. Sample sizes tend to be small, and older women may have trouble remembering accurately events that may have occurred 20 or even 30 years ago, especially when they are asked about specific children, as is necessary for the computation of direct estimates from birth histories.¹¹⁷ These problems help explain the great variance in the figures used by Hill et al. to estimate South Korean infant mortality in 1960. These figures range from 57 per 1000 (direct estimate from the 1974 KNFS for 1959-1964) to 107 per 1000 (indirect estimate from the 1974 KNFS for 1962). The indirect estimates from the 1970 census are 105 per 1000 (based on women aged 45-49, reference date 1959) and 88 per 1000 (based on women aged 40-44; reference date 1962).¹¹⁸

Whereas the Hill et al. figure for 1960 is considerably higher than the other estimates in Table 7, its figure for 1975, 24 per 1000, is much lower (the alternatives range from 32 to 41 per 1000). Corroborating the impression that the Hill et al. figure for 1975 is too low, a World Bank

¹¹⁶ United Nations 1992: 286-287.

¹¹⁷ Hill et al. 1999: 9.

¹¹⁸ United Nations 1992: 286-287.

report noted that the South Korean Ministry of Health and Social Services estimated infant mortality around 1975 to be 38 per 1000, and added that "several surveys indicate that this estimate is low."¹¹⁹ The Yearbook of Public Health and Social Statistics published by the Ministry of Health and Social Affairs put infant mortality in 1976 at 40.4 per 1000, falling steadily to 34.2 per 1000 in 1983.¹²⁰ These estimates (of unknown derivation) are also much higher than those of Hill et al. (1999). Likewise, the Hill et al. estimate for 1995, 6 per 1000, is 33-40 percent lower than four alternative estimates in Table 7, as well as lower than alternative estimates from the Population Reference Bureau (11 per 1000 for the late 1990s);¹²¹ from "government statistics" (13 per 1000 for 1992);¹²² and from government life tables (8.5 per 1000 for 1995).¹²³ Perhaps the most credible figures come from surveys in 1993 and 1996, which reported infant mortality rates of 9.9 and 7.7 respectively.¹²⁴ Because it is unwise, where avoidable, to combine alternative series, there is little choice but to use the Hill et al. (1999) series for 1960-1995, which is identical to the World Bank (2008c) series for 1960, 1970, 1980, and 1990 (the only years available in the World Bank database prior to 1995), for analysis in the book.

8. Thailand

Thais are legally obliged to report deaths within 24 hours and births within 15 days,¹²⁵ but the country's official vital registration statistics have serious deficiencies.¹²⁶ Until about

¹¹⁹ World Bank 1979: 114.

¹²⁰ Suh 1985: 33.

¹²¹ Haub 2000.

¹²² Mehrotra, Park, and Baek 1997: 277.

¹²³ Korea NSO 1998: 94.

¹²⁴ 1993: KIHSWA 2002; 1996: OECD 2002: 42.

¹²⁵ Krongkaew 1982: 69.

1980, less than half of Thai births took place in medical facilities. Many Thais were unaware of, or unconcerned with, the legal obligation to report births and deaths, and many such reports disappeared during the compilation process.¹²⁷ As early as 1930 a member of the royal family lamented "that the accuracy of original returns, especially those from outside the Registration Area of Bangkok, are subject to question."¹²⁸ Estimates of birth underregistration during the 1960s and 1970s ranged from 15 to 30 percent.¹²⁹ Estimates of death underregistration were even higher. The death rate measured by vital registration statistics was only 50 percent of that measured by the 1964-65 Survey of Population Change and only 59 percent of that measured by the 1974-75 round of the same survey.¹³⁰

In Thailand as in other countries, the reporting of infant deaths is even less complete than the reporting of deaths at older ages. Unlike in most other countries, however, infant death reporting deteriorated from 1960 to 1980.¹³¹ The infant mortality rate estimated by the 1964-65 Survey of Population Change, 84 per 1000, was about two and a half times as high as the vital registration-derived figure of 31 per 1000. Twenty years later, the rate estimated by the 1985-86 Survey of Population Change, 41 per 1000, was more than four times as high as the vital registration figure of 10 per 1000. In 1996, vital registration statistics put Thai infant mortality at 6 per 1000, lower than in the United States, whereas the 1995-96 Survey of Population Change generated an estimate of 26 per 1000 (itself on the low side of alternative estimates in Table 8a), more than four times the 1996 vital registration figure.

¹²⁶ Hill, Vapattanawong et al. 2007.

¹²⁷ Rungpitarangsi 1974: 11.

¹²⁸ Varavarn 2000 [1930]: 215.

¹²⁹ Knodel and Debavalya 1978: 34; Krongkaew 1982: 69; Luther, Dhanasakdi, and Arnold 1986: 1; Thailand. MoPH 1981: 8.

¹³⁰ 1964-65: Rungpitarangsi 1974: 11. 1974-1975: Porapakkham 1986: 15.

¹³¹ Luther, Dhanasakdi, and Arnold 1986: 11.

By the early 1980s the Ministry of Public Health had come to recognize that "deaths are highly underreported in the provincial vital registration system, and the proportion of underreporting is highest for infant and child deaths. This makes vital registration data generally useless."¹³² Accordingly, the infant mortality statistics that the Ministry reported on its web site in 2002¹³³ were derived from the Survey of Population Change. One organization that did make use of vital registration-based infant mortality statistics is the Thailand office of the United Nations Development Programme.¹³⁴ A major focus of the organization's Human Development Report of Thailand 1999 was to compare human development achievements across the country's 76 provinces (changwats). The use of vital registration-derived infant mortality rates seriously compromises such comparisons. Infant death records are usually far less complete in a country's poor provinces than in its rich ones. Hence, the actual infant mortality gaps between Thailand's poor and rich provinces may be wider than the Report's vital registration-based tables make them appear. These vital-registration based estimates do seem to be both underestimated and compressed. All but a handful of the 76 provinces have recorded infant mortality rates of between 5 and 15 per 1000, and most of the provinces that fall outside this range have recorded rates of 1 or 2 per 1000, well below the infant mortality rate of New Hampshire (4.3 per 1000 in 1997), which in the late 1990s had the lowest infant mortality among the US states. In the Indonesia Human Development Report 2001, provincial and district (regency/city) infant mortality rates were calculated from census and survey data by indirect methods.¹³⁵ This technique seems preferable to the Thai method of simply reporting the seriously underestimated infant mortality figures from vital registration data.

¹³² Thailand. MoPH 1981: 19.

¹³³ Thailand. MoPH 2002.

¹³⁴ UNDP-Thailand 1999.

¹³⁵ Indonesia BPS 2002.

The inadequacies of Thailand's vital registration statistics require derivation of estimated infant mortality rates from survivorship questions in censuses and surveys. Thailand's first modern census was taken in 1909-1911; subsequent ones were taken in 1919, 1929, 1937, 1947, and every tenth year from 1960 to 2000 inclusive.¹³⁶ More recent censuses, including those of 1970 and 1980, have included questions about the number of children ever born and the number of children surviving.¹³⁷ The census data have problems of their own. One group of researchers found "marked underenumeration of the 0-4 age group in each census [1960, 1970, and 1980] and especially in the 1960 census, in which age rounding was apparently prevalent."¹³⁸ Others have suggested that the 1960 census was better than the 1970 census, during which insurgencies were taking place and for which populations in some areas had to be estimated rather than enumerated.¹³⁹ Despite these problems, infant mortality rates calculated from answers to survivorship questions in the 1970 and 1980 censuses were not too far off from those produced for 1965 and 1975 from the Surveys of Population Change (Tables 8a and 8b).

Thailand, in short, has a poor vital registration system, but also produces extensive and fairly reliable census and survey data from which to estimate infant and child mortality. The Survey of Population Change provides a reasonable estimate of infant and child mortality rates in 1995-6, and the Hill et al. estimates (1999), which utilize the highest-quality sources recorded in Tables 8a and 8b, provide credible figures for the period from 1960 to 1990. The most recent infant mortality estimate for Thailand with a solid empirical basis at the time of this writing was derived from a Multiple Indicator Cluster Survey conducted from December 2005 to April 2006

¹³⁶ Das Gupta et al. 1974: 36; Domschke and Goyer 1986: 851-58; Thailand. NSO 2002.

¹³⁷ Domschke and Goyer 1986: 855, 857.

¹³⁸ Luther, Dhanasakdi, and Arnold 1986: 19.

¹³⁹ Rungpitarangsi 1974: 10.

by Thailand's National Statistical Office with the collaboration of UNICEF and other national and United Nations agencies. This study was "the largest survey on the situation of women and children ever carried out in Thailand."¹⁴⁰ On the basis of child survivorship questions asked in this survey, researchers estimated that Thailand in mid-2003 had an under-5 mortality rate of 10 per 1000 and an infant mortality rate of 9 per 1000. Reconciling these figures with estimates derived from census and survey data for earlier years, a group of experts from United Nations organizations assigned Thailand in 2005 an under-5 mortality rate of 8.4 per 1000 and an infant mortality rate of 7.7 per 1000 (Book Table A1).¹⁴¹

9. Indonesia

Before 1900 birth and death records for Indonesia existed only for the island of Java. Such records date back to the British occupation of 1811-1816, when all Javanese village heads were required to keep records of births and deaths in order to facilitate a taxation system (a practice retained by the Dutch after they returned in 1816). Birth and death records were flawed by underregistration and other problems, but they remain, along with a few local surveys after 1860, the main source of population data for Java in the 19th century.¹⁴² Fairly good vital registration systems emerged in a few Javanese localities in the late 1930s, but the Japanese occupation (1942-45) and subsequent hostilities with the Dutch (1945-49) halted this progress.¹⁴³ Vital registration recovered after 1950, but continued to be "marginalised as a source of demographic data" because of underregistration.¹⁴⁴ As late as the 1990s, the vital registration

¹⁴⁰ UNICEF Office for Thailand 2007: 4.

¹⁴¹ World Bank 2008 (Country Data Sheet for Thailand).

¹⁴² Widjojo 1970: 24-25, 42-47, 58, 62.

¹⁴³ Dasvarma 1986: 61-62; De Haas 1939: 16; Hugo et al. 1987: 132; Hull 1997: 288; Muhidin 2002: 151; Widjojo 1970: 94, 101-103, 139, 144.

¹⁴⁴ Hull 1997: 288.

system in Indonesia recorded less than 60 percent of births and deaths.¹⁴⁵ Inadequate funding and poor coordination among government agencies, rather than any lack of willingness on the part of the population to cooperate, were mainly responsible for the inadequacy of the system.¹⁴⁶ Good vital registration records permit more direct and timely estimates of mortality rates than do census or survey data, and as Iskandar noted, "at some point the unit cost of developing accurate death records from an established registration system is considerably less than that needed to obtain reliable and valid data from retrospective surveys."¹⁴⁷

Given the deficiencies of vital registration data, it is felicitous that "the Central Bureau of Statistics (BPS), often in collaboration with other government agencies, has done an excellent job of designing and implementing surveys and censuses from which it is possible to estimate some simple measures of fertility and mortality."¹⁴⁸ Census data are the main source of mortality estimates for the period from 1920 to 1960. The 1920 and 1930 censuses under Dutch colonial rule enumerated only parts of Java. Estimates from other areas were turned in by village heads, and the process varied according to region, making it hard to produce nationwide mortality estimates.¹⁴⁹ No censuses were taken between 1931 and 1960, and political turmoil contributed to the loss of all information from the 1961 census except for data covering Jakarta, Yogyakarta, and East Java. The censuses of 1971, 1980, and 1990 covered the whole country, but the census of 2000 was again compromised by political instability, forcing the government to sample rather than enumerate several regions.¹⁵⁰ Each of the four censuses from 1971 to 2000 included

¹⁴⁵ Iskandar 1997: 228.

¹⁴⁶ Hull 1997: 288-289; Iskandar 1997: 205-206.

¹⁴⁷ Iskandar 1997: 230.

¹⁴⁸ Hull 1997: 286.

¹⁴⁹ Domschke and Goyer 1986: 647-648; Muhidin 2002: 127; Widjojo 1970: 3.

¹⁵⁰ Bresnan 1993: 23; Dasvarma 1986: 62; Domschke and Goyer 1986: 648-649; Muhidin 2002: 131.

questions to ever-married women about children born and children surviving.¹⁵¹ The responses to these census questions were used to produce indirect estimates of infant mortality (Table 9).

Since the 1960s the Central Bureau of Statistics (Badan Pusat Statistik, BPS), the main government statistical agency, has estimated infant and child mortality levels mostly by sample surveys in which ever-married women are asked questions about ever-born and surviving children. The BPS conducted a National Socioeconomic Survey (SUSENAS) in most years after the mid-1960s and in each year from 1989 to 2000. It also administered Intercensal Population Surveys (SUPAS) in 1976, 1985, and 1995.¹⁵² The BPS surveys and the reports based upon them have been criticized for confusing questions, inadequate pretests, small samples, and misleading precision, but they provide, along with Macro International's Demographic and Health Surveys of 1987, 1991, 1994, and 1997, indispensable data on infant and child mortality in Indonesia after 1960.¹⁵³ Estimates of infant mortality based on these surveys are included in Table 9.

A Demographic and Health Survey was taken in mid-2007, but infant mortality estimates based on its findings were not available at the time of this writing, and were not factored into the World Bank infant mortality estimates in Table A1 in the book. In fact, the most recent empirical observations used in the calculation of the World Bank estimates come from birth histories and survivorship questions in the Demographic and Health Survey of 2002-2003, and correspond to the year 2000.¹⁵⁴ The infant mortality estimate for 2005 presented in Table A1 is a projection based on data points from before 2000.

¹⁵¹ Domschke and Goyer 1986: 653; Muhidin 2002: 130-132, 136.

¹⁵² Muhidin 2002: 134-140.

¹⁵³ Criticisms of the BPS surveys are advanced in Betke 2001: 5-10; Hull 1997: 286-288; and Iskandar 1997: 228.

¹⁵⁴ World Bank 2008 (Country Data Sheet for Indonesia).

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