

Population Health Measures as Indicators of Fertility Change

A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy at George Mason University

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Fall Semester 2008
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Dedication

This work is dedicated to Natalie Elise and Jakob Michael, my greatest accomplishments in life.

Acknowledgements

I would like to thank my children, Natalie and Jakob, for their incredible love, support and sacrifice in this long endeavor. To my parents, Walt and Donna Metscher, I owe more than I can ever repay. Your unwavering belief in me has been essential to any success I have achieved. I am indebted to all my friends, family and colleagues who have provided endless encouragement and counsel.

I am so grateful for the support and mentorship of Dr. Aranuld Nicogossian who has supported me throughout my years of study and research at GMU, and especially through my deployment to and return from Iraq; to Dr. Jack Goldstone, my Committee Chair, who has patiently guided me through this long process; and to Dr. Kathryn Jacobsen and Dr. Richard Niska for their valuable input in the refinement of this manuscript. The faculty and staff of the School of Public Policy have been incredibly helpful and supportive in every way and I am truly grateful for their contributions to this work.

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Abstract

POPULATION HEALTH MEASURES AS INDICATORS OF FERTILITY CHANGE

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This dissertation examines the relationships among measures of mortality, fertility, burden of disease, and socioeconomic factors. Regression modeling is used to determine (1) whether population mortality or child mortality better forecasts fertility levels; (2) if a child health model provides a stronger indicator of fertility than child mortality alone; and (3) what impact socioeconomic controls have on the application of these models. A global dataset of 143 countries over a fifteen-year time span (1990-2005) is used. Results indicate that both the child mortality rate and the child health model are strong indicators of fertility change and produce better results than population mortality or socioeconomic factors alone. Use of health measures has an additional advantage over child mortality: health indicators are easily linked to policy and lend themselves to action. The models were then applied at the country level with regional data from India, Mexico, and the Philippines. As with the global analysis, population mortality was found to be a relatively poor indicator of fertility levels. However, the performance of the child health

model varied significantly, as did the significance of individual predictor variables within the model. In all country analyses, the model assisted in the identification of the child health factors that are most related to fertility rates within each particular setting. The use of health measures as indicators of fertility change adds value in two ways: (1) by facilitating the linkage of changes in fertility levels to specific contributing factors that can inform good health policy decisions and (2) by associating health status to population growth, health advocates can elevate the importance of health policies among the many competing national priorities.

1. Introduction

The Malthusian premise states that populations will always tend toward growth but will inevitably be held in check by controls such as war, disease, and famine. Thomas Malthus' theories were based on an integral relationship between mortality and fertility. An underlying assumption is that war, disease, and famine result in death. In modern society, they often do not. As a result, impacts of disease and injury, short of death, must be considered an important factor in population growth and fertility projections. If populations naturally tend toward growth, but the traditional population controls noted by Malthus no longer check population growth in the same way, then other dynamics for exploring the mitigation of population growth should be explored.

Prior to the development of the advanced mathematical models in use today, population health was traditionally evaluated in terms of life expectancy because it was relatively easy to estimate.¹ Additional measures for health include infant mortality and child mortality, which also lend themselves to relatively easy measurement. Because fertility is expected to respond to changes in mortality, these measures of mortality have long been used as predictors of changes in fertility.² Lower levels of mortality, as more

¹ Life expectancy reflects the overall mortality of a population, across all age groups. Life expectancy is estimated from a life table, which is a series of estimates of the probability of dying, the death rate, and the number of survivors per age group. (World Health Organization. <http://www.who.int/whosis/indicators/2007LEX0/en/index.html>)

² See elaboration in Section 2.1.2.

individuals and especially children survive, are generally expected to lead to lower levels of fertility.³

However, with socioeconomic development and advances in technology, there are changing patterns of disease and disability that may also significantly impact fertility patterns. People who in earlier times would likely have died from disease or injury are now able to survive, but the impact of their disease or injury may impact child bearing, reliance on children for support, or the ability to sustain a family. Ultimately this could change the desired or actual number of children born. A drop in population mortality may not lower fertility if the disease burden remains high.

Both mortality and morbidity may have significant roles in the decisions that families make about how many children to have. Theories of demographic transition (discussed in section 2.1.) hypothesize a significant relationship between mortality and fertility. Observed populations have typically started with high levels of mortality and high levels of fertility, but eventually transition to a stable state of low mortality and low fertility. While causation is not definitively established, socioeconomic development and improvements in health and technology are likely among the contributing factors.

³ Benefo, Kofi and T. Paul Schultz. 1996. Fertility and child mortality in Cote d'Ivoire and Ghana. *The World bank Economic Review* 10 (1): 123-156. Also Frank W. Notestein, The population of the world in the year 2000, *Journal of the American Statistical Association*, 45, no. 251 (1950): 335-345. Also Warren S. Thompson, Population, *The American Journal of Sociology*, 34, no. 6 (1929): 959-975. Also Keith Montgomery, *The demographic transition* (Department of Geography and Geology, University of Wisconsin, 2006), available from <http://www.uwmc.uwc.edu/geography/Demotrans/demtran.htm>; Internet; accessed November 2006. Also John Cleland, The effects of improves survival on fertility: A reassessment. *Population and Development Review* 27, Supplement: Global Fertility Transition (2001): 60-92. Also T. Paul Schultz, *The fertility transition: Economic explanations* (New Haven, CT: Yale University, 2001).

Morbidity reflects the health of populations, and is primarily measured in terms of incidence (new) and prevalent (existing) of illness, disease, impairment, or disability. Morbidity-related measures may provide a more comprehensive picture of the well-being of populations, since they capture the impact of diseases and injuries that cause impairment as well as those that cause death.

With theoretical bases in demographics, fertility, and the burden of disease all proposing relationships between both *mortality and fertility* and *morbidity and fertility*, it is a worthy exercise to examine whether changes in health measures may be more closely correlated to changes in fertility levels than measures that use only mortality.

Theories about demographic transitions often describe changes in population distributions over time as a function of linked changes in mortality and fertility. Demographic changes are clearly a function of births and deaths, but the precise nature of the interaction between the two is quite complex and many intervening variables impact both. Fertility transition theories attempt to capture the dynamic of noticeable and sustained declines in fertility rates that accompany demographic transitions.

A better understanding of how both burden of disease and socioeconomic variables impact population change through fertility will inform policymakers in the development of strategies for health improvement, social programming, and managing population growth.

2. Literature and Theory Base

This section will provide a brief review of the literature and theories that form the basis for this research. First, the theories of demographic transition will be explored, particularly in relation to theories of fertility transition. Second, the literature on burden of disease theories and measures will be addressed. Lastly, will be a discussion of theories that establish socioeconomic development as an important component of demographic and fertility change.

2.1. Demographic Transition

Frank Notestein's pioneering 1945 article on population projections for the year 2000 provided the first comprehensive description of what is now known as the demographic transition.⁴ The standard definition for the demographic transition is *a population moving from a situation with high fertility and high mortality to a period of low fertility and low mortality.*

⁴ Per Dudley Kirk, Demographic transition theory. *Population Studies* 50, no. 3 (1996): 361-387.

The modern transition model typically has four stages.^{5,6} Stage One describes a pre-modern state, in which high fertility and mortality rates are relatively stable. Stage Four describes a post-industrial state that marks the conclusion of the transition and return to stability with low levels of both mortality and fertility. Stages Two and Three are intermediate transitional stages. Stage Two reflects the industrializing state when mortality begins to fall while fertility rates are unchanged or rising. Stage Three reflects the maturation of the industrialization and the start of a decline in fertility. Stage Three relies heavily on fertility theory for justification and evaluation.

2.2. Demographic Theories of Fertility Transition

The fertility transition is characterized by a noticeable and sustained decline in rates of human fertility. Studies have shown that when a country achieves a drop of 10% in the fertility rate it will never see sustained fertility growth again.⁷ The period leading up to the 10% decline in fertility is referred to as the *onset*. In essence, *onset* begins when the fertility rate first shows any decrease, and once fertility reaches a 10% drop, the

⁵ Thompson's (1929) original model categorized all countries as falling into three groups based upon the relationship between births and deaths. In 1934, Adolphe Landry labeled the three groups primitive, intermediate, contemporary. (Kirk 1996, 362) Notestein (1950) labeled these three groups as (A) Incipient Decline, (B) Transitional Growth, and (C) High Growth Potential (Sources: Frank W. Notestein, The population of the world in the year 2000, *Journal of the American Statistical Association*, 45, no. 251 (1950): 335-345. Also Warren S. Thompson, Population, *The American Journal of Sociology*, 34, no. 6 (1929): 959-975.

⁶ Keith Montgomery, *The demographic transition* (Department of Geography and Geology, University of Wisconsin, 2006), available from <http://www.uwmc.uwc.edu/geography/Demotrans/demtran.htm>; Internet; accessed November 2006; see also John Cleland, The effects of improved survival on fertility: A reassessment. *Population and Development Review* 27, Supplement: Global Fertility Transition (2001): 60-92.

⁷ T. Paul Schultz, *The fertility transition: Economic explanations* (New Haven, CT: Yale University, 2001).

onset period is concluded and the transition period begins.⁸ A major challenge among researchers is projecting the timing and pace of these fertility transitions because the point in their development at which countries have experienced fertility decline is widely variant. Additionally, the rate at which fertility declines, once the first drop in fertility is identified, is also widely variant. For example, the *onset* for fertility transition has been documented in many countries. Belize and Guatemala took more than 30 years to hit *onset* from the point where initial decline began, while Mexico took only 15 years.⁹ Once *onset* is achieved, the rate of transition is measured separately, and also varies significantly. Some countries have completed transition, while others are still in the process (or not even begun). For countries that have transitioned, Caldwell (2001) notes that in Europe the transition stage typically has taken about 26 years and in the Middle East it has taken about 15 years.¹⁰

Many different dynamics influence this process including the social, economic, and political environments of each country. Generally, countries experiencing more rapid socioeconomic development and having more proactive agendas on population management can accelerate the timing of transition.¹¹ Despite significant documentation and research on fertility transitions in Europe, some warn against using this as a predictor for developing areas such as Sub-Saharan Africa that may take much longer because of

⁸ Also note that fertility transitions are distinct from demographic transition in that they do not incorporate a mortality component.

⁹ John C. Caldwell, Regional paths to fertility transition. *Journal of Population Research*. (2001a).

¹⁰ As of 2001, only one country in Sub-Saharan Africa had reached this milestone, so it is premature to make projections about this region. (Caldwell 2001a)

¹¹ Dirk J. Van de Kaa. Europe's second demographic transition. *Population Bulletin* (1987) 42, no.1. See also John C. Caldwell, The globalization of fertility behavior, *Population and Development Review* 27, Supplement: Global Fertility Transition (2001): 95-115.

the notable social and economic disparities in this subcontinent.¹² These disparities create uneven development, with some segments of society experiencing a fertility transition while others segments are left behind. Many of the extensive studies of fertility have looked at European countries which had fewer relative disparities during their periods of transition and cannot replicate conditions in Sub-Saharan Africa.

The European Fertility Project, initiated by Princeton University in 1963, contributed greatly to capturing many of the temporal and spatial dynamics of the demographic transition in early transitioning countries.¹³ Both socioeconomic development and shifts in mortality have been established as longstanding factors in transition. Interestingly, the work of Knodel and van de Walle (1979) in this area could not substantiate the premise that declines in mortality preceded declines in fertility.¹⁴ Declines in both mortality and fertility always occurred in conjunction with a transition, but the sequencing varied. Research published by Bongaarts and Watkins (1996) found no immediate correlation between the two.¹⁵ Their study concluded that while socioeconomic development is a crucial component of fertility change, proximity to other transitioning countries may also significantly impact transition.

¹²Caldwell 2001, The globalization of fertility behavior.

¹³ Ansley J. Coale and Susan Cotts Watkins (eds.). *The Decline of Fertility in Europe: the Revised Proceedings of a Conference on the Princeton European Fertility Project*. Princeton University Press, 1986.

¹⁴ John Knodel and Etienne van de Walle, Lessons from the Past: Policy Implications of Historical Fertility Studies, *Population and Development Review* (1979): 217-45.

¹⁵John Bongaarts and Susan Cotts Watkins, Social Interactions and contemporary fertility transitions. *Population and Development Review* 22, no. 4 (1996): 639-682.

Fertility transitions are underway – or nearly complete – in much of the world. In 1970-75, 60% of countries had rates of 4.5 or higher per woman. By 1985, this was 50%; by 1995 only 40% of countries had rates of 4.5 or higher.¹⁶ The United Nations (UN) has projected that most countries will complete their demographic transitions by 2050.¹⁷ But regions and countries move at strikingly different rates due to the unique characteristics of each area, so it is important to monitor how these changes are affecting populations. Identifying indicators and trends from early transitioning countries may provide valuable information for other regions that are still in early stages of transition.

Sub-Saharan Africa is the late-comer to fertility transition. Of the fifty countries currently classified by the UN as *least developed*, thirty-four are in Sub-Saharan Africa. At the turn of the century, about 25% of countries in this region had been identified as beginning a decline, but many of these countries have not yet hit the 10% decline criteria that defines onset for decades. In 1996 the fertility rate for all of Sub-Saharan Africa was 8.0.¹⁸ In 2006, the aggregate fertility rate was just above 6.0.¹⁹

The existing research on the fertility transition evaluates fertility changes in light of population mortality changes as reflected in the stages of demographic transition, which posits that declines in fertility relate to declines in population mortality. But population mortality is just one of many mortality measures. Perhaps the most basic is the *crude death rate* (CDR), which is the total number of deaths per 1000 people in a

¹⁶ Source: Rodolfo A. Bulatao, Introduction. *Population and Development Review* 27, Supplement: Global Fertility Transition (2001): 1-14.

¹⁷ John Bongaarts, *Completing the fertility transition in the developing world: The role of educational differences and fertility differences* (New York: Population Council, 2003), 177.

¹⁸ Kirk 1996.

¹⁹ Caldwell 2001a; Bongaarts 2003.

specified population during a specified time period (often one year). This measure is broad, easily comparable (especially when age-adjusted rates are calculated), and adjusted to population size because it is based on a *per capita* scale. It is often used in the calculation of indicators such as the Rate of Natural Growth within a population (crude birth rate minus crude death rate). The terms *mortality rate* and *crude mortality rate* are equivalent to the term *crude death rate*. Other measures of mortality rate include *infant mortality rate* (IMR), which is the number of deaths of children between birth and the first birthday per one thousand live births, and the *child mortality rate* (CMR), which is the number of deaths of children less than 5 years old per one thousand live births. An alternate version of the CMR only includes children between one and five years old, which keeps the populations measured by the IMR and CMR from overlapping. When a CMR is reported, the age range included should be clearly noted. Unless otherwise stated, CMR in this manuscript will refer to the mortality rate for children under the age of 5 (0-5 years).

2.3. Theories for Determinants of Fertility Change

Socioeconomic Theories

Socioeconomic development undoubtedly has an impact on fertility behavior.²⁰ The resources available to individuals and families influence household decision making, and key among these decisions is family size. The addition of children to a family has both costs and benefits. Economic utility may demonstrate a basis for household demand

²⁰ A more in-depth treatment of the impact of socioeconomic variables is provided in Section 5.

for children, but that demand must be considered within the framework of a society. The household does not exist in a vacuum, but thrives or languishes within a societal context. A traditional pre-industrial rural family-farming household may value offspring differently than a post-industrial urban wage-earning household.

A good starting point for highlighting the relationship between socioeconomic factors and fertility is to evaluate how these factors have historically aligned with the timing of transition. Baschieri (2005) emphasizes the importance of social and economic modernization in formulating explanations for changes in fertility.²¹ In contrast, Guengant (2002), contends that the onset of the fertility transition is not dependent on level of development or other socioeconomic factors, but concedes that evaluation of those proximate determinants are certainly relevant.²² Bulatao (2001) identified a diverse array of explanations for fertility transition that touch upon many aspects of societal development including the changing economic contributions of children, the opportunity costs of childbearing, family transformation, improved opportunities for fertility regulation, and delays in marriage, among others.^{23,24}

Microeconomic Theories

Socioeconomic change is not the only theory of fertility. In the 1950s and 1960s, economists Becker and Leibenstein posited that fertility was both a conscious decision

²¹ Angela Baschieri, The effect of modernization on desired fertility in Egypt. In *Population Association of America 2005*, (Philadelphia, PA: Southampton Statistical Science Research Institute, 2005), 37.

²² Jean-Pierre Guengant, *The proximate determinants during the fertility transition* (United Nations, 2002).

²³ Bulatao, 2001.

²⁴ (1) mortality reduction, (2) reduced economic contributions from children, (3) opportunity costs of childbearing, (4) family transformation, (5) vanishing cultural props for childbearing, (6) improved access to effective fertility regulation, (7) marriage delay, and (8) diffusion.

and a purposeful act that could be explained by a simple intuitive micro-economic model.²⁵ Leibenstein used utility/disutility theories to determine whether a family would have an *n*th child, and Becker incorporated fixed assumptions for utility-maximizing behavior to demonstrate a household production function.²⁶

Pritchett supports the widely held economic theory that actual fertility reflects a conscious desire for additional children and that couples can generally control their fertility.^{27,28} Pritchett's research seeks to validate the relationship between desired and actual fertility. He shows that 90% of inter-country differences in actual fertility can be explained by variances in desired fertility. The case for incorporating utility into fertility decisions is strong, but most acknowledge that development factors also have significant influence.

From the perspective of utility, children may be an ideal commodity because acquisition incurs minimal upfront costs, but long-term benefits can be considerable.^{29,30} If the bearing of children has utility for a household, then it would follow that the loss of a child would likely prompt some response to that lost utility. Robinson breaks the economics of fertility theory into two schools: the *Chicago/Becker* school and *everyone*

²⁵ A supply function was later added to this model by Easterlin.

²⁶ The demand for children is actually a demand for the services they will provide over time.

²⁷ Lant H. Pritchett, Desired fertility and the impact of population studies, *Population and Development Review* 20, no. 1 (1994): 1-55.

²⁸ Family planning advocates dispute this position, believing that higher levels of fertility are due to lack of contraception.

²⁹ Robinson 1997.

³⁰ Robinson notes that this can make high fertility especially attractive for low-income households.

else.³¹ While Becker and the Chicago School emphasize a utility function, “everyone else” favors expanded emphasis on socioeconomic factors.

Many researchers have explored the relationship between child mortality and fertility behavior. Benefo and Schultz (1996) showed that child mortality can increase the demand for more children.³² This demand can be manifested in two primary ways: replacement behavior and anticipatory loss behavior. The former refers to increased fertility following the actual loss of a child, thus the household *replaces* the lost child with another. The latter refers to fertility behavior where a household anticipates that a certain percent of offspring will not survive to adulthood and, therefore, *desired fertility increases in anticipation of future losses*.

Others researchers provide additional support for these theories. Olsen (1983) investigated replacement theories and found that the direct replacement approach (also referred to as responsive fertility) depended on a household having a preference for a set number of children.³³ He referred to anticipatory loss behavior as *hoarding* and noted that it was a function of the prevailing mortality rate. He then took the theories a bit further and described two additional variations on the theories, which included *societal replacement* and *biological replacement*. *Societal replacement* reflects societal customs and is related to hoarding. *Biological replacement* is more closely related to direct replacement and involves the change in intervals to subsequent births following the death

³¹ Warren C. Robinson, The economic theory of fertility over three decades. *Population Studies* 51, no. 1 (1997): 63-74.

³² Kofi Benefo and T. Paul Schultz, Fertility and child mortality in Cote d'Ivoire and Ghana, *The World bank Economic Review* 10, no. 1(1996): 123-156.

³³ Randall J. Olsen, Mortality rates, mortality events, and the number of births, *The American Economic Review* 73, no. 2 (1983): 29-32.

of an infant. Cleland (2001) found that while replacement behavior was demonstrated by a modest effect, hoarding behavior was not strong at all.³⁴ He explained this contradictory finding by emphasizing that hoarding behavior requires probabilistic reasoning, and that people generally do not employ such strategic thought processes in fertility decisions.

Bridging Theoretical Concepts

The theories that identify a relationship between child mortality and fertility align with the demographic transition theories that posit that a decline in mortality precedes a decline in fertility. Olsen (1983) notes that “demographic transition theory views a decline in infant mortality as a pre-condition for a decline in fertility.”³⁵ Although initial theories in fertility transition mutually supported this concept, it has been demonstrated that it is not always true.³⁶ The dominant theories in the 1960s argued that reductions in child mortality would reduce fertility, but by the 1970s declines in mortality had not been matched by associated declines in fertility.³⁷

Cleland asserts that “little support has been found for the highly plausible thesis that mortality exerts a direct, albeit lagged, influence on fertility through the conscious realization by parents that they no longer need to have so many children as an insurance against possible future child losses. At the aggregate level, mortality decline in the

³⁴ Cleland 2001.

³⁵ Olsen 1983, 29.

³⁶ Kirk 1996.

³⁷ James Trussell and Randall Olsen, Evaluation of the Olsen technique for estimating the fertility response to child mortality, *Demography* 20, no. 3 (1983): 391-405.

developing world has always preceded falls in natality but no further empirical regularities, or generalizations, about their relationship have been identified.”³⁸

2.4. Burden of Disease

The underlying theories of demographic transition, mortality, and fertility shifts that were examined in the previous section provide a basis for the relationships between *fertility and population mortality*, and also between *fertility and child mortality*. In this section, the underlying concepts of societal welfare exemplified by mortality measures are expanded to evaluate the comprehensive effects of burden of disease. The theory base for the burden of disease and its measures are briefly explored to set the stage for the development of a child health model that can reflect the dynamics of disease burden.

Over time, the measures of population health have expanded to include measures of morbidity that are based on the ideas that that death is not the only burden imposed by disease and that different diseases vary in duration and severity. In 1976, Zeckhauser and Shepard introduced the Quality Adjusted Life Year (QALY) as a measure of the non-fatal impacts of disease on survivors.^{39,40} Their article was a launching point for spirited discussion about valuation of lives, and in particular the value of lives by age. In the 1980s the World Bank (WB) and the World Health Organization (WHO) started a collaboration to estimate the burden of disease on a global scale. The groundwork for the Global Burden of Disease and Injury Study began in 1988 when the World Bank initiated

³⁸ Cleland 2001, 63.

³⁹ Richard Zeckhauser and Donald Shepard, Where now for saving lives?, *Law and Contemporary Problems* 40 (1976): 5-45.

⁴⁰ The QALY introduced a scale which reflects a composite impact from disease (including intensity and duration). It is scored on a 0-1 scale where “0” would be death and “1” would be perfect health.

a four-year Health Sector Priority Review.⁴¹ Harvard professor Christopher J.L. Murray introduced the concept of the Disability Adjusted Life Year (DALY) as a “common measure of effectiveness for the review to use across interventions dealing with diverse diseases.”⁴² The DALY incorporates both *Years of Life Lost* (YLL) and *Years Lived with Disability* (YLD), and has been the dominant approach to burden of disease calculations since its publication.⁴³

The World Health Organization’s 1993 World Development Report, with a theme of *Investing in Health*, endorsed the DALY and set the stage for the DALY to become the standard measure of burden of disease. Murray subsequently published an expanded explanation of the methodology for estimating DALYs. While he acknowledges the limitations inherent in trying to develop global disability weights, the DALY remains the most commonly used measure of population morbidity.⁴⁴

The quantification of burden of disease is an inexact science that is undergoing constant revision and refinement by health scientists and also economists and policy-makers, for whom this calculation has tremendous potential for assisting in the evaluation of cost-effective interventions that not only relieve the disease burden, but also promoting development and economic growth and foretelling patterns of population growth. It is this potential that makes the ongoing evolution of burden of disease measurements so important.

⁴¹ The actual Global Burden of Disease and Injury Study would begin in 1992.

⁴² Dean Jamison, Forward to The Global Burden of Disease and Injury Series, in *The global burden of disease*, Eds. Christopher J.L Murray and Alan D. Lopez, (Harvard University Press, 1996). xvi.

⁴³ DALY includes consideration of sex and age, but includes no other social measures.

⁴⁴ Christopher J. L. Murray, Quantifying the burden of disease: The technical basis for disability-adjusted life years. *Bulletin of the World Health Organization* 72, no. 3 (1994): 429-446. See also Lopez et al, 2006.

Since the ultimate expression of the DALY is uni-dimensional, it is possible to use the information from the measure to make resource allocation decisions. In allocating resources, costs are expressed in a uni-dimensional way (monetary units, usually dollars). In order to determine cost-effectiveness, health programs must be expressed in a similar uni-dimensional way.⁴⁵ Obviously, by taking a multi-dimensional concept such a disease burden and reducing it to a uni-dimensional measure, much of the richness of the information will likely be lost in translation.

Because mortality measures are not very comprehensive, they cannot reflect the many complexities of population health. The DALY measure provides a viable alternative to mortality measures because it is comprehensive, comparable, and uni-dimensional. It can be used to compare different populations and assess differences in one population over time.

In calculating burden of disease, there are three primary concerns discussed in the literature: age-weighting, discounting, and recognition of socioeconomic disparities. The valuing of certain age groups is inherent in any calculation of burden that considers life expectancy. Without further adjustment, the young would always be more “valued” than the old simply because there are more potential years of life lived to be lost by the young. This is known as a continuous age-weighting function. This function devalues old age and, when used to allocate resources, shifts those resources toward the young. Some support the concept of continuous age-weighting, advocating that every year lived is of

⁴⁵ Adnan A. Hyder, Guida Rotllant, and Richard H. Morrow, Measuring the burden of disease: Healthy life years, *American Journal of Public Health* 88, no. 2 (1998): 196-202.

equal value, and therefore, more is better. Williams' Fair Innings approach endorses this concept.⁴⁶

The World Bank, however, weights age based upon social values. In this approach, the young have a lower value because they are in a stage of dependency and make little productive contribution. The age-weights are greatest for those in their mid-20s because those are peak years for economic productivity. The weights gradually decrease as people age and are assumed to become less productive. This is a human capital approach, which applies unequal weights to capture differing social roles across an entire life span.⁴⁷ The WHO's Global Burden of Disease and Injury Study utilizes the human capital function.

The theory of discounting is applied in health just as it is in economics. The value of a healthy year lived in the future is not necessarily valued as much as a healthy year lived today. There is a preference for health now, and future healthy years are discounted to reflect that time preference. This is a highly controversial concept, but remains a fixed component of the DALY calculation. The DALY applies a 3% discount on future years based upon conventional expected yield on investments. This percentage is consistent with the World Bank's Disease Control Priorities Study.⁴⁸

⁴⁶ Alan Williams, Intergenerational equity: An exploration of the 'fair innings' argument. *Health Economics* 6 (1997): 117-132.

⁴⁷ Fox-Rushby and Hansen (2001) demonstrate how changing age weights and discount rates change the resulting DALY calculations.

⁴⁸ Jamison et al. *Disease Control Priorities in Developing Countries*. Washington, D.C.: Oxford University Press and The World Bank (2006).

In developing the DALY, Murray and Lopez included consideration of health outcomes that result in a loss of social welfare.⁴⁹ However, at the same time, they include only age and sex as demographic variables considered in weighing the results.⁵⁰ The weighting of sex has its basis in historical biological differences in survival potential for males and females. Gold and Muening proposed merging multiple existing measures, such as the HALY (Health Adjusted Life Year), HRQL (Health Related Quality of Life), QALY (Quality Adjusted Life Year), and DALY (Disability Adjusted Life Year), and introducing income and race variables.

There is substantial evidence that many socioeconomic factors contribute to disease burden and ought to be considered for inclusion in population health indices. Hyder et al. (1998) and Jelsma et al. (2000) evaluated DALY measures in Ghana and Zimbabwe (respectively) and found that the inability of the DALY to capture local dynamics was definitely a limiting factor.⁵¹ It is recognized however, that by making a measure broad enough to allow comparisons, the capture of local dynamics must be sacrificed.

Although the DALY is clearly the preferred quantitative measure for burden of disease at present, there are numerous constraints that limit its usefulness at this time, including the relative infancy of the measure, the lack of longitudinal collection of data in most world regions, the lack of country-level data from previous decades, the changing

⁴⁹ Christopher J.L. Murray and Alan D. Lopez. *The global burden of disease* (Harvard University Press, 1996).

⁵⁰ Christopher J.L. Murray, Rethinking DALYs. In *The global burden of disease*, eds. Christopher J.L. Murray and Alan D. Lopez (Harvard University Press, 1996), 17.

⁵¹ Hyder, Rotllant, and Morrow 1998. See also Jennifer Jelsma, Vimbai G. Chivaura, Kuakwashe Mhundwa, Willy De Weerd, and Paul de Cock, The global burden of disease disability weights, *The Lancet* 355.9220 (2000): 2079.

definitions of world regions, the shift from expert opinion to population-based valuations of health status, the continual evolution and refinement of the calculation of the measure, and improvements in mathematical modeling. There have also been improvements in the surveillance mechanisms that are used to collect quality data for use in the estimation process.⁵² The many methodological improvements in the last decade make the measure very promising for continued application, but practically void its use as a tool for longitudinal comparison during these formative years.

The first comprehensive publication of DALY estimates was calculated using data for 1990.⁵³ However, since it was a newly-developed measure, the estimates were made only at the regional level and the researchers used whatever country level evidence could be assembled to construct regional estimates.⁵⁴ As a result, the regional estimates for more developed economies are considerably more accurate than those for less developed areas that have limited health monitoring systems.

The 1990 regional estimates were designed around the eight regions defined by the 1993 World Development Report and assembled based upon a combination of geographic locations, economic strength, and population concentrations, and the resulting regions were very heterogeneous.⁵⁵ The 1990 regions were:

⁵² AD Lopez, CD Mathers, M Ezzati, DT Jamison and CJL Murray, Measuring the Global Burden of Disease and Risk Factors, 1990-2001, in *Global Burden of Disease and Risk Factors*, Lopez et al., eds. (Washington, D.C.: The World Bank, 2006)..

⁵³ Murray and Lopez 1996.

⁵⁴ Personal correspondence with Alan Lopez, March 21, 2007.

⁵⁵ The World Bank, *World Development Report 1993: Investing in Health* (Oxford: Oxford University Press, for the World Bank, 1993).

Established Market Economies
Former Socialist Economies of Europe
Other Asia and Islands
Latin America and the Caribbean

India
China
Sub-Saharan Africa
Middle Eastern Crescent

Following the publication of the 1990 estimates, the calculation methodology for the DALY was refined significantly. The next iteration of a comprehensive DALY was published in 2006 using data and population health estimates from 2001. The new methodology addressed some of the concerns about uncertainty and presented more refined country-level estimations. The World Health Organization and many individual countries have adopted the DALY methodology as a primary approach to health accounting, and its use by more countries and global health organizations continues to increase.⁵⁶

Following the publication of the 2001 estimates, data related to the DALY have been made available on the WHO website for the years 2000 and 2002, and subsequent years will be made available as work continues. However, due to the ongoing refinements in calculation methodology and unevenness of the application of the newest methods for data collection, the annual reports are not able to be used as a baseline for identifying statistical trends. (Some recent estimates have been re-calculated using older methodologies to facilitate general comparisons, but this has been done for only a few measures.)

The relatively sparse inventory of DALY estimates makes it unrealistic at this time to construct comparable datasets that would demonstrate shifts in burden of disease

⁵⁶ Lopez et al. 2006.

from a longitudinal and/or cross-country perspective. The constraints are so great that the application of any resulting analysis would be inconsequential in real life even if they turned out to be statistically significant. Until the cache of DALY estimates is more robust and consistent, other more widely-available measures must be used to evaluate the burden of disease within populations.

2.5. Socioeconomic Impacts

As noted in the discussions on demographic transition, mortality measures, and burden of disease measures in the sections above, there is reason to believe that socioeconomic variables also impact fertility rates in a potentially significant way. While the full extent of that impact is outside the scope of this research, consideration of the dynamic is included. In this section, some of the underlying theories about socioeconomic impacts on health transitions are discussed, and this provides a framework for the inclusion of socioeconomic control variables in the evaluation of models designed to forecast fertility change.

2.5.1. Socioeconomic Development

Socioeconomic development is multi-dimensional. Often seen as synonymous with modernization, it carries implications about industrialization and urbanization; improvements in communications, education, and science and technology; and advances in nutrition, health, and medical science. As socioeconomic structures evolve and technological advances reduce early deaths, the economic utility assigned to children

(and thus fertility) changes as well. The current literature on fertility theory focuses on a dynamic called the quality-quantity trade-off, which helps to explain this evolution.

Social theorists have produced frameworks that explain how societies evolve from tribal entities that rely on families and lineage to modern societies that are based on individualistic strengths manifested through collaborative networks.⁵⁷ As societies shift from an emphasis on collective strengths to valuing individual contributions, an impact on fertility decisions and the subsequent utility of children is inevitable.

Schultz has written extensively about this dynamic, and assumes that fertility goals are defined, in large part, by the number of surviving children.⁵⁸ As child survival improves there is a downward pressure on birthrates, and this is related to socioeconomic changes that create a reduced demand for the labor of children and less reliance on children for support in old age.⁵⁹ Additionally, as the cost of rearing children increases (through educational costs, the opportunity costs of adults – especially women – balancing work and family responsibilities, and other factors) the addition of more children results in greater cost and less economic utility.

Caldwell elaborates on the changes in fertility decisions in developed countries post-transition with the *wealth flow theory* of fertility decline.⁶⁰ In pre-modern societies, wealth flowed from children to their parents. The parents invested a relatively small amount in their children and reaped significant economic benefits from their children's

⁵⁷ David Ronfeldt, *Tribes, institutions, market, networks: A framework about societal evolution* (Santa Monica, CA: RAND, 1996), P-7967.

⁵⁸ T. Paul Schultz, *The Fertility Transition: Economic Explanations* (New Haven, CT: Yale University, 2001).

⁵⁹ David E. Bloom, *Global demographic change: Dimensions and economic significance* (Harvard School of Public Health, 2005).

⁶⁰ John C. Caldwell, *Demographic transition theory* (The Netherlands: Springer, 2006).

labor and support. In modern societies, that flow is reversed. If fertility decisions were solely economic decisions, then this flow reversal would imply that people would stop having children. This, of course, is not the case. Children are still born, but with greater household investment made in each child, the trade-off is quality for quantity.

While the evidence base supports the contribution that socioeconomic development makes towards fertility decline, the benefits of such development are not uniform. High income countries identified as having significant levels of gender inequality continue to have high levels of fertility.⁶¹

Societal change along with economic development is crucial to improving the status of women and reducing fertility. One study demonstrated how economic development in traditional societies that is not accompanied by societal or cultural change is harmful to the welfare of women in more traditional societies because in early stages of development inequalities initially increase until women can achieve more political and economic parity.⁶² Therefore, an examination of changes in the socioeconomic status of women in countries is highly relevant to understanding factors that contribute to reduced fertility.

One aspect of women's status shown to influence fertility decisions is the level of economic dependency on men. As discussed earlier, there are strong economic and

⁶¹ C. Safilios-Rothschild, The status of women and fertility in the third world in the 1970-1980 decade, Working Paper No. 118 (New York: Center for Policy Studies, The Population Council, 1985); see also "Raising women's status in developing countries lowers fertility rates," *International Family Planning Perspectives* 12, no. 4 (Dec 1986): 136-7; see also Cynthia B. Lloyd, The contributions of the world fertility surveys to an understanding of the relationship between women's work and fertility, *Studies in Family Planning* 22, no.3 (May-Jun 1991): 144-161; see also M. Cain, *Women's status and fertility in developing countries: son preference and economic security*, World Bank Staff Working Paper No. 682 – Population and Development Series No. 7. (Washington, D.C.: The World Bank, 1984).

⁶² A. Chaurasia, Dimensions of status of women in developing countries, *Journal of Family Welfare* 4, no. 3 (Sep 1994): 42-50.

cultural motivations for having children to support the family and the parents as they age. This creates a significant preference for sons that often leads to higher levels of fertility as families increase their number of children to ensure that there is a surviving son to provide security for the family. As women improve their social, political, and economic standing within society, it allows children of both sexes to provide security for their parents, reducing discrimination against female births and potentially decreasing fertility rates.⁶³

The improved standing of women through social and economic development provides women with more independence, a greater voice in society, more economic freedom, and access to knowledge resources that may otherwise not be available to them. As women contribute more to their families' incomes and contribute to the long term economic sustainability of their families, and invest more heavily in fewer children (quality vs. quantity) there is downward pressure on fertility rates.⁶⁴

In studying the results of World Fertility Surveys to explore how women's work roles impacted fertility, Cynthia Lloyd documented that levels of socioeconomic development explain part, but not all, of the differences in fertility among populations.⁶⁵ A range of other factors play into the complex mix of determinants of fertility. Among these is the role of population health, particularly the burden of disease borne by children in developing countries. One study showed that the overall literacy of females in the

⁶³ Cain 1984.

⁶⁴ Bulatao, 2001.

⁶⁵ Lloyd, 1991.

population impact positive child health practices (even in families where the mother was not literate).⁶⁶

2.5.2. Interaction among Socioeconomic Impacts, Burden of Disease, Mortality, and Fertility

Christopher J.L. Murray and Alan Lopez, original researchers of the Global Burden of Disease Project, state that “A population’s health status influences all components of population change. In addition to the obvious direct effect of individual health status on mortality and morbidity, it has a direct impact on fertility, largely through improved child survival, but also through the biological capability of a sick woman to bear children.”⁶⁷ Identifying relationships between population health characteristics and fertility rates lends itself to a greater understanding and use of disease burden estimates.

With a reduction in the incidence of fatal acute disease, and an increase in chronic and acute (but curable) diseases, so the death rate alone does not fully explain the complex health profile of a population. This information is, of course, far more difficult to gather and assess. There is no ideal means for collection, and the dynamics of disease identification and classification, as well as determination of disability levels, is challenging at best.⁶⁸

Within any society there is a very complex interaction that occurs among a variety of social factors, economic development, technological and scientific advances, changes

⁶⁶ Sangeeta Parashar, Moving beyond the mother-child dyad: women’s education, child immunization, and the importance of context in rural India, *Social Science & Medicine* 61 (2005): 989-1000.

⁶⁷ Christopher J.L. Murray and Alan Lopez, *Progress and directions in refining the global burden of disease approach: A response to Williams.* (2006), 17.

⁶⁸ MH Wahden, The epidemiological transition, *Eastern Mediterranean Health Journal* 2, no. 1 (1996): 8-20. Available from <http://www.emro.who.int/Publications/EMHJ/0201/02.htm>.

in population health status, and even political will. As noted earlier, a premise in many publications on fertility theory is that decreases in fertility follow decreases in mortality, and that decreases in mortality are said to follow improved economic development.

The relationship between economic development and decreases in mortality and morbidity is frequently discussed. While there is clear evidence of association between changes in the two, it is clearly not a simple cause-and-effect relationship. Szeter (2003) noted that economic growth has “ambivalent health effects.”⁶⁹ He notes that prosperity presents a greater potential for health improvements and therefore the relationship between the two might best be described as a *contingent* relationship. The illustration in Figure 1 represents a relational dynamic between economic development and health. It is interesting to note that the historical record shows that after periods of significant economic growth, the health status of a population often *decreases* until sufficient social and political will is applied to counteract the impact of development and protect the population.⁷⁰ “While economic growth may be necessary, it is never a sufficient precondition for improving population health.”⁷¹

Despite the range of theories on the dynamics of fertility change, there is almost universal agreement that there is some relationship between child and infant mortality and fertility. However, there is no agreement about the strength of the relationship, and there is insufficient evidence of causality in either direction.

⁶⁹ Simon Szeter, The population health approach in historical perspective, *American Journal of Public Health* 93, no. 3 (2003): 421-431.

⁷⁰ Szeter 2003

⁷¹ Szeter 2003, 426.

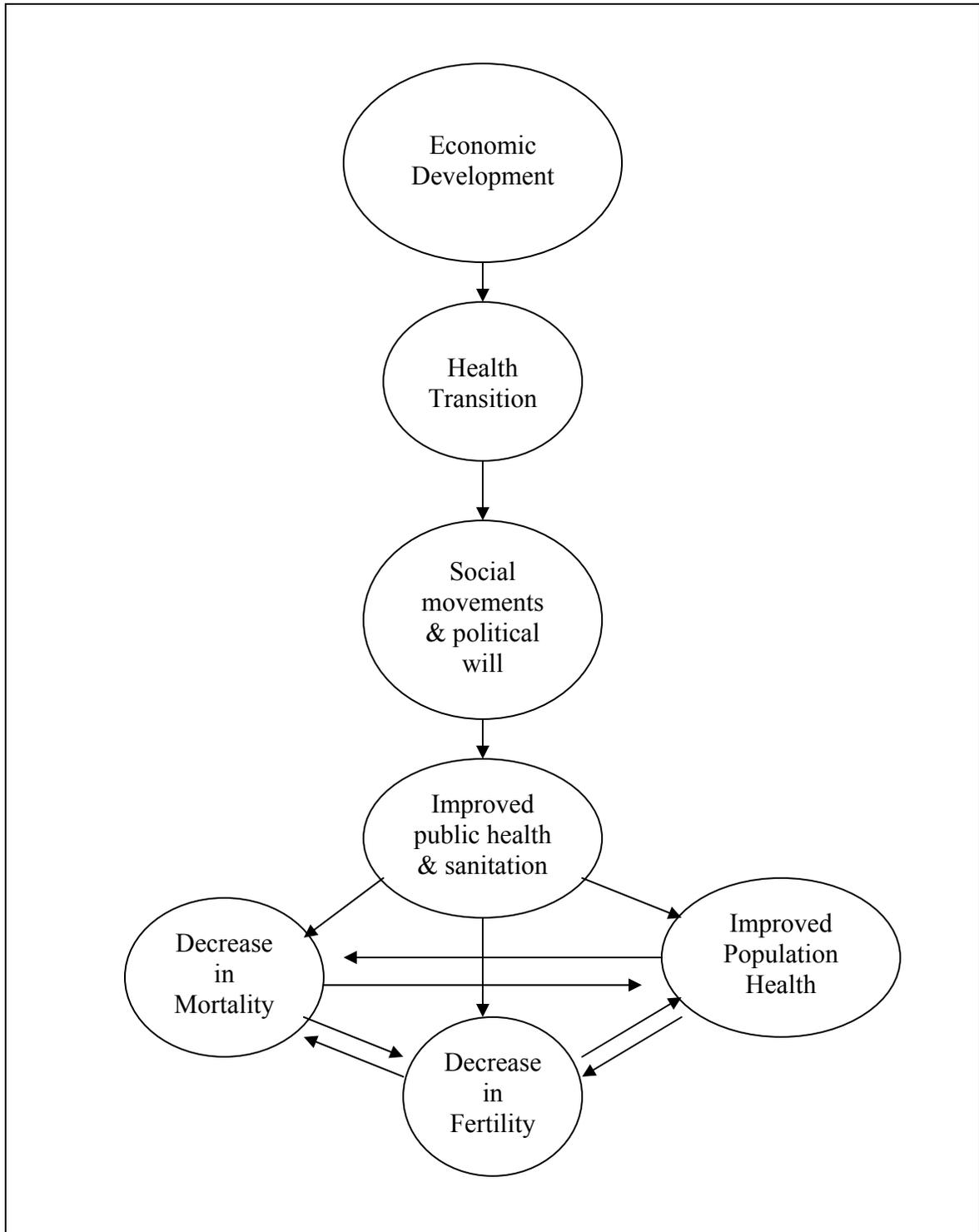


Figure 1. One possible depiction of the relationship between economic development and related changes in mortality, morbidity, and fertility.

The sequence of changes in mortality followed by changes in fertility as indicated by the demographic transition model is not consistently supported by historical fact. In some cases fertility fell before mortality declined (United States and France).⁷² The European Fertility Project found that declining mortality preceded drops in fertility as often as declining fertility preceded drops in mortality.⁷³

Caldwell (2001) challenged both the cause-effect notion promoted by Demographic Transition Theory and any implication that socioeconomic changes are the sole cause for changes in mortality.⁷⁴ This is in synch with the historical perspective presented by Szeter (2003), who asserted that focusing on the socioeconomic explanation for change “subtly downgrades the specific contributions made by public health interventions and especially by breakthroughs in medical science.”⁷⁵

Two main lines of thought emerge in the literature about which factors have the most direct influence on declining fertility rates. One is that better access to contraceptives has the biggest impact.⁷⁶ This theory implies that people want fewer children and will choose smaller families if they have access to contraception. This is

⁷² Szeter 2003; see also J. Bourgeois-Pichat, The general development of the population of France since the eighteenth century, in *Population in History: essays in historical demography*, D. Glass and D. Eversley D, eds. (London, England: Arnold, 1965): 474-506; see also CN Degler, *At odds: women and the family in America from the revolution to the present*, (Oxford, England: Oxford University Press, 1980), Chapter IX.

⁷³ Coale and Watkins. 1986.

⁷⁴ John C. Caldwell, Population health in transition, *Bulletin of the World Health Organization*. 79, no. 2 (2001b): 159-160.

⁷⁵ Szeter, 2003, 160.

⁷⁶ John Bongaarts of the Population Council estimates that 40% of fertility declines can be attributed to this. (Roush 1994; Sinding 2000, 1842)

opposed to the view of World Bank Economist Lant Pritchett, who believes that high fertility is a result of individual or societal desire for a high number of children.⁷⁷

Regardless of the exact determinants of family size, many consider ongoing rapid population growth in the developing world as a significant burden on continuing development.⁷⁸ Within the less developed countries, it is common for government ministers to believe that (in the words of Sinding) “slower rates of growth will considerably ease at least short-term burdens on health, education, and social welfare budgets.”⁷⁹

The international community has also identified population growth in the developing world as a constraint to advancement. One report noted that “the MDGs [Millennium Development Goals] are difficult or impossible to achieve with current levels of population growth in the least developed countries and regions. . . . [and] voluntary limitation of family size is also essential for developing countries striving to meet the MDG of eliminating gender disparities in primary and secondary education by 2015.”⁸⁰

While some states are using (or considering use of) population control policies that regulate family size, a more effective approach may be to utilize policy to create

⁷⁷ W. Roush, Population: the view from Cairo. *Science* 265 (1994): 1164-1167. See also Steven Sinding, The great population debates: how relevant are they for the 21st century? *American Journal of Public Health* 90, no. 12 (Dec 2000): 1841-1845.

⁷⁸ Sinding 2000.

⁷⁹ *Ibid.*, 1843.

⁸⁰ Martha Campbell, John Cleland, Alex Ezeh, and Ndola Prata, Return of the Population Growth Factor, *Science* 315 (2007): 1501-1502.

societal changes to impact desired fertility on the front-end.⁸¹ Both targeted and comprehensive health policy strategies may provide an avenue for controlling the rate of population growth and improving population health.

⁸¹ Ashook Barnwal, Success of the Indonesian population program: Lessons for India, *Journal of Development and Social Transformation* 1 (2004): 43-50. Also Akinrinola Bankole, Desired fertility and fertility behaviour among the Yoruba of Nigeria: A study of couple preferences and subsequent fertility, *Population Studies* 49, no. 2 (1995): 317-328. Also Charles Hirschman, The recent rise in Malay fertility: A new trend or a temporary lull in a fertility transition? *Demography* 23, no. 2 (1986): 161-184.

3. Research Design

3.1. Statement of the Problem

The development of population health measures and the ongoing dedication to collecting and documenting morbidity measures on a global scale through endeavors such as the Global Burden of Disease (GBD) project make it possible to start a more comprehensive evaluation of the relationship between morbidity and fertility. The traditional microeconomic theories of fertility such as *replacement* and *anticipatory loss (hoarding)* behavior would clearly be mitigated by increased child survival.⁸² Socioeconomic developments can change both the economic and cultural value of children, which may also result in changing patterns of fertility.⁸³ This research explores four propositions:

1. The literature shows evidence of a relationship between overall population mortality (Crude Death Rate) and fertility.^{84,85} But based upon fertility theories

⁸² Replacement behavior refers to increased fertility following the actual loss of a child, thus the household *replaces* the lost child with another. Hoarding refers to fertility behavior where a household anticipates that a certain percent of offspring will not survive to adulthood and, therefore, *desired fertility increases in anticipation of future losses*. (Benefo and Schultz, 1996)

⁸³ This theory is encapsulated in the quality-quantity trade-off (discussed in section 2.5). As socioeconomic conditions improve, there is less demand for the labor of children and less reliance on children for support in old age. And as the cost of rearing children increases (through educational costs, opportunity costs of women choosing work or family, etcetera) the addition of more children results in greater costs and less economic utility.

⁸⁴ Crude birth rate indicates the number of live births occurring per year per 1,000 midyear population (World Bank, World Development Indicators).

⁸⁵ Dudley Kirk, Demographic transition theory. *Population Studies* 50, no. 3 (1996): 361-387. Also

such as *replacement* and *anticipatory loss*, there is reason to believe that child mortality will be more closely related to fertility change. Is child mortality, as measured by the under-5 child mortality rate (CMR), a stronger indicator of fertility change than the crude death rate (CDR)?

2. Morbidity and health measures provide a more comprehensive picture of population health than mortality measures. Can changes in health measures better forecast decreases in fertility than mortality measures alone? Based upon fertility theories of anticipatory loss and replacement, the child mortality rate (CMR) and total fertility rate (TFR) should be highly correlated. Is this relationship weakened by controlling for child morbidity? Is there significantly stronger correlation between TFR and child *health* measures than between TFR and CMR?
3. What impact do socioeconomic variables have on the relationship between child health, child mortality, and changes in fertility?
4. How do various child health indicators, controlled for a variety of socioeconomic impacts, compare in explaining differences in fertility levels? Based upon these results, which measures are most useful as indicators of changes in fertility levels? How might population health policies on disease mitigation/control be targeted to have the greatest impact on the fertility function of population growth?

Frank W. Notestein, The population of the world in the year 2000, *Journal of the American Statistical Association*, 45, no. 251 (1950): 335-345. Also Warren S. Thompson, Population, *The American Journal of Sociology*, 34, no. 6 (1929): 959-975.

The exploration into these questions will provide insight into the potential value of the continuing study of the relationship between burden of disease and fertility. As the dynamics of life and death change, scientific and technological advances along with socioeconomic development provide the opportunity to preserve life in many states of health. Gaining a better understanding of how these changes impact fertility rates will be a valuable tool for health planners and policy-makers who are responsible for directing resources that might change patterns of population growth.

3.2. Hypotheses

Hypothesis #1

Child mortality measures will be a stronger predictor of fertility change than overall population mortality (crude death rate).

Hypothesis #2

Child health indicators, by themselves or in combination, will better indicate changes in fertility than will child mortality measures alone. Morbidity and health measures provide a more comprehensive and responsive reflection of the health of a population, and may also provide more accurate predictors of fertility rates.

Hypothesis #3

Child mortality and health indicators will be better predictors of fertility changes than will changes in social or economic conditions, even though the role of improvements in socioeconomic status (SES) is recognized as a major cause of changes in fertility.

Moreover, the addition of socioeconomic changes as controls to models of child health and mortality impacts on fertility will not substantially reduce the impact of health and mortality measures on fertility change.

These hypotheses are explored as outlined below. First, I review the literature on the theoretical basis of demographic shifts and related theories of mortality and fertility change, burden of disease, and socioeconomic impacts. This is followed by an outline of the data collection, definitions, and methods of handling and adjustment. Then each hypothesis is analyzed using the described data set.

After summarizing the results of the global study, I examine the models by focusing on country-level dynamics with a set of case studies of fertility, mortality, and morbidity in India, Mexico, and the Philippines. The countries studied bear a significant child mortality burden, but the impact of health and socioeconomic variables within each setting can affect the policy implications for health planning and population growth.

3.3. Rationale

The concept of this research problem centers around fertility theories related to anticipatory loss/replacement and socioeconomic improvements. Therefore, the scope of this analysis begins with population mortality and then is narrowed to focus on the health impacts and mortality of children under five, and their relationship to fertility changes. That is not meant to imply that the health of the larger population does not have an impact, but based upon the replacement fertility theory as the basis of the problem, the primary driver is the state of the child.

A leading authority in determining the relevant factors for data collection for child health and mortality, as well as socioeconomic status, is the United Nations (UN) Millennium Development Programme. The UN, its agencies, and the World Bank publish work that has been endorsed by the international community through the UN's adoption of the Millennium Development Goals (MDGs), which respond to the world main development challenges (see Table 1).⁸⁶

There are eight MDGs, and several provide the basis for selection of indicators used in this research. Within each of the eight goals are specific and measurable targets that allow progress to be tracked. Each of these targets has unique progress indicators. In the conduct of the research at hand, these MDG indicators are assumed to be standardized by the international community, and where appropriate, are adopted as the indicators used in this analysis.

Table 1. UN Millennium Development Goals.

| | |
|--------|--|
| Goal 1 | Eradicate extreme poverty and hunger |
| Goal 2 | Achieve universal primary education |
| Goal 3 | Promote gender equality and empower women |
| Goal 4 | Reduce child mortality |
| Goal 5 | Improve maternal health |
| Goal 6 | Combat HIV/AIDS, malaria, and other diseases |
| Goal 7 | Ensure environmental sustainability |
| Goal 8 | Develop a global partnership for development |

⁸⁶ World Health Organization, UN Millennium Project Task Force on Child Health and Maternal Health, *Health and the Millennium Development Goals* (Geneva, Switzerland: WHO Press, 2005); see also *Who's got the power? Transforming health systems for women and children*, (London: Earthscan, 2005). Comprehensive explanations and justifications of the formulation of the MDGs are available at <http://www.un.org/millenniumgoals/>. The World Bank also provides a Child & Health page at <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTCY/0,,contentMDK:20249172~menuPK:565287~pagePK:148956~piPK:216618~theSitePK:396445,00.html>.

The United Nations data identify malnutrition, vaccine preventable diseases, and neonatal causes as leading contributors to burden of disease and mortality in children, especially in less developed countries. Pneumonia, diarrhea, measles, and malaria are major concerns, and along with AIDS, account for 56% of deaths of young children, and malnutrition is a contributing factor in about half of these deaths.⁸⁷ The World Bank notes many of these diseases are preventable with inexpensive public health measures such as hand washing, access to safe water and sanitation facilities, immunizations, and good nutrition.⁸⁸ Both the UN and the World Bank emphasize the need to reduce deaths in the first four weeks of life, which can be accomplished by increasing maternal knowledge, access to pre-natal care, access to health resources, and the use of preventive health measures such as those mentioned above. Additionally, the UN recognizes the unequal distribution of morbidity and mortality among and within countries, attributing these largely to socioeconomic inequities, and is focusing on strengthening health systems as a means of achieving the Millennium Development Goals.⁸⁹

3.4. Methodology

In this methodology section, I will discuss how and why specific variables were selected for consideration in the evaluation of the relationship between fertility, mortality, child health, and socioeconomic status. First, I discuss the constraints that precluded the use of some potential predictor variables, and then I provide a summary of the variables

⁸⁷ UN Millennium Project Task Force on Child Health and Maternal Health, *Who's got the power? Transforming health systems for women and children.*

⁸⁸ World Bank provides a Child & Health page at <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTCY/0,,contentMDK:20249172~menuPK:565287~pagePK:148956~piPK:216618~theSitePK:396445,00.html>

⁸⁹ UN Millennium Project Task Force on Child Health and Maternal Health.

that were ultimately included and provide an overview of the data sources used to populate these data sets.

Next, I provide descriptions and notes about the dependent variable of Total Fertility Rate (TFR). This is followed by detailed descriptions of the independent variables considered for mortality, child health, and socioeconomic status. Included here are details about how the data were collected and annotations regarding any adjustments performed on the datasets.

3.4.1. Primary Data Sources

The primary source for the data used in this research is the United Nation's *World Populations Prospects: The 2006 Revision Population Database*, which provides extensive country-level population data as far back as 1950.⁹⁰ Additionally, databases managed by the United Nations Statistical Division⁹¹ and UN agencies such as the Food and Agriculture Organization (FAO)⁹² and the World Health Organization (WHO)⁹³ were accessed, and the Human Development Report (HDR) from the United Nations Development Programme (UNDP) was used.⁹⁴ The World Bank's *World Development Indicators* (WDI) dataset was used to extract social, labor, education, and health indicators.⁹⁵ Indicators on women's political status were identified from the Inter-

⁹⁰ Available through the UN at <http://esa.un.org/unpp/index.asp?panel=2>. Accessed throughout 2007 and 2008.

⁹¹ Available through the UN at <http://unstats.un.org/unsd/default.htm>. Accessed throughout 2007 and 2008.

⁹² FAOSTAT is available at <http://faostat.fao.org/default.aspx>. Accessed throughout 2007 and 2008.

⁹³ WHO Data and Statistics are available at <http://www.who.int/research/en/>. Accessed throughout 2007 and 2008.

⁹⁴ Human Development Reports are available at <http://hdr.undp.org/en/>. Accessed throughout 2007 and 2008.

⁹⁵ Limited access to the WDI dataset is publically available at <http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=135>. Accessed throughout 2007 and 2008.

Parliamentary Union (IPU).⁹⁶ Additional data sources include (but are not limited to) other World Bank (WB) resources such as HNPSStats, the World Development Reports (through WB), the World Health Reports (through WHO), the United Nations Development Program (UNDP), the United Nations Children's Fund (UNICEF), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Labour Organization (ILO), and the Population Reference Bureau (PRB). Data sources are noted for each variable in the sections below.

3.4.2. Selection of Variables

3.4.2.a. Dependent Variable

Total Fertility Rate (TFR) was selected as the dependent variable for this research because it is the internationally accepted measure for fertility and is widely reported on many levels. The *Total Fertility Rate* represents the average number of live births a typical woman has during her child-bearing years (typically ages 15-49). TFR is a synthetic rate expressed in terms of *children per woman*.⁹⁷ Although other fertility measures are available, both the United Nations and the World Bank use TFR as their primary indicator of fertility. The UN and World Bank provide TFR estimates for each country in five year increments going back to 1950, and the estimates used here are drawn from the World Population Prospects database of the United Nations.⁹⁸

⁹⁶ Available through the Inter-Parliamentary Union at <http://www.ipu.org/english/home.htm>.

⁹⁷ TFR is a synthetic rate meaning that it is not something that is actually counted. Rather, age specific fertility rates are used to estimate a "standardized" fertility level that would occur if a woman were to experience the age specific rate as she passed through each age range in a given year.

⁹⁸ Assumptions for the calculation of these estimates as well as the details for country level sources are found at the UN World Population Prospects website at <http://esa.un.org/unpp/index.asp?panel=4>.

3.4.2.b. Independent Variables – Mortality / Health

Mortality measures for this study need to reflect both the population mortality and the child mortality levels. Perhaps the most basic population mortality figure is the *crude death rate* (CDR), which is the total number of deaths per 1000 people in a specified population during a specified time period (often one year). This measure is broad, easily comparable, and adjusted to population size because it is based on a *per capita* scale. It is often used in the calculation of indicators such as the Rate of Natural Growth within a population (crude birth rate – crude death rate). The *mortality rate* is equivalent to the CDR and will be the measure applied in the evaluation of *Hypothesis #1*, that child mortality measures will be a stronger predictor of fertility change than overall population mortality.

The *Child Mortality Rate* (CMR) reflects the probability that a child will die before the age of 5, per 1000 children under five in the total population. This indicates child survival and reflects the social, economic, and environmental conditions in which children live. The relationship between TFR and CMR will be compared to the relationship between TFR and CDR in order to evaluate whether the fertility theories related to *hoarding* and *anticipatory loss* provide a potentially stronger basis for predicting changes in fertility.

CMR data are typically calculated from death registrations, when country-level counts are reliable. The number of deaths of children under 5 years of age is divided by the number of births and the result is multiplied by 1,000.⁹⁹

For the evaluation of *Hypothesis #2*, that child health indicators will better indicate changes in fertility than will child mortality measures alone, measures reflecting on child health are required. Based upon the factors of interest to the international community the following indicators will be considered for their relationship to the corresponding areas of concern. Each of the possible indicators identified in Table 2 below are discussed along with their definitions, sources and relevance.

Table 2. Child Health Areas of Concern and Possible Indicators.

| <u>Areas of Concern</u> | <u>Possible Indicators</u> |
|---------------------------------|--------------------------------------|
| Pneumonia | Children receiving ARI treatment |
| Diarrhea | Children receiving oral rehydration |
| Measles vaccine | Children immunized against measles |
| Malaria | Children using treated nets |
| Neonatal causes | Neonatal care; maternal mortality |
| Immunization programs | Children immunized (esp. measles) |
| Hand washing | Access to water and sanitation |
| Access to clean water | Access to improved water sources |
| Access to sanitation facilities | Access to improved sanitation |
| Nutrition | Undernourishment rates |
| Health system resources | Physicians per 1000, attended births |

Immunization Rate for Measles

The measles immunization rate reflects the percent of children who received at least one dose of measles vaccine by age 1. For application in this analysis, the variable

⁹⁹ The source for the data is the World Bank. Notes on methodologies for use of this data are located at <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20798121~menuPK:2236139~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html>.

is reversed and now shows those who did *not* receive the vaccine by age one.

Immunization programs are an essential component for reducing under-five mortality and this indicator reflects the coverage and the quality of the child health-care system in each country.

The source for the estimates used here is the World Health Organization (WHO), and these estimates come from reports of vaccinations given by health providers. The coverage rate is calculated by dividing the total number of vaccinations by the number of children in the target population.¹⁰⁰

Access to Improved Sanitation Facilities

This variable reflects the percent of the population that has access to improved sanitation facilities. It was reversed to show the percent *without* access. These estimates come from the World Bank World Development Indicators database.¹⁰¹ The WDI definition states that this variable “refers to the share of the population with at least adequate excreta disposal facilities (private or shared, but not public) that can effectively prevent human, animal, and insect contact with excreta. Suitable facilities range from simple but protected pit latrines to flush toilets with sewerage.”¹⁰²

Access to Improved Water Sources

This variable reflects the percent of the population that has access to clean water sources. It was reversed and, in the analysis, represents the percent of the population

¹⁰⁰ Additional information and references can be found through the WHOSIS, World Health Organization at <http://www.who.int/whosis/indicators/2007Immunized/en/index.html>.

¹⁰¹ World Bank World Development Indicators Database.

¹⁰² World Bank World Development Indicators Database. Definitions of WDI variables are found in the Methodology section of the WDI Database under *Definitions*.

without access to improved water sources. These estimates come from the World Bank World Development Indicators database.¹⁰³ The WDI defines this generally as the proportion of the population with reasonable access to adequate (usually 20 liters per person per day) amounts of safe water.¹⁰⁴ It is important to note that access to improved sources by this definition does not ensure that the water from any given source is adequate in amount or quality, as these characteristics are not part of the evaluation in most surveys.

Maternal Mortality

The maternal mortality rate reflects the number of female deaths that occur during pregnancy and childbirth per 100,000 live births. The source of the estimates used in this analysis is the United Nations, as compiled from the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and the United Nations Population Fund (UNFPA/MDG).¹⁰⁵ In general, maternal mortality estimates are believed to be subject to many types of error in less developed countries.

Undernourished Population

This variable reflects the percent of the population that is undernourished. According to the Food and Agriculture Organization, undernourishment refers to the condition of people whose dietary energy consumption is continuously below a minimum

¹⁰³ World Bank World Development Indicators Database.

¹⁰⁴ The World Bank, Statistics, available from <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20451574~menuPK:64133152~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html>; Internet; accessed throughout August 2007.

¹⁰⁵ Ibid.

dietary energy requirement for maintaining a healthy life and carrying out a light physical activity. The source for these estimates is the Food and Agriculture Organization (FAO) Statistics Division (a UN agency).¹⁰⁶ Data for a 3-year period were used for the estimation of the prevalence of undernourishment.¹⁰⁷

Treatment for Acute Respiratory Infection (ARI)

Pneumonia is one of the leading causes of child morbidity and mortality in the world: ARIs are responsible for almost 20% of all deaths of children under 5 worldwide.¹⁰⁸ Access to antibiotic treatment when a child has symptoms of acute respiratory infection is a significant factor in survival. This variable reflects the proportion of children under age 5 with acute respiratory infection (ARI) who are taken to a health provider. This is a key indicator for coverage of intervention and care-seeking, and provides critical inputs to the monitoring of progress towards child survival-related Millennium Development Goals and Strategies. These estimates come from the World Bank World Development Indicators database.¹⁰⁹

Oral Rehydration Therapy

Diarrheal diseases are one of the major causes of mortality for children under 5, accounting for 1.8 million child deaths worldwide each year. This variable reflects the proportion of children under age 5 with diarrhea in the last 2 weeks who received oral

¹⁰⁶ FAOSTATS. Food and Agriculture Organization of the United Nations. Information Database. <http://faostat.org/>

¹⁰⁷ The FAO's methodology for the calculation of food deprivation can be found at http://www.fao.org/es/ess/faostat/foodsecurity/Files/undernourishment_methodology.pdf.

¹⁰⁸ WHO. <http://www.who.int/whosis/indicators/2007ARICildFacility/en/index.html>.

¹⁰⁹ More information is available from the WHO website at <http://www.who.int/whosis/indicators/2007ARICildFacility/en/index.html>.

rehydration salts (ORS) or an appropriate household solution of sugar, salt, and clean water. Early intervention for diarrheal diseases can be fairly basic and inexpensive, and has significant impact on survival. Monitoring the use of this very cost-effective intervention is crucial for evaluating progress towards the child survival-related Millennium Development Goals. The estimates used in this analysis are drawn from the World Bank World Development Indicators database.¹¹⁰

Contraception Prevalence

This variable reflects the proportion of women of reproductive age (15 through 49 years of age) who are using (or whose partner is using) any modern contraceptive method at a given point in time. According to the World Health Organization, contraceptive use is a good indicator of health and access to health resources. The estimates used here come from the World Bank World Development Indicators database.¹¹¹

Prenatal Care for Pregnant Women

Prenatal care is important to both the health of the infant and the mother. Prenatal care providers not only monitor the health status of pregnant women and their fetuses, but can also provide information on family planning, breastfeeding, nutrition, and infant care. The data for this variable reflect the proportion of pregnant women who receive prenatal care. This variable has been reversed and now reflects those women *not* receiving

¹¹⁰ More information is available from the WHO website at <http://www.who.int/whosis/indicators/2007DiarrhoeaChildORTFluids/en/index.html>.

¹¹¹ World Bank World Development Indicators Database.

prenatal care. The estimates used in this analysis come from the World Bank World Development Indicators database.¹¹²

Poverty at \$1/day

This is the proportion of the population living on less than \$1 day, in terms of PPP (purchasing power parity). The dollar per day poverty line has fixed purchasing power across countries or areas and is often called an “absolute poverty line” or measure of extreme poverty.¹¹³

Use of Insecticide-treated Bed Nets

Malaria imposes significant disease burden on the world’s poorest countries. Each year, more than 500 million people become ill with malaria.¹¹⁴ The majority of cases are in Sub-Saharan Africa, but the disease affects populations around the world. This indicator reflects the use of insecticide-treated bed nets by children under 5 years old as a preventive measure for malaria, as a percentage of all children under 5. It is defined as the percentage in malaria endemic areas that the previous night slept under an insecticide treated bed net. Use of these nets can cut all-cause child mortality over the first two years by 20 percent.¹¹⁵ The source of the estimates used here is the World Bank World Development Indicators database.^{116,117}

¹¹² More information is available from the WHO website at <http://www.who.int/whosis/indicators/2007ContraceptivePrevalence/en/index.htm>.

¹¹³ United Nations Development Group, 2003.

¹¹⁴ World Health Organization at <http://www.who.int/whosis/indicators/007ITNChild/en/index.html>. See also *2005 World Malaria Report*. New York: UNICEF and World Health Organization (2005) available at <http://www.rbm.who.int/wmr2005/index.html>.

¹¹⁵ Ibid.

¹¹⁶ Ibid.

Births Attended by Skilled Health Personnel

This variable reflects proportion of births attended by skilled health personnel as a percentage of all deliveries (or births depending on available data). *Skilled health personnel* include only those who are properly trained and who have appropriate equipment and drugs, but exclude many traditional birth attendants, even if they have received a short training course. Due to the difficulty in measuring maternal mortality directly, indicators such as attended births are often used for tracking progress in reducing maternal deaths. The source of these estimates is the World Bank World Development Indicators database.¹¹⁸

Physicians per 1000 population

The ratio of physician providers to the population served is a recognized indicator of health system adequacy and population health in general. This variable reflects the number of physicians serving the population, as a density per 1,000 total residents. Although there is no international consensus about the optimal ratio of physicians to a population, there is convincing evidence that the number and quality of workers are positively associated with many positive health outcomes including immunization coverage, outreach of primary care, and infant, child, and maternal survival.¹¹⁹ The source of these estimates is the World Bank World Development Indicators database.¹²⁰

¹¹⁷ United Nations Development Group, 2003.

¹¹⁸ Ibid.

¹¹⁹ World Health Organization at <http://www.who.int/whosis/indicators/2007HumanResourcesForHealth/en/index.html>.

¹²⁰ World Bank World Development Indicators Database.

3.4.2.c. Initial Handling of Health Data

Country level data used in this analysis began with data from 143 countries. The selection criteria for these 143 countries are listed in Appendix B. Data were reported in five year increments for 1980, 1985, 1990, 1995, 2000, and 2005. Any adjustments used to conform the available data to these groupings are explained below.

The analysis began with the inclusion of all the possible indicators identified in Table 2, above. There were a total of 13 health-related variables considered in the initial analysis. With 143 countries and 6 reporting periods, a fully populated variable would have 858 data points. However, only one variable, immunizations, was fully populated. The next section explains how missing data points were handled.

Handling Missing Data

Both the High income and Low income countries had more missing data than the Middle income countries. High income countries had significant missing data in select health variables because many of the variables being monitored are not of concern in these countries. For example, the High income countries generally do not report the proportion of children receiving oral rehydration therapy or being seen for acute respiratory infection since most children in higher income countries have adequate access to health care services and are at reduced risk of the effects of failure to receive early

medical treatment. On the other end of the spectrum, Low income countries often have very sparse data sets due to lack of monitoring and evaluation capacity.¹²¹

Because of the patterns in missing data that can be attributed, in part, to income or socioeconomic status, the missing data are not random. Therefore, missing data is a significant constraint.

Listwise deletion was used to handle missing data, which means that only cases with complete data are included. This does result in a loss of statistical power as fewer cases are available to be analyzed.

Adjustments to data

The configuration of each variable at its source is described in detail in the previous section. Some adjustments were made to the data. These are outlined below (presented alphabetically).

- a. All variables - in some instances the most recent data year provided was for 2004 rather than 2005, in these cases, the 2004 data was used as a proxy for 2005 data. Data was evaluated in comparison with the previous available data points and based on the slow rate of change over time of these variables it is reasonable to use 2004 data as estimates for 2005.
- b. ARI treatment (% of children under 5 years old taken to a health provider). Data were presented for 5-year groupings. For missing data, any value reported in the five year span ending in the reported year (i.e. the 2005 number includes data

¹²¹ Pietro Gennari, Estimating regional aggregates in the presence of missing country data: the case of MDG indicators. Statistics Division, United Nations Economic and Social Commission for Asia and the Pacific. Presented to the Forum for Asia/Pacific statisticians, September 2006, Daejeon, South Korea.

from the 2001-05 timeframe) was recorded. If more than one value was reported in the timeframe – which only occurred a few times – the value closest to the end of the timeframe is used.

- c. Proportion of births attended by skilled health personnel. Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an adjoining year, the value of the adjoining year was adopted for the purpose of this analysis.
- d. Contraceptive prevalence (% of women ages 15 through 49). Values for each year group include any data reported in the five year span ending in the reported year (i.e. the 2005 number includes data from the 2001-05 timeframe). If more than one value was reported in the timeframe the value closest to the end of the timeframe is used.
- e. Percent of population *without* access to improved water source. Because many High income, developed countries did not report any figures, highly developed countries with missing data were assigned values of 100 for each reporting period (countries affected include Denmark, France, Greece, Ireland, Italy, Norway, and Portugal). Note that this scale was subsequently reversed for analysis to reflect percent *without* access.
- f. Percent *not* receiving first measles vaccine. Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an adjoining year, the value of the adjoining year was used as a proxy measure. Where data

were missing, and there was data in both adjacent years, the median of the two were used.

- g. Maternal mortality rate per 100,000 live births. No adjustments were made to this data set.
- h. Malaria prevention (use of insecticide-treated bed nets in the under-5 population). Values for each year group include any data reported in the five year span ending in the reported year (i.e. the 2005 number includes data from the 2001-05 timeframe). There were no multiple values in any time period.
- i. Undernourished as a percent of population. For this variable, any country below 2.5 is simply reported as <2.5. Therefore, a value of 2 was assigned to each of these data cells. Also, undernourishment was not reported for many of the most developed countries; for these countries, a value of two was also assigned. The countries affected include Australia, Austria, Belgium, Canada, Denmark, France, Finland, Israel, Italy, Germany, Ireland, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States.
- j. Oral Rehydration Therapy - diarrheal treatment (% of children under 5 receiving oral rehydration and continued feeding). Values for each year group include any data reported in the five year span ending in the reported year (i.e. the 2005 number includes data from the 2001-05 timeframe). There were no multiple values in any time period.
- k. Physicians per 1000 population. Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an adjoining year,

the value of the adjoining year was adopted for the purpose of this analysis.

Where data were missing, and there was data in both adjacent years, the midpoint of the two were used.

- l. Poverty gap at \$1 a day (PPP) (%). Values for each year group include any data reported in the five year span ending in the reported year (i.e. the 2005 number includes data from the 2001-05 timeframe). If more than one value was reported in the timeframe the value closest to the end of the timeframe is used.
- m. Pregnant women *not* receiving prenatal care (%). Values for each year group include any data reported in the five year span ending in the reported year (i.e. the 2005 number includes data from the 2001-05 timeframe). If more than one value was reported in the timeframe, which happened only a few times, the value closest to the end of the timeframe is used.
- n. Percent of population *without* access to improved sanitation. Many high income developed countries did not report any figures. If a country had no report and was highly developed and had high income, it was assigned a value of 100 for each year grouping. (Countries affected include Denmark, France, Greece, Ireland, Italy, Norway, and Portugal.) Note that this scale was subsequently reversed for analysis to reflect percent *without* access.
- o. Total Fertility Rate. This data set was fully populated and no adjustments were made.

Following the adjustments to the data described above, a summary of the consolidated data sets was compiled and is provided below (Table 3).

Table 3. Child Health Data Summary.

| Variable | Source | Years Available ¹²² | Observations |
|------------------|-----------|--------------------------------|----------------|
| ARI | WB/WDI | ---,---,---,95,00,05 (sparse) | 139 obs |
| Attended Births | WB/WDI | ---,85,90,95,00,05 (sparse) | 342 obs |
| Contraceptives | WB/WDI | 80,85,90,95,00,05 (sparse) | 403 obs |
| Clean Water | WB/WDI | ---,---,90,95,00,05 | 558 obs |
| Immunizations | WHO | 80,85,90,95,00,05 | 858 obs |
| Maternal Mort. | UN/WHO | ---,---,90,95,00,05 | 568 obs |
| Treated Bednets | WB/WDI | ---,---,---,---,00,05 (sparse) | 50 obs |
| Nutrition | FAO | 80,---,91,96,00,05 | 638 obs |
| Oral Rehydration | WB/WDI | ---,---,---,95,00,05 (sparse) | 83 obs |
| Physicians | WB/WDI | 80,85,90,95,00,05 | 574 obs |
| Poverty | WB/WDI | 80,85,90,95,00,05 (sparse) | 277 obs |
| Prenatal care | WB/WDI | ---,---,90,95,00,05 (sparse) | 240 obs |
| Sanitation | WB/WDI | ---,---,90,95,00,05 | 549obs |
| <i>TFR</i> | <i>UN</i> | <i>80,85,90,95,00,05</i> | <i>858 obs</i> |

Initial elimination of variables ($r^2 < 0.20$) or ($n < 400$)

A cut-off point was set that variables must have a minimum of 400 observations to be robust enough for consideration. Employing this criterion, the variables for the *Poverty at \$1 a day*, *Use of treated bednets*, *Oral rehydration therapy*, *ARI Treatments*, *Proportion of births attended by skilled health personnel*, and *Pre-Natal care* were eliminated.

Additionally, a cut off point of $r^2 \geq 0.20$ was set for the evaluation of whether each variable had significant enough an impact of the dependent variable to be retained. All variables with r^2 values less than 0.20 when regressed against TFR will be eliminated from further calculations for this analysis. The variable for *Immunization* ($r^2 = 0.0099$) did not meet this criterion for inclusion and is eliminated.

¹²² For years marked “---“ no data is available.

All remaining variables will be further considered for inclusion in a child health model in the analysis in Section 4.

3.4.2.d. Independent Variables – Socioeconomic Status of Women

While there is no universally accepted definition of what factors constitute socioeconomic status (SES), the broad literature on socioeconomic development makes clear that measures of SES should consider indicators for *education, occupation, and income/wealth/standard of living*. There are a variety of possible indicators within each of these central aspects of SES. As with the indicators for child health, the UN Millennium Development Goals also have a focus on development as it relates to women, and the international consensus on these measures will be helpful in selecting variables for this research.

Goal 3 of the MDGs is to *promote gender equality and empower women*. The factors the international community is focusing on include *gender disparities in education, literacy, women in non-agricultural wage employment, and the share of women in parliament*.¹²³ Using the broad definition of SES and the areas of emphasis for MDG Goal #4, which is to reduce the under-five mortality rate by two-thirds between 1990 and 2015, the following indicators will be considered for their relationship to the corresponding areas of concern. Each of the possible indicators identified in Table 4 below is discussed along with their definitions, sources, and relevance.

¹²³ United Nations Development Group, 2003.

Table 4. SES of Women Areas of Concern and Possible Indicators.

| Areas of concern | Possible Indicators |
|-----------------------------|--|
| Education | Enrollment, completion level, lack of schooling |
| Literacy | literacy rates |
| Employment | Female labor force and participation, unemployment |
| Occupation | Agricultural employment figures |
| Income | Gross National Income |
| Gender disparities | Females holding seats in parliament, gender equality measure, gender-related development indicator |
| Dependency | % of population under 15, Age dependency ratios |
| General development factors | HDI, phone lines |

Education / Literacy Variables

Females with No Schooling

This variable reflects the percent of females (ages 15 and older) with no formal schooling. The source for these estimates is the World Bank World Development Indicators database.¹²⁴

Average Years of School Completed

This variable reflects the average number of years of school completed for females aged 15 and older. The source for these estimates is the World Bank World Development Indicators database.¹²⁵

¹²⁴ World Bank. World Development Indicators Database.

¹²⁵ Ibid.

Ratio of Female to Male Enrollment

Educational enrollment ratios are a useful measure of participation in education. This variable reflects the proportional enrollment of females to males in primary and secondary levels of education. These estimates were collected through the World Bank World Development Indicators database. There are some limitations for such measures because the information is generally collected at the beginning of each school year and there is typically a higher drop out rate for females over the course of the school year. Another constraint is the fact that it is believed that administrators tend to inflate numbers because enrollment is tied to funding and staffing. This is a problem because the data for this indicator is typically provided by Ministries of Education or from household surveys.¹²⁶

Female Literacy

The adult female literacy rate includes females ages 15 years and older and reflects those who cannot, with understanding, read and write a short, simple statement about their daily life. Literacy is a very difficult indicator to measure and requires sophisticated, controlled surveys for best accuracy. The estimates used here come from the World Bank World Development Indicators database (based on UNESCO calculations).¹²⁷

¹²⁶ United Nations Development Group, 2003.

¹²⁷ World Bank. World Development Indicators Database.

Literacy Parity

The literacy parity variable reflects the women to men parity index, as a ratio of literacy rates, for population between the ages of 15-24. These are UNESCO estimates drawn from the United Nations Statistical Division database.^{128,129}

Illiteracy Rates for Women

The illiteracy rate variable is the percent of women ages 15 and older who are illiterate. The data come from UNESCO estimates, which were drawn from the United Nations Statistical Division database.¹³⁰

Employment, Occupation and Income Variables

Female Labor Force

The female labor force is the percent of the total labor force that is female. This consists of all women in the economically active population, defined by the International Labour Organization (ILO) as being all women between the ages of 15 and 64 whether employed or unemployed.¹³¹ These estimates come from the World Bank World Development Indicators database.¹³²

¹²⁸ UNSTATS, United Nations at http://unstats.un.org/unsd/cdb/cdb_advanced_data_extract.asp.

¹²⁹ United Nations Educational, Scientific and Cultural Organization. Revised Recommendation concerning the International Standardization of Educational Statistics (Paris, 1978); see also Chapter 2 of the UNESCO Statistical Yearbook (Paris, UNESCO Institute for Statistics, 2004). Available from <http://www.uis.unesco.org>, Core Theme: Literacy.

¹³⁰ United Nations at http://unstats.un.org/unsd/cdb/cdb_advanced_data_extract.asp; see also the United Nations Educational, Scientific and Cultural Organization.

¹³¹ International Labour Office. *Key Indicators of the Labor Market*, 5th Edition. Chapter 2 Participation in the World of Work (KILM 2). Geneva.

¹³² World Bank. World Development Database Indicators.

Female Participation in the Labor Force

Female Participation reflects the percent of the female working age population (15-64) that *participates* in economically productive labor. The overall labor force includes those employed and unemployed, while the participating labor force includes only those who are economically productive in supplying labor for producing goods or services during a specified period.¹³³ These estimates come from the World Bank World Development Indicators database.¹³⁴

Female Unemployment

The female unemployment rate is the percent of the female labor force that is unemployed. To be classified as unemployed, a woman must not be employed but must have taken steps to seek paid employment during a designated period. It is calculated by dividing the number of women who are unemployed by the total number of women in the labor force. These estimates come from the World Bank World Development Indicators database.

Women in Non-agricultural Employment

This indicator reflects the percent of female labor force that is employed in non-agricultural jobs. This is expressed as a percentage of total employment in the non-agricultural sector, including both industry and services. These estimates come from the World Bank World Development Indicators data set. Source data may come from a

¹³³ International Labour Office. *Key Indicators of the Labor Market*, 5th Edition. Chapter 2 Participation in the World of Work (KILM 2). Geneva.

¹³⁴ World Bank. World Development Indicators Database.

variety of outlets including census collection and labor force surveys. This is an MDG indicator monitored to “measures the degree to which labor markets are open to women in industry and service sectors, which affects not only equal employment opportunity for women but also economic efficiency through flexibility of the labor market and, therefore, the economy’s ability to adapt to change.”¹³⁵

Gross National Income, PPP, Current International \$

The World Bank defines Gross National Income (GNI) as the sum of gross value added by all resident producers plus any product taxes (less subsidies) that are not included in the valuation of output plus net receipts of income from abroad. When presented in terms of PPP (purchasing power parity), the GNI is converted to international dollars using PPP rates. An international dollar has the same purchasing power over GNI as the U.S. dollar in the United States.¹³⁶ Although this income measure is not specific to female income, it provides an indicator of national economic well-being, of which females hold a share.

Gender Equality and Disparity Variables

Percent of Seats Held by Women in Parliament

This indicator reflects the percent of seats held by women in single-house parliaments or the lower-houses of parliament in each country. The MDG factors this variable as a measure of gender equality and empowerment of women, noting that

¹³⁵ International Labour Organization.

¹³⁶ World Bank at <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20451574~menuPK:64133152~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html>.

women's representation in parliaments reflects the opportunities for women in political and public life. The data in this analysis are drawn from the Inter-Parliamentary Union (IPU) based upon reports from national parliaments.¹³⁷

Gender Empowerment Measure

The Gender Empowerment Measure (GEM) is a “composite index measuring gender inequality in three basic dimensions of empowerment—economic participation and decision-making, political participation, and decision-making and power over economic resources.”¹³⁸ This measure factors in the percent of women in parliamentary seats, legislatures, senior positions, and professional and technical positions, and also includes ratios of earned income.¹³⁹

Gender-related Development Index

The Gender-related Development Index (GDI) is a “composite index measuring average achievement in the three basic dimensions captured in the human development index—a long and healthy life, knowledge and a decent standard of living—adjusted to account for inequalities between men and women.”¹⁴⁰ The GDI is based on the Human Development Index (HDI) (discussed later), which measures average achievement, but the GDI adjusts the scores to reflect the inequalities between men and women in life

¹³⁷ Inter-Parliamentary Union at <http://www.ipu.org/english/home.htm>.

¹³⁸ United Nations Development Programme (UNDP), *Human Development Report 2007/2008* (New York: Palgrave MacMillan, 2007).

¹³⁹ UNDP. Human Development Report 2007/2008. Technical Note 1. Also available at http://hdr.undp.org/en/media/hdr_20072008_en_complete.pdf.

¹⁴⁰ United Nations Development Programme (UNDP), 2007.

expectancy at birth, adult literacy rate and all-level enrollment ratios, and estimates earned income per capita.¹⁴¹

Dependency Indicators

Age Dependency Ratio

The age dependency ratio reflects the ratio of the number of dependent children (under 15 years of age) to the working age population (ages 15-64). This measure is relevant to this analysis because the dependency burden falls largely upon females. The source of these estimates is the World Bank World Development Indicators database.

Population aged 0-14 years

This variable reflects the number of people below the age of 15, as a percent of the total population, and is another mechanism for estimating the burden of dependency for women. These estimates were gathered through the World Bank World Development Indicators database.

Broad Development Indicators

Human Development Index

The HDI is a composite index that factors in measures from three dimensions: health, knowledge, and standard of living. Specifically it includes life expectancy, adult literacy, gross enrollment ratios, and GDP per capita. The HDI has a minimum and a maximum for each dimension, and the HDI score shows where a country stands within

¹⁴¹ Ibid.

the established range and expresses this as a value between 0 and 1. The scores for the three HDI components are then averaged in an overall index. The HDI was created with the publication of the first Human Development Report in 1990 and has since been calculated back to 1975.^{142,143}

Phone Mainlines per 1000

This indicator reflects the level of infrastructure that is essential to the development process. The descriptor in the MDG manual states that “telephones allow people to exchange experiences and learn from each other, enabling higher returns on investment and avoiding problems of duplication or missing information. The use of information and communication technologies can make Governments more transparent, thereby reducing corruption and leading to better governance. It can help people in rural areas find out about market prices and sell their products at a better price. It can also overcome traditional barriers to better education by making books available online and opening the door to e-learning.”¹⁴⁴

3.4.2.e. Initial Handling of Socioeconomic Data

The socioeconomic data came from the same 143 countries and reported year groupings used for the health data. Initially all 18 socioeconomic indicators identified in the section above were considered for inclusion in the analysis. None of these were fully populated and missing data is handled through the methods described for the health data

¹⁴² UNDP at <http://hdr.undp.org/en/statistics/indices/hdi/>.

¹⁴³ UNDP at http://hdr.undp.org/en/media/hdr_20072008_tech_note_1.pdf.

¹⁴⁴ United Nations Development Group, 2003.

sets. Just as with the health data, adjustments were needed to conform the available socioeconomic data to the reported year groups. These adjustments are explained below (presented alphabetically). Variables not listed below here had no adjustments.

- a. Percent of women working in agricultural sector jobs. Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an adjoining year, the value of the adjoining year was adopted for the purpose of the analysis. Some values were adopted from cells two years removed.
- b. Human Development Index. Data from 2004 are used as 2005 data.
- c. Illiteracy Rates for Women ages 15 years and older. High income OECD countries typically do not have illiteracy rates reported through UNESCO. However, in calculating the HDI for each country, UNDP assigns a value of 0.99 to these countries. Therefore, the same value was assigned for this research. The countries affected are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Ireland, Japan, the Netherlands, New Zealand, Norway, Slovakia, Switzerland, the United Kingdom, and the United States
- d. Women to men parity index, as ratio of literacy rates for ages 15-24. Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an adjoining year, the value of the adjoining year was adopted for the purpose of the analysis. Some values were adopted from cells two years removed. 2005 year is populated with 2003 data, the last year available. The High income countries did not report for this metric and were assigned a parity of

- 1.0. That value was assigned to Australia, Austria, Belgium, Canada, Denmark, France, Finland, Germany, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, the UK, and the US.
- e. Adult female literacy rate (≥ 15 years). Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an adjoining year, the value of the adjoining year was adopted for the purpose of the analysis. Some values were adopted from cells two years removed.
- f. Percent of seats held by women in single or lower houses of parliament. Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an adjoining year, the value of the adjoining year was adopted for the purpose of the analysis. Some values were adopted from cells two years removed. Data displayed for 1995 are from 1997, the first year for which data are available.
- g. Phone mainlines per 1000. Where data were missing in some of the 2005 data cells, 2004 data are used as a proxy.
- h. Enrollment ratio (female to male) for primary education. Data for the year 1995 were not reported for any country. Since the trend at the country level is linear, data from 1990 and 2000 were used to find the mean value and these were used for 1995. If data was missing for either of those years, 1995 was reported as missing.
- i. Percent of female labor force that is unemployed. Where data were missing for the year being analyzing (5 year increments) but there was a valid number in an

adjoining year, the value of the adjoining year was adopted for the purpose of the analysis.

Following the adjustments to the data described above, a summary of the consolidated data sets was compiled and is provided below (Table 5).

Table 5. Women's SES Data Summary.

| <u>Variable</u> | <u>Source</u> | <u>Years Available</u> ¹⁴⁵ | <u>Observations</u> |
|----------------------|---------------|---------------------------------------|---------------------|
| Agriculture | WB/WDI | 80,85,90,95,00,05(sparse) | 366 obs |
| Dependency | WB/WDI | 80,85,90,95,00,05 | 856 obs |
| Female Labor | WB/WDI | 80,85,90,95,00,05 | 856 obs |
| Female Participation | WB/WDI | 80,85,90,95,00,05 | 856 obs |
| GDI | HDR | ---,---,---,---,00,05 | 257 obs |
| GEM | HDR | ---,---,---,---,00,05 | 136 obs |
| GNI | WB/WDI | 80,85,90,95,00,05 | 760 obs |
| HDI | HDR | 80,85,90,95,00,05 | 721 obs |
| Illiteracy | UNStats | 80,85,90,95,00,05 | 678 obs |
| Literacy Parity | UNStats | 80,---,90,95,00,05(sparse) | 339 obs |
| Literacy Rate | WB/WDI | 80,85,90,95,00,05(sparse) | 192 obs |
| No Schooling | WB/WDI | 80,85,90,95,00,05 | 498 obs |
| Seats in Parliament | IPU | ---,---,---,95,00,05(sparse) | 392 obs |
| Phone Lines | WB/WDI | 80,85,90,95,00,05 | 826 obs |
| Population under 14 | WB/WDI | 80,85,90,95,00,05 | 856 obs |
| Education Ratio | WB/WDI | ---,---,90,95,00,05 | 339 obs |
| TFR | UN | 80,85,90,95,00,05 | 858 obs |
| Unemployment | WB/WDI | 80,85,90,95,00,05(sparse) | 395 obs |
| Years of Schooling | WB/WDI | 80,85,90,95,00,05 | 498 obs |

Initial elimination of variables ($r^2 < 0.20$) or ($n < 400$)

As with the health data, a cut-off point was set that variables must have a minimum of 400 observations to be robust enough for analysis. Employing this criterion,

¹⁴⁵ For years marked “---” no data is available.

five variables are eliminated: *Percent employed in agriculture*, *Education Ratio*, *Literacy Rate*, *Gender Equality Measure (GEM)* and *Gender-related Development Index (GDI)*.

Similarly, all variables with r^2 values less than 0.20 when regressed against TFR are eliminated from further calculations. The variables for *Women in parliament*, *Literacy parity*, *Females in the labor force*, *Female labor participation rate*, and *Female unemployment* did not meet this criterion for inclusion and are eliminated.

Eight socioeconomic variables are retained for consideration as controls for the models used in the analysis.

3.4.3. Procedures for Conduct of Analysis

To begin the analysis, I statistically and graphically demonstrate the traditional assumptions of the relationship between changes in mortality and fertility. This is demonstrated through the use of scatterplots, trend lines, and ordinary least squares regression. Understanding this relationship provides a foundation for the evaluation of *Hypothesis #1*.

A study of child health factors is conducted primarily using a population trend design employing scatter plots, trend analysis, simple linear regression, and multiple linear regression. A regression model is developed to explore factors contributing to morbidity in children under five.

The datasets initially include estimates from 143 countries across a span of 25 years, with data reported in 5-year increments.¹⁴⁶ Using the data sets described in the previous section, retained data and estimates are evaluated to determine any collinearity

¹⁴⁶ See Appendix B for country selection rationale.

concerns and determine the structure of the models to be used in the analysis. Ultimately, variables that are adequately robust, meet a minimum threshold for explaining variance in the dependent variable, and are not significantly co-linear with other variables, are retained for inclusion in the analysis to model a composite variable to indicate change in total fertility rates.

The outcome of this analysis is then evaluated against the strength of the child mortality rate (CMR) to test *Hypothesis #2* and determine which indicators better forecast changes in fertility.

Next, the procedures outlined for handling child health data are repeated to identify the appropriate variables related to women's socioeconomic status (SES) to evaluate their influence on fertility both directly and as controls in the evaluation of the child health model and mortality variables to test *Hypothesis #3*.

Finally, three country studies are presented that are designed to explore the dynamics of these variables in select countries facing challenges with population growth. This section examines the variations in the utility of mortality, health, and socioeconomic indicators within the context of each country. These analyses also serve to demonstrate the complexities of the multiple variables included in this research and demonstrate how the unique characteristics of different countries, populations, and cultures must be factored into potential policy recommendations.

4. Analysis

4.1. Analysis – Mortality and Fertility¹⁴⁷

As discussed in Section 2, there has been much exploration and documentation of the relationship between mortality and fertility. While there is sufficient evidence to demonstrate that it is not a direct causal pathway there is clearly a connection, and the studies discussed indicate that shifts in one are historically accompanied by shifts in the other. Therefore, an exploration of this dynamic is helpful to illustrate how these elements change over time and evaluate the strength of the relationship between mortality and fertility. This exploration will provide a basis for comparison for the testing of the hypothesis.

This analysis begins with a measure for total population mortality called the crude death rate (CDR) or mortality rate. This measure is the total of number of deaths per 1000 people in a given population, presented here as an annual rate. The Total Fertility Rate and Child Mortality Rate are also used in this analysis.

From a global perspective, we see that fertility and mortality rates have a generally curvilinear relationship that forms a J-curve (Figure 2). Movement along the curve is shifting to the left over time. The shape of this distribution indicates that as

¹⁴⁷ Primary data sources for the global and regional overview is the United Nations, Population Division, Department of Economic and Social Affairs. *World Population Prospects: The 2006 Revision*. May 2007. see also the World Bank World Development Indicators database.

countries move to lower fertility rates we see a shift from a positive relationship with the death rate to a negative relationship. This is discussed in more detail below (Figure 2).

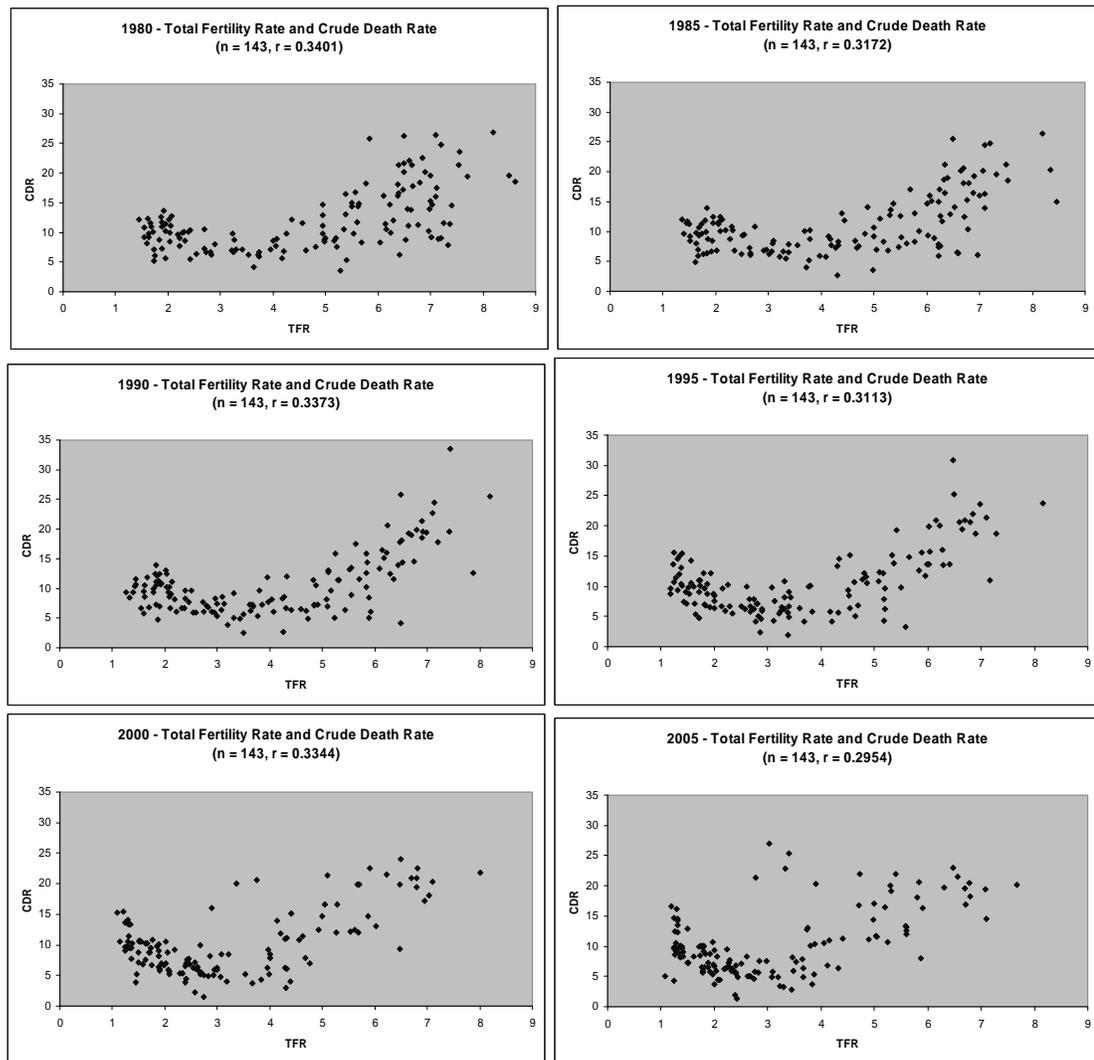


Figure 2. Correlation between Total Fertility Rate and Crude Death Rate over time (143 countries, 1980-2005)

In economic and political models, the J-shaped curve typically shows a relationship between two factors that move from a relationship of decline to one of

growth – usually showing a rightward shift.¹⁴⁸ In the J-curve between fertility and mortality, movement along the curve is leftward since reduced fertility (rather than growth) is the desired outcome (Figure 3).¹⁴⁹

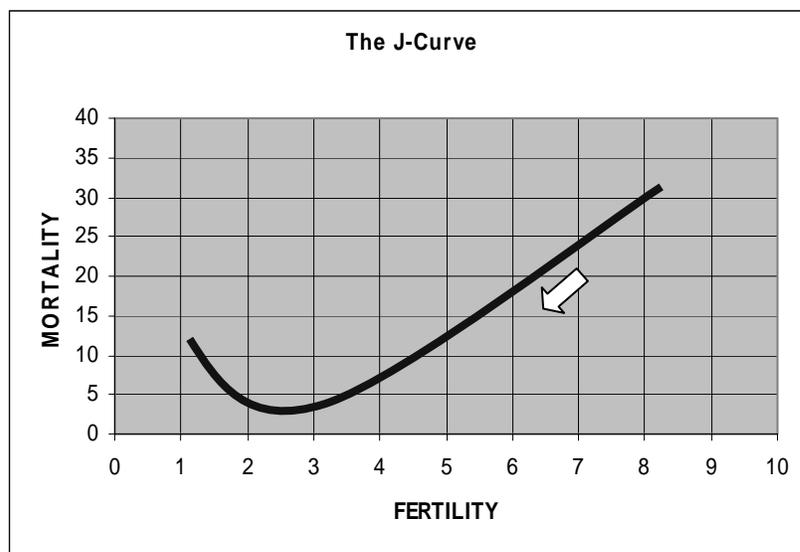


Figure 3. Illustration of the J Curve dynamic.

This shift is also reflected in the population pyramids that generally change shape as countries move into higher levels of development and see improvement in national economic measures. Less developed countries are typically in the rapid growth stage with high fertility rates, low life expectancies, and a population pyramid that is wide at

¹⁴⁸ The rightward shift is associated with a positive change, as growth is typically viewed as a positive outcome. A recent political model using the J curve showed the dynamic relationship between openness and stability showing that states move from a stable situation without openness into a period of instability before returning to stable situation with an open society. See also Ian Bremmer, *The J Curve: a new way to understand why nations rise and fall* (New York: Simon & Schuster, 2006).

¹⁴⁹ There is also a J-curve that is used to explain exponential population growth. The population growth J-curve posits that population growth will grow exponentially until it reaches “carrying capacity” where the earth cannot sustain that level of population and therefore population growth will decline.

the bottom with a large number a children and grows narrow at the top as the population thins with age progression (thus the pyramid nomenclature). As countries develop and they move into different population growth stages, progressively fewer children are being born and life expectancies increase so that the “pyramids” are now becoming more cylindrical. A graphical example of this dynamic is demonstrated by the sample population pyramids for countries in different stages of population growth (Figure 4). In this illustration, the Democratic Republic of the Congo is in a rapid growth stage and shows the typical pyramid structure. This country would fall into the upward right tail of the J-curve. Both the United States and Germany are in the left tail of the J-curve. The United States has a fertility rate at near-replacement level, and Germany has a fertility rate below replacement level.

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Figure 4. Sample Population Pyramids at Different Stages of Growth (1998).¹⁵⁰

¹⁵⁰ Graphic from the United Nations, *World Population Prospects, The 1998 Revision*. Available through the Population Reference Bureau at: <http://www.prb.org/Educators/TeachersGuides/HumanPopulation/Change.aspx?p=1>.

In evaluating the relationship between mortality and fertility from a statistical perspective, there is further evidence of the J-shaped curve relationship and a country's positioning on this demographic curve (fertility-mortality) correlates to its socioeconomic development (as reflected by both World Bank income and United Nations development levels) . This demonstrates the relationship between socioeconomic status and changing demographic patterns.¹⁵¹

Within the four stages of demographic transition (Section 2.1.1.) we recall that demographic transition is *a population moving from a situation with high fertility and high mortality to a period of low fertility and low mortality*. Stages 1 and 4 are beginning and end stages where fertility and mortality strike somewhat of a balance. Stages 2 and 3 are transitioning stages. Through analysis we see that Stage 1 countries (with low incomes and low levels of development) and Stage 4 countries (with high income and high levels of development) have stronger correlations. This reflects the *rough balance* between fertility and mortality describes in the definition of the demographic transition (Tables 6 and 7, below).

The middle income countries, which may typically fall into Stage 2 and Stage 3 where populations are transitioning from high fertility to low fertility, show weaker correlations. During the transition, the trends affecting population patterns (births and deaths) begin to shift, but the sequencing, pace, and timing of the shifts can vary widely

¹⁵¹ Edward M. Crenshaw, Matthew Christenson and Doyle Ray Oakey Demographic Transition in Ecological Focus. *American Sociological Review* 65, No. 3 (2000): 371-391; see also Dudley Kirk Demographic Transition Theory, *Population Studies* 50, No. 3 (1996):361-387; see also Notestein 1950; see also C. R. Winegarden and Mark Wheeler. The Role of Economic Growth in the Fertility Transition in Western Europe: Econometric Evidence, *Economica* New Series 59, No. 236 (1992): 421-435.

and therefore the correlations are weakened.¹⁵² A similar dynamic is seen when countries are evaluated based upon their development levels, however, the differentiation between the upper and middle tiers is much less pronounced.

Table 6. r-squared value of TFR and CDR, 1980-2005, by income level (n=143).

| TFR & CDR by Income | r² |
|--------------------------------|----------------------|
| All Countries (n=143) | 0.3216 |
| Low Income (n=47) | 0.4942 |
| Lower Middle Income (n=41) | 0.1405 |
| Upper Middle Income (n=25) | 0.0726 |
| High Income (n=30) | 0.2264 |

Table 7. r-squared value of TFR and CDR, 1980-2005, by development level (n=143).

| TFR & CDR by Development | r² |
|--------------------------------------|----------------------|
| All Countries (n=143) ¹⁵³ | 0.3216 |
| Least Developed (n=37) | 0.3951 |
| Less Developed ¹⁵⁴ (n=62) | 0.1847 |
| More Developed (n=44) | 0.1918 |

The shift among stages of demographic transition and the socioeconomic changes reflected by development and income levels become more apparent when presented graphically based on these strata. Figures 5 and 6 (below) show ecological studies plotting countries (n=143) in years from 1980-2005, illustrating the portion of the J-curve occupied by each stratum – both by income and development levels. It is apparent that

¹⁵² Caldwell, 2001a; see also Knodel and van de Walle 1979.

¹⁵³ This number uses the 143 countries outlined in Appendix B.

¹⁵⁴ This figure includes the Less developed countries *without* the Least developed countries. Throughout this research reference to Less developed countries excludes the Least developed countries unless otherwise stated.

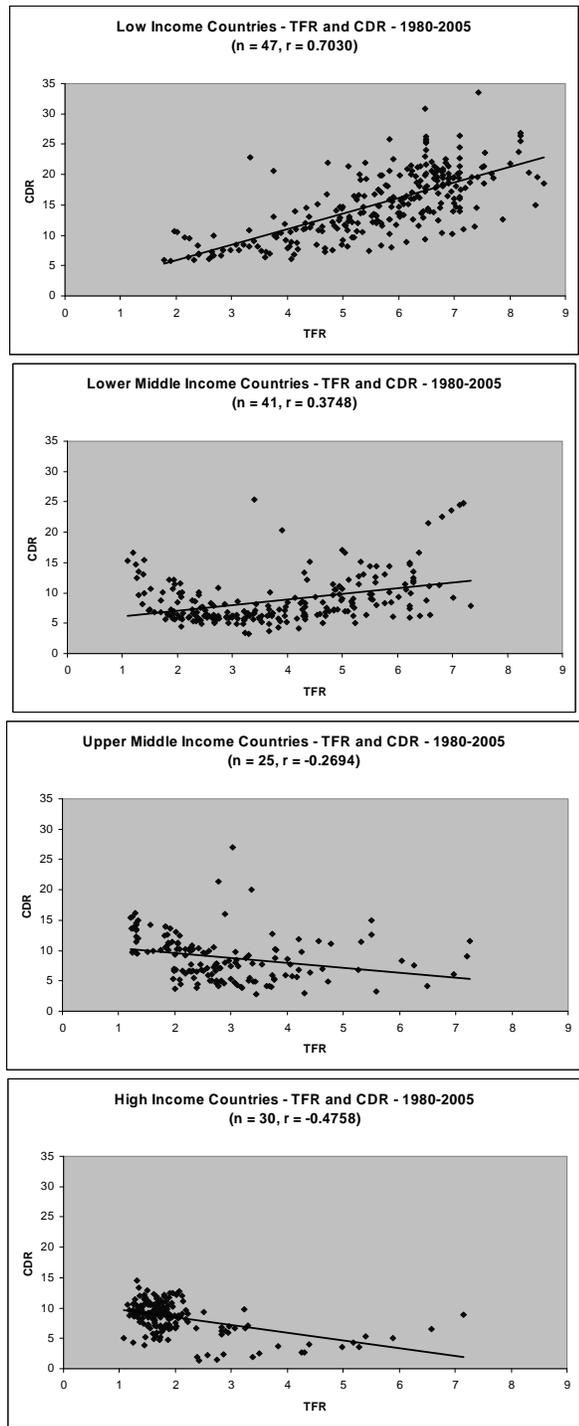


Figure 5. Correlation between TFR and CDR by income level.¹⁵⁵

¹⁵⁵ World Bank World Development Indicators. Income status is based upon World Bank groupings (See Appendix B).

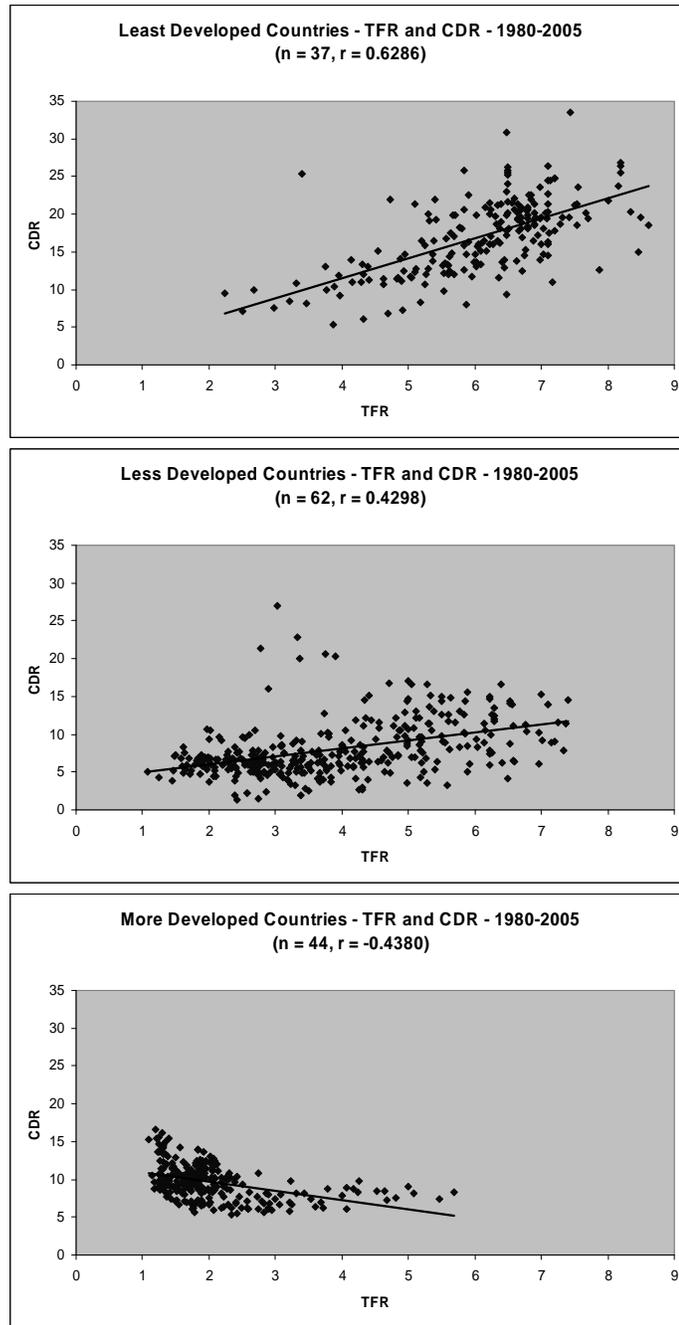


Figure 6. Correlation between TFR and CDR by development level, 143 total countries.¹⁵⁶

¹⁵⁶ Development status based upon UN categories. (See Appendix B).

neither the income groups nor development groups are equally distributed along the curve. High income countries and more developed countries are clustered at low fertility and low death rates with a negative relationship.

The Middle income countries that may be considered transitioning (Stages 2 and 3) are distributed more along a curvilinear path, but with Upper Middle income countries beginning to show the same negative relationship that we find in High income countries. Lower Middle income countries show a moderated positive relationship from what is seen in the Low income countries. The Less developed countries occupy a portion of the curve similar to that of the Middle income groupings.

Among the Low income countries, we lose the curvilinear effect and see a much stronger and positive linear relationship of the right-tail of the J-curve. Similarly, the Least developed countries also have a strong positive relationship and occupy the right tail of the curve.

Examining the relationship between fertility and mortality provides the basis for understanding an important aspect of changing demographics in countries over time, namely, their general relationship with socioeconomic trends. To bring the fertility-mortality dynamic into greater focus for this research, it is useful to now concentrate specifically on the one subcomponent of mortality – the child mortality rate.¹⁵⁷ This focus will facilitate the evaluation of the fertility theories of replacement and anticipatory loss (see Section 2.1.2.).¹⁵⁸

¹⁵⁷ Child mortality rate refers to deaths per 1000 children under the age of five.

¹⁵⁸ Globally, the child mortality rate (CMR) and the crude death rate have a correlation of $R=0.8587$, with the highest correlation in the Low Income countries where the level approaches perfect correlation

Looking at total fertility rate in isolation, there is a definite downward trend in the in every income level worldwide in recent decades (Figure 7). The extent of this decline varies by income strata. The High income countries have lower overall fertility rates and relatively small decline, while the Low income countries have higher rates but have experienced a greater degree of reduction over this time period.

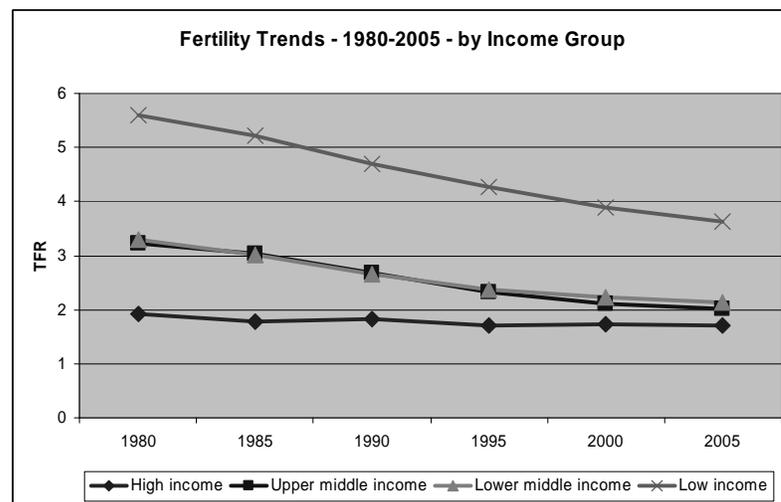


Figure 7. Trends in Total Fertility Rate (TFR) by Income Level.¹⁵⁹

Similarly, there is a global trend toward reduced child mortality at all income levels over this period. And while the direction of the change is consistent, the degree of the change varies by income level with Low income countries seeing greater drops.

($r = 0.9858$). The r-values between CMR and TFR are higher globally and in every income level than the corresponding r-values between CDR and TFR.

¹⁵⁹ World Bank World Development Indicators. Data aggregated by group at the source and includes all 209 World Bank-reported countries (see Appendix B).

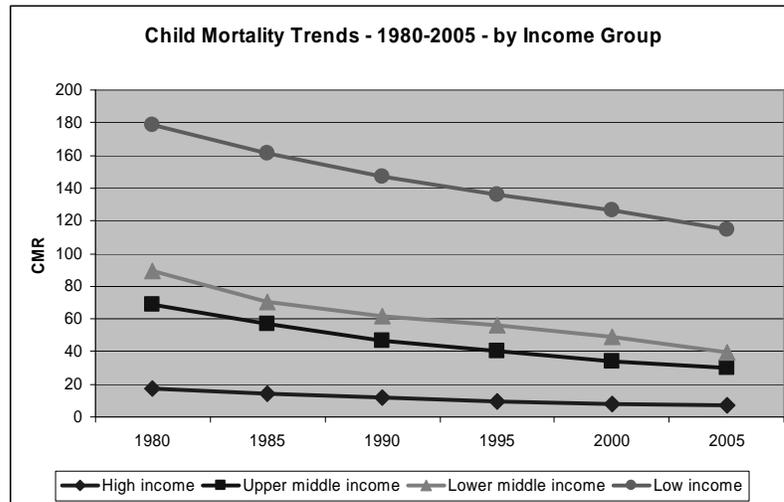


Figure 8. Trends in Child Mortality Rate (CMR) by Income Level.¹⁶⁰

Moving beyond trend analysis, a visual display of scatterplots along with correlation analysis offers a view the relationship and trend from a different perspective. Figure 9 (below) illustrates a consistently positive linear relationship between Total Fertility Rate and Child Mortality Rate with a temporal shift toward both lower fertility and lower child mortality, which is consistent with the general trends. The upper limits of both variables come down over time and the relationship has become even more linear as outlying countries regress toward the mean, with a modest improvement in the correlation from $r = 0.8228$ in 1980 to $r = 0.8870$ in 2005. Most noticeable is the general leftward shift toward lower fertility.

¹⁶⁰ World Bank World Development Indicators. Data aggregated by group at the source and includes all 209 World Bank-reported countries (see Appendix B).

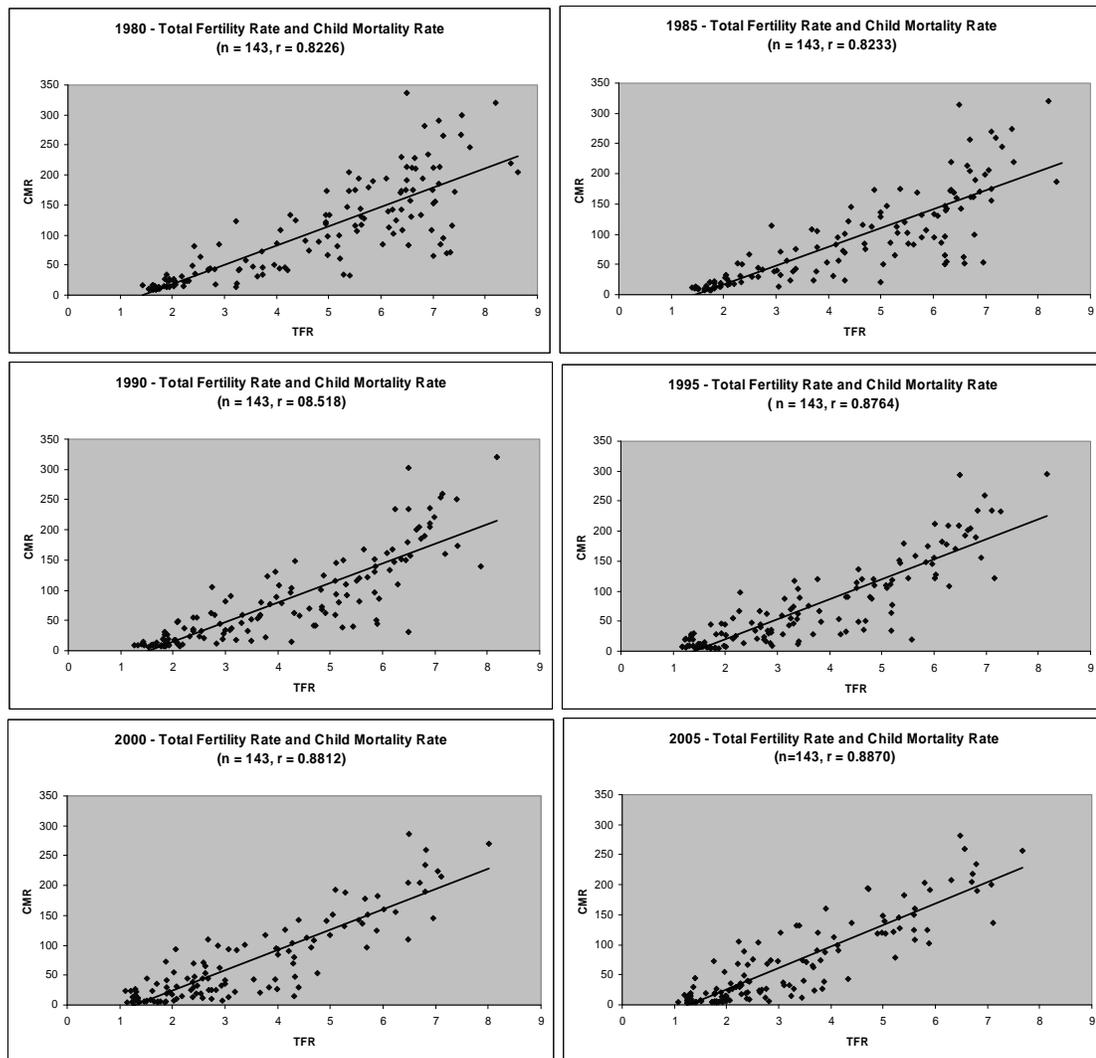


Figure 9. Correlation between TFR and CMR over time (n = 143).

Also evident is the loss of the J-curve that was seen in the scatter plots between Crude Death Rate (CDR) and Total Fertility Rate. The relationship here is more linear. The “hook” of the J-curve disappears because for higher-income countries, a much larger percentage of the population is older, and their natural passing creates a higher number of deaths per thousand population (reflected in the CDR) than societies that are lower and middle income and have generally not transitioned to having much smaller youth cohorts.

For each of the six time frames displayed above, a correlation and regression was conducted between Total Fertility Rate (TFR) and Child Mortality Rate (CMR). For each period the relationships are statistically significant below the 0.01 level. As displayed in the graphical representation, the correlation between the two variables increases over time. By 2005, fertility and child mortality have an r^2 value of 0.7868.

Table 8. Relationship between TFR and CMR over time (n=143).¹⁶¹

| TFR and CMR | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| r | 0.8226 | 0.8233 | 0.8518 | 0.8784 | 0.8812 | 0.8870 |
| r² | 0.6766 | 0.6778 | 0.7255 | 0.7680 | 0.7766 | 0.7868 |

At a global level, a significant relationship exists between TFR and CMR and the strength of this relationship increases over time. However, this cursory analysis also indicates that socioeconomic development and income measures also correlate with demographic shifts.

Here the regressions previously conducted between fertility and the overall mortality rate are repeated, but substituting the Child Mortality Rate for the Crude Death Rate. We see indication of the same relationship among the income groupings, with High income and Low income groups (and More and Least developed countries) having stronger relationships. But in all income strata and development levels, the relationship between fertility and child mortality is stronger than it was between fertility and overall mortality (crude death rate) (Tables 9 and 10)

¹⁶¹ World Bank World Development Indicators. Significant at the 0.05 level.

Table 9. r-squared value of TFR and CMR, 1980-2005, by income level (n=143).¹⁵⁷

| TFR & CMR | r² |
|----------------------------|----------------------|
| Countries (n=143) | 0.7312 |
| Low Income (n=47) | 0.5974 |
| Lower Middle Income (n=41) | 0.5008 |
| Upper Middle Income (n=25) | 0.3501 |
| High Income (n=30) | 0.6169 |

Table 10. r-squared value of TFR and CMR, 1980-2005, by development level (n=143).¹⁶²

| TFR & CMR by Development | r² |
|--------------------------------------|----------------------|
| Countries (n=143) | 0.7312 |
| Least Developed (n=37) | 0.5204 |
| Less Developed ¹⁶³ (n=62) | 0.4770 |
| More Developed (n=44) | 0.6484 |

This examination has provided graphical illustration and statistical documentation that demonstrates the traditional assumptions about the relationship between fertility and mortality found in the literature. In short, there are clear correlations in the changes of both, yet the strength of the relationships differ depending on variations in stages of fertility transition, income strata and development levels.

In testing *Hypothesis #1*, that child mortality will be a better indicator of fertility change than population mortality (crude death rate), I find that (Table 11):

¹⁶² World Bank World Development Indicators. Significant at the 0.05 level.

¹⁶³ This figure includes the Less developed countries *without* the Least developed countries. Throughout this research reference to Less developed countries excludes the Least developed countries unless otherwise stated.

Table 11. r-squared values of TFR to CDR and CMR (143 countries, 1980-2005).

| TFR & CDR | TFR & CMR |
|--------------|--------------|
| $r^2=0.3216$ | $r^2=0.7312$ |

The child mortality rate is a significantly stronger indicator of fertility change than is the population death rate. This supports the fertility theories of replacement and anticipatory loss by demonstrating the loss of a child is significantly statistically correlated to increased fertility. This supports the validity of *Hypothesis # 1*.

The following sections will evaluate measures of child health and measures of women's socioeconomic status as they relate to Total Fertility Rate. The relationship between fertility and child health measures, controlled for the impact of women's socioeconomic measures, will then be compared to the traditional mortality measures discussed in this section and used to determine which measure or measures will prove to be the better indicator(s) of fertility change.

4.2. Analysis – Mortality and Health Measures

In the preceding section, the traditional assumption of using mortality measures as predictors for fertility change was illustrated and quantified. The use of population mortality was evaluated against the use of child mortality as supported by the fertility theories of replacement and anticipatory loss (test of *Hypothesis #1*). The result found a strong relationship between child mortality and fertility and demonstrated that there is validity in using child mortality as a predictor of fertility change.

Hypothesis #2 states that child *health* measures will be a better predictor of fertility change than will child *mortality* measures alone. Health measures provide a more comprehensive and responsive reflection of the health of a population than do mortality measures, and to the extent that population health impacts fertility rates, better comprehensiveness would facilitate greater accuracy.

As identified in the Methodology (Section 3.4) there is good international consensus about key indicators of child health status, with malnutrition, vaccine preventable diseases, and neonatal causes identified as leading contributors to burden of disease and mortality, especially in less developed countries.

Based upon the initial review of potential variables for child health indicators (described in Section 3.4.2), the following analysis will further evaluate the six retained child health variables: *sanitation*, *maternal mortality*, *physicians per 1000*, *nutrition*, *contraceptive use*, and *access to clean water*.

Co-linearity between the remaining 6 independent variables was assessed by performing correlations for each pair. Among the independent variables, correlations with $r \geq 0.8$ were analyzed for potential variable elimination.

Only one correlation exceeded this threshold. The variables for *clean water* and *sanitation* had $r = 0.8406$. This correlation is not surprising given the joint nature of the two variables wherein infrastructure improvements for one often accompany infrastructure improvements for the other. The literature almost universally uses the variables of clean water and sanitation together, often combining them into a single variable. In this case, *sanitation* is the preferred variable because the Millennium

Development Goals (MDG) include it as an indicator for Goal 7, Ensuring Environmental Sustainability. Access to *clean water* is not an MDG indicator and is eliminated here due to excessive collinearity.

Additionally, all independent variables were evaluated for collinearity with the dependent variable of Total Fertility Rate (TFR). Variables correlated to TFR with an $r \geq 0.85$ were assessed for potential elimination. The variables for *contraceptive use* correlates with TFR at $r = -0.8898$. Initially included here as an indicator of health system resources, contraception also has a direct impact on fertility rates, exclusive of other child health measures. Because of this direct causal relationship between use of contraceptives and decreases in fertility, use of this variable as a health indicator is overshadowed. Therefore, it is eliminated.

Table 12 below summarizes all the potential variables considered to represent various aspects of child health. It indicates the initial eliminations due to missing data ($n < 400$) and significance with regard to the dependent variable ($r^2 < 0.20$). It further shows the elimination of variables due to collinearity, and lists the four variables that are retained to construct the Child Health Model.

Table 12. Retention and Elimination of Child Health Variables.

| Dependent variable | Independent variable | Observations | r | r² | Retain? |
|---------------------------|-----------------------------|---------------------|----------------|----------------------|------------------------------------|
| TFR | Sanitation | 549 | 0.8053 | 0.6485 (65%) | Yes |
| TFR | Maternal Mort | 568 | 0.7827 | 0.6125 (61%) | Yes |
| TFR | Physicians | 574 | -0.6525 | 0.4258 (43%) | Yes |
| TFR | Nutrition | 638 | 0.6519 | 0.4250 (43%) | Yes |
| | | | | | |
| <i>TFR</i> | <i>Contraceptives</i> | <i>403</i> | -0.8898 | <i>0.7918 (79%)</i> | co-linearity w/TFR |
| <i>TFR</i> | <i>Clean Water</i> | <i>558</i> | <i>0.7899</i> | <i>0.6239 (62%)</i> | co-linearity w/SAN (0.8406) |
| <i>TFR</i> | <i>Immunizations</i> | <i>858</i> | <i>0.0994</i> | 0.0099 (1%) | r² < 0.20 |
| <i>TFR</i> | <i>Poverty</i> | 277 | <i>0.5822</i> | <i>0.3390 (34%)</i> | n < 400 |
| <i>TFR</i> | <i>Attended Births</i> | 242 | <i>-0.7675</i> | <i>0.5890 (59%)</i> | n < 400 |
| <i>TFR</i> | <i>Prenatal care</i> | 240 | <i>0.4156</i> | <i>0.1728 (17%)</i> | n < 400 |
| <i>TFR</i> | <i>ARI treatments</i> | 139 | <i>-0.3767</i> | <i>0.1419 (14%)</i> | n < 400 |
| <i>TFR</i> | <i>Treated Bednets</i> | 50 | <i>-0.2689</i> | <i>0.0723 (7%)</i> | n < 400 |
| <i>TFR</i> | <i>Oral Rehydration</i> | 83 | <i>-0.2159</i> | <i>0.0466 (5%)</i> | n < 400 |

Four variables are retained for further analysis: These include *access to improved sanitation facilities, maternal mortality, physicians per 1000, and nutrition.*

Adjustments to Timeframe of Analysis

With the four retained variables identified, further observations of the data were made. The lack of reported data for 1980 in one variable (*Sanitation*) and 1985 in two variables (*Sanitation* and *Nutrition*) results in significant loss of retained cases due to the listwise deletion employed for missing values. The timeframe for analysis is therefore reduced to the 15 year period (4 data points) from 1990 through 2005. Using this revised timeframe, all variables now have adequately populated cells to produce valid statistical

results.¹⁶⁴ Therefore, the analysis proceeds with 143 countries, 4 time periods, and 4 independent variables.

Performing an initial multiple regression with the four variables proposed for the child health model finds that 41% of cases are lost due to missing data. The data set was then queried for complete cases only, and the model is tested here using only the 293 cases that are complete. This is still an adequately robust data set for this analysis.¹⁶⁵

There is a single dependent variable and four independent variables. The analysis of these variables is exploratory and there is no established theory on which to base the model selection. This lack of established theory, along with the fact that all selected variables are continuous, facilitates the use of regression as a model building design.¹⁶⁶

Multiple regression was conducted with the four independent variables resulting in $R^2 = 0.7717$. All variables are significant at the 0.05 level. This is a strong model as it has a stronger relationship with the Total Fertility Rate (TFR) than does either the Crude Death Rate (CDR) or the Child Mortality Rate (CMR), and the dynamics captured by the Child Health Model explain nearly 77% of the variation in fertility. (Note throughout this research, lower-case r reflects to simple regression and upper-case R reflects multiple regression).

¹⁶⁴ Running an initial regression shows that after listwise deletion of missing cases, 59% of the data is retained for further analysis (340 of 572 cases retained). This provides adequate retention and does not exceed 50% data loss.

¹⁶⁵ There was a shift in the representative mix of countries by development level. In the complete listing of 143 countries, 26% are from Least developed countries, while with the reduced data set used for the model, only 16% of retained cases are from Least developed countries. Both Less and More developed countries are slightly more represented in the model.

¹⁶⁶ W.W. Cooley and P.R. Lohnes, *Multivariate Data Analysis* (John Wiley & Sons, 1971); see also Richard Darlington, *Regression and Linear Models* (McGraw Hill College, 1990); see also J.Neter, W. Wasserman and M.H. Kutner, *Applied Linear and Statistical Models (2d edition)* (Homewood, Ill: Richard D. Irwin, 1985).

Using this result to test *Hypothesis #2*, I first recalculate the regression for TFR and CMR, and TFR and CDR, using only the 293 cases to ensure comparability. I find the following (Table 13):

Table 13. R-squared values of TFR to CMR and the Child Health Model (293 cases).¹⁶⁷

| TFR & CDR | TFR & CMR | TFR & Child Health Model |
|----------------------|----------------------|-------------------------------------|
| $r^2=0.0687$ | $r^2=0.7498$ | $R^2=0.7717$ |

For further exploration of this dynamic relationship, bivariate correlations were conducted between Child Mortality Rate (CMR) and the four individual child health variables to explore the potential of creating a five-variable composite model. The excessive collinearity between CMR and two of the variables (sanitation correlates at 0.8180 and maternal mortality correlates at 0.8698) precludes the building of such a model.

The results annotated in Table 13 support *Hypothesis #2* that states that child health measures are a better predictor of fertility change than mortality measures alone. However, the statistical differences between the CMR and Child Health models are not significant, indicating that both models are potentially useful predictors of fertility. Note that the improvements through this measure are much more moderate than those seen between CDR and CMR. Child health and child mortality have more inherent co-linearity as declines in health contribute directly to increases in mortality. However, the

¹⁶⁷ Findings are significant at the .05 level.

health-related variables used in this model are already in existence and require no new data collection efforts and even moderate increases in strength have potential to improve assessment of expected fertility changes. Assessment of a model with includes both the child health components and the child mortality rate further improves the r-square value at the global level.

Additionally, the ability to assess the component parts of the model and attribute an identifiable portion of the variation to a specific health indicator is informative to decision makers who can manipulate changes in specific variables by targeting resources or policy. This provides information to policy makers about the importance that improvements in sanitation have in moderating fertility levels. Use of a mortality indicator can not provide this type of actionable analysis.

4.3. Analysis - Socioeconomic Controls

Incorporation of indicators of socioeconomic status informs this research by incorporating a well established and documented relationship between social and economic changes and fertility as discussed in Section 2.3. This portion of the analysis will determine how the predictive power of mortality and health indicators is altered by adding these controls.

This analysis begins with the 8 retained socioeconomic variables described in Section 3.4.3.e. Collinearity between these remaining independent variables was assessed by performing correlations for each pair, and identifying those with correlations of $r \geq 0.85$ for potential variable elimination. Seven correlations exceeded this threshold

(*Phone lines, HDI, Dependency, Population under 14, No Schooling, Years in School and Illiteracy*).

As anticipated, the three remaining variables associated with **education** (no schooling, years of schooling, and illiteracy) are highly correlated with one another with most r-values >0.8. These variables were evaluated as a group:

- a. *Years of schooling* and *no schooling* measure two sides of the same issue. And with the previously stated preference for the *illiteracy* variable, in like manner it is preferred over *years of schooling*, which also has a weaker dataset. Therefore, ***years of schooling will be eliminated.***
- b. There is high collinearity between *illiteracy* and *no schooling*. In some cases they may actually represent the same data because in countries lacking the sophisticated surveys required to accurately represent illiteracy, *no schooling* is often used as a surrogate.¹⁶⁸ However, the *illiteracy* dataset is considerably more robust. Therefore, *illiteracy* is preferred over *no schooling* and ***no schooling will be eliminated.***

Also anticipated was the high correlation ($r = 0.9503$) between the *population under age 14* and the *dependency ratio*, which uses the under 14 population as a component in its calculation. Dependency ratio is a more complex measure that reflects shifts in the shape of the population pyramid. Both of these variables have collinearity issues with the Total Fertility Rate since the fertility rate directly impacts them ($r > 0.9$ in

¹⁶⁸ United Nations Development Group, 2003.

both cases), therefore both **variables** (*population 14 and under and dependency ratio*) **will be eliminated** from further analysis.

GNI (*Gross National Income*) per capita and *phone mainlines per 1000* are highly correlated at $r=0.8974$. Increasing numbers of phone often accompany economic improvements. *GNI* will be retained because, as an income measure, it is an important component of assessment of socioeconomic status. Therefore, *phone mainlines per 1000* **will be eliminated**.

Lastly, *HDI* (*Human Development Index*) is very highly correlated ($r=0.9010$) with years of school. Since literacy and education are both components in the calculation of *HDI*, this is to be expected. Because *HDI* is already a composite measure and incorporates multiple indicators within it, it would be difficult to attribute impact to specific indicators. Therefore, *HDI* **will be eliminated from further analysis**.

Additionally, all independent variables were evaluated for co-linearity with the independent variable of Total Fertility Rate (TFR). Variables correlated to TFR with an $r \geq 0.85$ were assessed for potential elimination. Most of the variables that exceed this limit have been eliminated through other criteria. The variable for *illiteracy* correlates with TFR at $r = 0.8002$, just barely above the threshold. This variable will be retained despite its high correlation. Having eliminated other literacy and education-related measures it is essential to maintain an indicator of this type in the model. The UN Millennium Development Goal for women's equality and empowerment uses literacy as a key measure of progress.

Two variables are retained to be used as potential controls for the socioeconomic status of women in the analysis of the child health model. These include *illiteracy*, and *GNI per capita*.

In Table 14 the handling of all considered socioeconomic variables is summarized with indications as to the cause for elimination, as appropriate, as well as the identification of those variables that were ultimately retained for further analysis.

Table 14. Retention and Elimination of Women's SES Variables.

| Dependent variable | Independent variable | Observations | r | r² | Retain? |
|---------------------------|-----------------------------|---------------------|----------|----------------------|--------------------------------|
| TFR | Illiteracy | 678 | 0.8002 | 0.6403 (64%) | Yes |
| TFR | GNI | 760 | -0.6234 | 0.3887 (39%) | Yes |
| | | | | | |
| <i>TFR</i> | <i>Phone Lines</i> | 826 | -0.7032 | 0.4945 (49%) | collinearity |
| <i>TFR</i> | <i>HDI</i> | 721 | -0.8837 | 0.7810 (78%) | collinearity |
| <i>TFR</i> | <i>Dependency</i> | 856 | 0.9499 | 0.9023 (90%) | collinearity |
| <i>TFR</i> | <i>Population under 14</i> | 856 | 0.9373 | 0.8785 (88%) | collinearity |
| <i>TFR</i> | <i>No Schooling</i> | 498 | 0.8429 | 0.7105 (71%) | collinearity |
| <i>TFR</i> | <i>Years of School</i> | 498 | -0.8580 | 0.7023 (70%) | collinearity |
| <i>TFR</i> | <i>Seats in Parliament</i> | 392 | -0.3095 | 0.0958 (10%) | r² < 0.20 |
| <i>TFR</i> | <i>Literacy Parity</i> | 339 | -0.3072 | 0.0944 (9%) | r² < 0.20 |
| <i>TFR</i> | <i>Female Labor</i> | 856 | -0.1295 | 0.0168 (2%) | r² < 0.20 |
| <i>TFR</i> | <i>Female Participation</i> | 856 | -0.0012 | 0.0168 (2%) | r² < 0.20 |
| <i>TFR</i> | <i>Unemployment</i> | 395 | 0.1022 | 0.0104 (1%) | r² < 0.20 |
| TFR | Agriculture | 366 | 0.5020 | 0.2520 (25%) | n < 400 |
| TFR | Education Ratio | 339 | -0.6917 | 0.4784 (48%) | n < 400 |
| <i>TFR</i> | <i>GDI</i> | 257 | -0.9066 | 0.8219 (82%) | n < 400 |
| <i>TFR</i> | <i>GEM</i> | 136 | -0.4945 | 0.2446 (25%) | n < 400 |
| <i>TFR</i> | <i>Literacy Rate</i> | 192 | -0.7842 | 0.6150 (62%) | n < 400 |

Before applying these retained socioeconomic indicators as controls to the foregoing analyses, it is informative to evaluate their impact on fertility directly. As the literature presented on socioeconomic impacts indicates, multiple factors act on one another to ultimately impact outcomes such as fertility. Variables such as income and education, as reflected in the selected controls here, have both direct influences on fertility as well as indirect influences through health behaviors. When regressed against TFR (using the same set of complete cases applied in the Child Health analysis), this socioeconomic status (SES) model proves to be a strong model by itself, but does not perform as well as child mortality alone or the Child Health Model alone (Table 15).

Table 15. R-squared values for Child Health and SES (using identical complete cases).¹⁶⁹

| TFR & Child Health Model | TFR & SES Model |
|-------------------------------------|-----------------------------|
| R²=0.7717 | R²=0.5923 |

For the evaluation of the mortality and morbidity models, the retained socioeconomic variables were then added as controls to the regressions performed in earlier. Applying these controls to the child health model resulted in $R^2 = 0.7846$, a slight improvement over the model without controls ($R^2 = 0.7717$). Adding them to the Crude

¹⁶⁹ Significant at the 0.001 level.

Death Rate (CDR) model resulted in $r^2 = 0.5995$, a dramatic increase over CDR's strength without control variables. All variables are significant below the 0.05 level.¹⁷⁰

The introduction of the control variables had only very slight impact on the coefficients of the variables in the child health model. The coefficient for sanitation dropped 0.005, nutrition increased 0.001, maternal mortality was virtually unchanged, and physicians per 1000 dropped by 0.075. None of these changes has significant implications for the use of this model or these control variables.

The fact that socioeconomic variables of income and women's education do not significantly improve or alter the ability of the child health model to predict changes in fertility significantly reinforces the importance and potential utility of health measures. This may be an indication of the primacy of health measures over socioeconomic measures in predicting fertility change.

When these controls are added to the regression against Crude Death Rate and the Child Mortality Rate, there are also improvements in the performance of the models to indicate fertility change. The table below (Table 16) displays the results for each analysis with and without socioeconomic controls.

To populate this table, the regressions between total fertility rate and child mortality rate that was initially presented was re-run using only the cases used to calculate and test the Child Health model. This helps ensure comparability of results. Additionally, as validation of the selection of CMR over CDR as the appropriate

¹⁷⁰ Correlations between the control variables, GNI per capita and female illiteracy, and the Child Health variables were evaluated for potential multi-collinearity, none neared the established threshold. The highest correlation was between GNI and Sanitation at $r = -0.6759$.

mortality measure to evaluate fertility, an identical regression was conducted against CDR.¹⁷¹

Table 16. R-squared values for Comparison with and without SES controls (using identical complete cases).

| | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|---------------------------|--------------|--------------|--------------------------|-----------------|
| Without control variables | $r^2=0.0687$ | $r^2=0.7498$ | $r^2=0.7717$ | $r^2=0.5923$ |
| With control variables | $R^2=0.5995$ | $R^2=0.7848$ | $R^2=0.7846$ | n/a |

Significant at the 0.05 level. Again, r^2 reflects simple regression; R^2 reflects multiple regression.

These results show several things. First, crude death rate (population mortality) alone is a very weak indicator of fertility change. Second, the Child Mortality Rate and the Child Health Model examined here are both strong indicators of fertility change. Without additional controls, the Child Health is moderately stronger than CMR. And third, although socioeconomic measures alone prove to be a good model, they do not perform as well as either child mortality or the Child Health model.

In evaluating the impact of controls on the effectiveness of the other measures to indicate fertility change, it is apparent that the control variables explain most of the variance when paired with CDR, which is otherwise not significant. When the SES (socioeconomic status) controls are added to the other models, the effectiveness of CMR

¹⁷¹ In preparation for running these regressions, each of the independent variables was evaluated against CDR using bi-variate correlation. With respect to CDR, Illiteracy, GNI, and physicians per 1000 correlate below 0.20, Nutrition at 0.2467, and Sanitation at 0.3297. The most highly correlated variable is Maternal Mortality at $r=0.4985$, not surprising since this is mortality measure that is a sub-component of CDR.

and Child Health become statistically indistinguishable. Between CMR and the Child Health model, the control variables have a slightly stronger impact when paired with CMR, as they close the moderate gap that exists without controls. This also indicates that measures of child health already incorporate more of the impact that women's socioeconomic status has on fertility change.

5. Preliminary Results

Both the child mortality rate and the child health model explored using global data in the previous chapters were strong predictors of fertility change and produced better results than population mortality or socioeconomic factors alone. The robustness of data on child mortality gives these variables more utility for use, particularly in longitudinal studies. However, the strength of the child health model indicates potential for continued exploration. While the power of the analysis was significantly reduced due to missing data in many of the considered areas, the ultimate model was tested using only complete cases, providing good consistency and validity. Although smaller in scale than originally anticipated, the results of this analysis are very promising for ongoing evaluation of child health measures as indicators of fertility change.

As composite health measures continue to develop and become more consistent across space and time, evaluation of their utility in indicating fertility change should continue. In the near term, basic health and socioeconomic indicators that are already being monitored may be very useful at the regional and country level as indicators of future population patterns.

There is a distinct advantage to policy makers in utilizing child health measures over child mortality measures as indicators for fertility change. Changes in child health measures can be tracked back to system inputs (either specific or collective) that better

inform future decision-making. Child mortality, on the other hand, is purely an outcome measure for which tracking causal factors necessary for policy planning would require a subsequent exploration of contributing health and socioeconomic factors to become actionable.

The evaluation of the three hypotheses presented in the foregoing analysis indicates that, using this global data set, (1) child mortality is a better predictor of fertility change than is population mortality, (2) the Child Health model is a better indicator of fertility change than child mortality alone, and (3) introduction of socioeconomic variables adds little or nothing to the performance of each of these in predicting fertility change.

To probe more deeply into these relationships, I now undertake a study of these relationships in several individual countries. In the next three chapters, I use country case studies to further assess the relationships among fertility, mortality, child health, and women's socioeconomic status. The dynamics within each country are different and the policy environment for each is unique. Ultimately, the usefulness of child health or socioeconomic variables as indicators of fertility change must be demonstrated at the country-level where policies are developed and implemented.

To accomplish this, three countries were selected to reflect a variety of challenges that policy makers face in targeting problems and implementing change. In this section I evaluate the research findings of this study in light of real world situations in three countries.

In identifying countries for these focused studies, I considered child mortality rates as the primary criteria for inclusion. The United Nations, through the Millennium Development Goals, now notes that just over 40 countries account for 90% of child deaths in the world.¹⁷² Because this research explores the relationship between child mortality and fertility, the focus here is on those countries that bear the greatest burden of child mortality and would presumably provide an opportunity to observe the relationships analyzed in this research. In their 2003 article in *The Lancet*, Black, Morris, and Bryce brought this disproportionate distribution of child mortality into focus by identifying 42 countries that bear the greatest burden of child mortality.¹⁷³ From this list, countries were selected that represent populous countries in different geographical regions, different income strata, and have adequate data for critical variables and multiple years available and accessible. I particularly sought federal countries in which good data are available at the regional, state or provincial level, to examine within-country correlations between fertility and mortality and health indicators.

The countries selected for case studies are (Table 17):

¹⁷² Department of Economic and Social Affairs, United Nations Statistics Division. 2005. Progress towards the Millennium Development Goals, 1990-2006, http://mdgs.un.org/unsd/mdg/Resources/Attach/Products/Progress2005/goal_4.doc, Accessed January 2008. See also Black RE, SS Morris and J Bryce. 2003. Where and why are 10 million children dying every year? *The Lancet*. 361: 2226-2234.

¹⁷³ Black et al.

Table 17. Selected Countries.

| Country | Location | Income Strata | HDI 2004 | Population 2005 | Child Mort Rate 2005 |
|----------------|-----------------|----------------------|-------------------|------------------------|-----------------------------|
| India | Asia | Low | 0.611 Rank 126 | 1103 M | 85 per 1000 |
| Mexico | North America | Upper Middle | 0.821 Rank 53 | 107 M | 28 per 1000 |
| Philippines | Western Pacific | Lower Middle | 0.763 Rank 84 | 93 M | 33 per 1000 |

The content of the country studies includes historical background and their current situation. Brief assessments of trends relating to fertility, mortality, child health, and women's socioeconomic status are offered. Where possible, current health and population policies will be identified and discussed within context of this research. For each country, the analyses conducted at the global level is repeated at the country level, using state, regional, or provincial-level data as the unit of analysis. The results will be evaluated for their variation from findings at the global level and assessed in light of country-level dynamics that may impact both the outcome of the analysis and its application toward policy determinations.

6. India

The study of India provides an opportunity to explore the hypotheses of this research at the country level, where policies relating to population growth, health, and socioeconomic development are typically implemented. India's federal structure, with wide disparities in income and fertility among its states, but good statistics for each state, allows a closer look at relationships between health and fertility on a regional level.

6.1. Background

India has experienced a broad range of cultural influences that have influenced its development. Although under Muslim rule for more than 500 years, Indian society is organized along the lines of Hinduism, with an active caste system and broad social disparities. During colonization by the British (1757-1947), India saw advances in agriculture and irrigation as well as industry and manufacturing. But even under British rule development was uneven, and many regions continue to be disadvantaged in the 21st century.¹⁷⁴

Following independence, the Indian government was established as a democratic, socialist, federal republic, which currently consists of 28 states and 7 union territories (see map, Figure 10).

¹⁷⁴ NJ Kurian, Government of India Planning Commission Report – Vision 2005 – Regional Disparities in India. (2005).



Figure 10. Map of India.

Economy

Traditionally the Indian economy consisted of traditional village farming, but the current economy includes modern agriculture, industries, services, and handicrafts.

Approximately 60% of the workforce is in the agricultural sector, 12% is in industry, and 28% is in services. The current unemployment rate is 7.2%.¹⁷⁵

Classified as a *low income* country by the World Bank, there has been substantial economic expansion in the last decade, and that has brought with it increasing concerns about population growth and poverty.¹⁷⁶ Actual economic progress per capita has been moderate and improvements in infrastructure and public services have lagged behind increases in Gross National Income (GNI, currently US\$820).^{177, 178} Regional differences remain marked.

India's current economic growth has origins in the structural adjustment reforms of 1991. India actively worked to improve its international standing economically, but the reforms caused cuts in social programs, including health and education.¹⁷⁹ One outcome of the economic reforms was an increase in poverty. And although the national trend is now improving, there are increasing disparities among and within states. An India Planning Commission report by economist Dr. N.J. Kurian characterizes two major divisions among the 15 states that account for almost 96% of India's population. He

¹⁷⁵ CIA World Fact Book (2007). Available from <https://www.cia.gov/library/publications/the-world-factbook/index.html>; Internet; Accessed February 2008.

¹⁷⁶ CIA World Fact Book.

¹⁷⁷ Sangeeta Parashar, Moving beyond the mother-child dyad: women's education, child immunization, and the importance of context in rural India. *Social Science & Medicine*. 61 (2005): 989-1000.

¹⁷⁸ Development Economics LDB database.

¹⁷⁹ Parashar.

refers to the groups as “forward” and “backward” states.¹⁸⁰ Although he discusses a range of differences between the groups (including literacy, income, and poverty), the primary descriptor is their differing stages of demographic transition, with “backward” countries typically showing higher levels of fertility and higher mortality and morbidity.¹⁸¹ Kurian notes that there are both “backward” states in India and there are “backward” regions within most states.¹⁸² I will refer to these groups as “more developed” and “less developed” states or regions. These internal disparities are important in determining effective national and regional policies.

Population

India has an estimated population of 1.129 billion people; approximately 30% of the population resides in urban centers with 70% spread among the rural regions.¹⁸³ Thirty-two percent of the population is under the age of 15 and only 5% is aged 65 or older. Life expectancy is 64 years and the median age is approximately 25 years.¹⁸⁴ The national total fertility rate is 3.11, but this varies significantly state-to-state, region-to-region and among socioeconomic classes.

Since 2000, the population growth rate has averaged 1.5% per year and overpopulation is a serious policy concern to the government of India. India’s National

¹⁸⁰ “Forward” states include Andhra Pradesh, Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Punjab and Tamil Nadu. “Backward” states include Assam, Bihar, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh and West Bengal.

¹⁸¹ There are also general differences in literacy rates, gender gaps, gross state domestic product, percentage of poor population, and patterns in private investment.

¹⁸² Kurian.

¹⁸³ CIA World Fact Book, 2007. downloaded January 2008. <https://www.cia.gov/library/publications/the-world-factbook/index.html>. See also Parashar; see also Development Economics LDB database.

¹⁸⁴ CIA World Fact Book.

Population Policy states that “stabilising population is an essential requirement for promoting sustainable development with more equitable distribution [of resources].”¹⁸⁵

Support in assessing and addressing population issues in India has been rendered by the United Nations, other nations and international nongovernmental organizations.

Sixty-one percent of the population over 15 years of age can read and write. But disparities exist in that female literacy is only 47.8% while male literacy is 73.4% (per the 2001 census).¹⁸⁶ Significant differences in literacy also exist between urban and rural populations.

Hinduism is a dominant influence in all aspects of society. The country is more than 80% Hindu, and people believe that individuals are born into a position in society that cannot be changed. Those born into the upper castes are often privileged and generally more educated, while those in the lower castes face considerable discrimination and social disadvantage, working mainly as laborers and servants. The caste system has become more flexible over time and is becoming less of a defining characteristic, particularly in the urban areas. The 73d Constitutional Amendment provided for the protection of, and positive discrimination for, those groups that the government determined had been historically disadvantaged, largely due to the caste system. These protected groups are called *Scheduled Castes* and *Scheduled Tribes*. Many development programs often target these groups, but little has actually been accomplished to minimize

¹⁸⁵ National Commission on Population (Government of India). 2000. National Population Policy 2000. New Delhi. Introduction.

¹⁸⁶ CIA World Fact Book.

the disparities in social classes and many indicators point to a broadening chasm between the *haves* and *have-nots*.¹⁸⁷

Health System

The establishment of the Health Survey and Development Committee in 1943 marked the beginning of real health service planning for India.¹⁸⁸ The provision of public health services and health education in India are currently the responsibility of the individual states, rather than a uniform program of the central government. Central planning by the Ministry of Health and Family Welfare focuses on administrative issues, technical services, and medical education and research. The decentralized system for provision of care has resulted in significant variation in the availability and effectiveness of services both among and within states, and access varies according to social geography, gender, class, and social status.¹⁸⁹ The local and regional variations in health care provide an excellent opportunity to study the relationships between varying health conditions and fertility.

The current basis for the national health program is the 2002 National Health Policy, which now includes provisions for a shift toward universal primary health care and supports only limited state role in healthcare. However, the state's role in providing health services remains very limited, with the state only providing the most basic preventive care. As a result there is a rapidly growing private, for-profit medical sector in India that contributes to exacerbating the divide between the wealthy and the poor.

¹⁸⁷ MD Gupta, Vidya Ramachandron and RK Mutatkar. Epidemiological profile of India: historical and contemporary perspectives. *J.Biosci*(Nov 2001) 26(4): 437-464.

¹⁸⁸ Gupta et al.

¹⁸⁹ Securing Rights – Citizens' report on MDGs. Bangalore, India: Books for Change.

The current system is a mix of ambulatory and curative care provided almost entirely by the private sector, and preventive care provided by the government.¹⁹⁰ This government care includes immunizations, safe motherhood and child wellness programs, and select disease surveillance. The hospital sector is also shifting toward the private market. The market-based approach to provision of care favors the wealthy and there is an increasing demand for more public financing and a more socially responsive system.¹⁹¹

The Indian government voices a strong national commitment to healthcare. In 2004, India spent approximately 5% of its GDP on health expenditures, an increase from 4.3% in 2000.¹⁹² Unfortunately, the decentralized state-led approach to health delivery has produced a system that is not well integrated with other social and economic development efforts that could be complementary to public health causes. There is insufficient political will and inadequate local infrastructure in some areas and this produces major regional variations.¹⁹³

There are many challenges with the delivery of care within the Indian system. The vast rural areas of the country are difficult to support due, in part, to ongoing staffing shortages. Primary Health Centers are the backbone of the rural structure, and rural patients with complex medical needs are sent to urban hospitals for care. Additionally, there are many cultural complexities that impact the delivery of care and achievement of successful health outcomes. Among these is the reliance on ancient indigenous medicine – referred to as Indian Systems of Medicine (ISM). Although

¹⁹⁰ Parashar.

¹⁹¹ Securing Rights.

¹⁹² World Bank – World Development Indicators database.

¹⁹³ Parashar; See also Securing Rights.

biomedicine is the preferred first choice in urban areas, even the upper classes resort to ISM if they do not get desired results from modern medicine. For some health problems, women continue to prefer ISM.¹⁹⁴ In 2002, the World Health Organization put forth guidelines for the use of traditional medicines, believing that disregarding cultural traditions about health is counter-productive to reaching populations in need. India now includes ISM practitioners in staffing models for some public programs.¹⁹⁵

6.2. Fertility

The total fertility rate (TFR) for India has been in steady decline and at 3.11 is nearing the rate of more developed nations (Figure 11). Several of the better functioning *more-developed* states within India actually have state-wide TFRs less than 2 and below replacement levels.¹⁹⁶ However, the *less-developed* state of Bihar has a total TFR of 4 (the highest in India), and a TFR of 4.22 in its rural areas.¹⁹⁷ Uttar Pradesh, India's most populous state, has a rural TFR of 4.13.

¹⁹⁴ Papiya Guha Muzumdar and Kamla Gupta, Indian system of medicine and women's health: a client's perspective. *J Biosoc.Sci* 39 (2007):819-841.

¹⁹⁵ Muzumdar.

¹⁹⁶ Replacement rate for developed countries is approximately 2.1. For South-central Asia, the replacement rate is estimated at 2.4. See TJ Espenshade, JC Guzman, and CF Westoff, "The surprising global variation in replacement fertility". *Population Research and Policy Review* (2003).

¹⁹⁷ International Institute for Population Studies (IIPS) and Macro International, National Family Health Survey (NFHS-3), 2005-06, India: Key Findings. (Mumbai: IIPS, 2007).

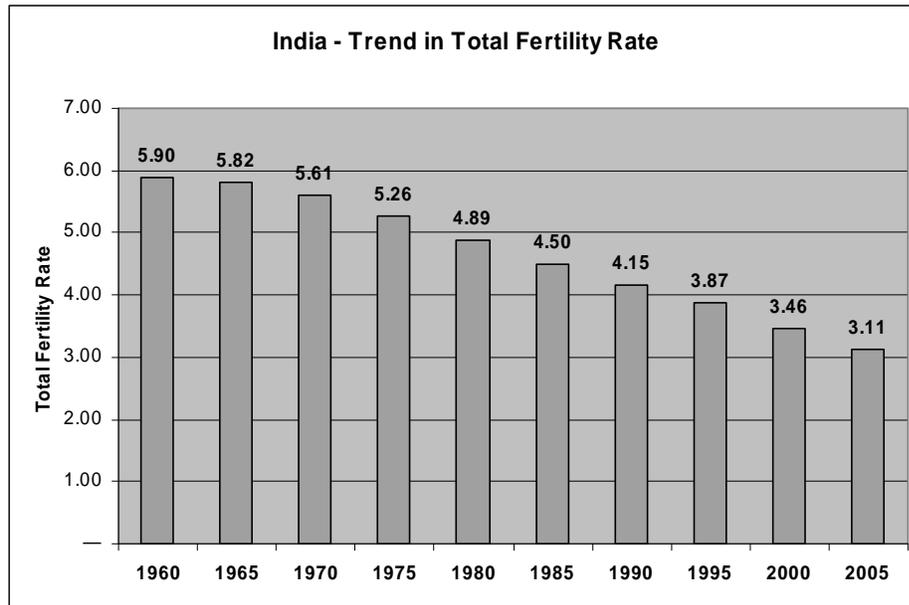


Figure 11. India – Trends in Total Fertility Rate.¹⁹⁸

With a cultural preference for sons, for many families it is important to ensure a son will survive to adulthood.¹⁹⁹ This preference can impact fertility rates. The differences in education, health, and income based on geography (urban vs. rural) and social standing can impact both the use of contraceptives and the survival of children. These in turn contribute to higher fertility rates especially for the most disadvantaged segments of society.²⁰⁰ Because of the disparities within the country and within states,

¹⁹⁸ United Nations Population Prospects Database 2006.

¹⁹⁹ Surveys from the New Delhi Operations Research Group (1991) indicate that 72% of rural families continue to have children until at least two sons are born. In urban families 53% desired at least two sons.

²⁰⁰ Victoria A. Velkoff and Arjun Adlakha. U.S. Census Bureau. Women of the World. December 1998 – “Women’s health in India” WID/98-3.

data aggregated at the national level can be misleading because they hide significant internal variation.²⁰¹

Figure 12 shows the state-level fertility rates as reported in the 2005 National Family Health Survey. The states considered to be *less-developed* are annotated with an “X” after the state name. This graph illustrates how the *less-developed* states have overall higher fertility rates than the *more-developed* states.²⁰²

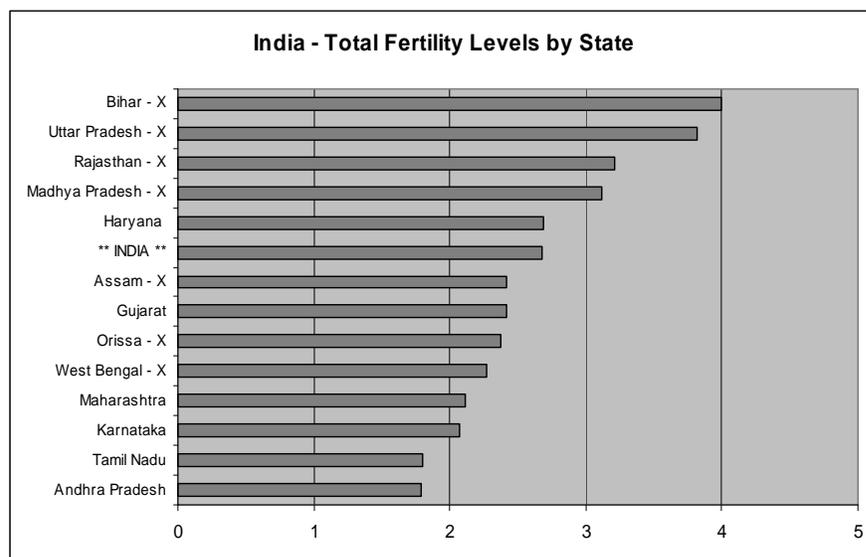


Figure 12. India – Fertility Levels, by State.²⁰³

²⁰¹ Note that the TFR reported in Figure 8.1-a from the United Nations for 2005 differs from the TFR reported from India’s National Family Health Survey shown in Figure 8.1-b. The time frame for data collection and the methodologies for data collection and calculation differ.

²⁰² Note that the selection of the terms *less-developed* and *more-developed* for these states are substitutes for the terms *Backwards* and *Forwards* as used in some of India’s economic reports. This categorization includes socioeconomic data beyond fertility rates, and therefore some of the countries labeled *less-developed* have fertility rates that are lower than *more-developed* states (and vice-versa) because the states have other socioeconomic measures do not align precisely with their fertility rates.

²⁰³ International Institute for Population Studies (IIPS) and Macro International. 2007. National Family Health Survey (NFHS-3), 2005-06, India: Key Findings. Mumbai: IIPS.

6.3. Health

Based upon the all-cause DALY rates,²⁰⁴ India carries one of the highest disease burdens outside of the African continent.²⁰⁵ India also bears a high burden specifically within the category of *communicable, maternal, perinatal and nutritional conditions*, which accounts for almost half (46%) of India's total disease burden (as measured in DALYs).²⁰⁶ Non-communicable diseases account for an additional 41% of the burden, and injuries account for 13% (Figure 13).²⁰⁷ The combination of poor living conditions, poverty, lack of sanitation, and poor nutrition contributes to these high rates of communicable disease.²⁰⁸ In the under-5 age group, the burden of disease is almost entirely attributed to communicable diseases and neonatal conditions.²⁰⁹

²⁰⁴ See Section 5.2. DALYs include both years of life lost and years lived with disability.

²⁰⁵ World Health Organization. Estimated DALYs per 100,000 by cause and Member State, 2002.

²⁰⁶ This grouping will be referred to here simply as "Communicable Diseases" although it comprises a larger scope of conditions. The major sub-categories in this grouping are infectious and parasitic diseases, respiratory infections, maternal conditions, perinatal conditions and nutritional deficiencies.

²⁰⁷ The Non-communicable Diseases category includes malignant neoplasms, other neoplasms, diabetes mellitus, endocrine disorders, neuropsychiatric conditions, sense organ diseases, cardiovascular diseases, respiratory diseases, digestive diseases, genitourinary diseases, skin diseases, musculoskeletal diseases, congenital anomalies and oral conditions. The Injuries Category includes unintentional and intentional injuries.

²⁰⁸ Gupta et al.

²⁰⁹ World Health Organization Core Health Indicators for the year 2000. Available at: http://www.who.int/whosis/database/core/core_select_process.cfm. Accessed February 2008.

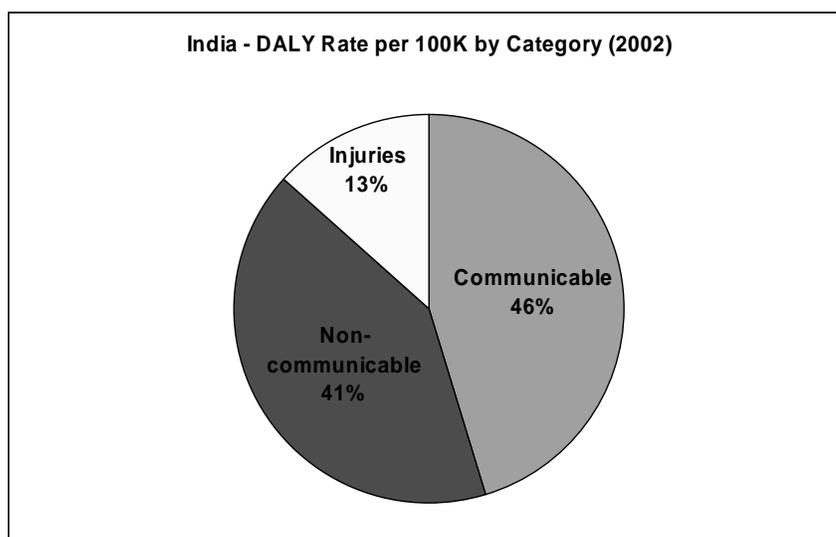


Figure 13. India – Categories of Burden of Disease (total population).²¹⁰

Just as with India's burden of disease rates, its child mortality rate (CMR) of 74 per 1000 children under 5 years old is among the highest in the world outside of Africa.²¹¹ There have been steady decreases over the last 50 years (Figure 14), but India's policies toward child mortality are still categorized by UNDP as *unacceptable*.²¹²

²¹⁰ World Health Organization. 2002. <http://www.who.int/healthinfo/bod/en/index.html>. Accessed February 2008.

²¹¹ World Bank. Figures for 2005.

²¹² United Nations Development Programme. *Country Evaluation: India*. 2002. Available at: <http://www.undp.org/eo/documents/country-review/IndainCR2002.pdf>

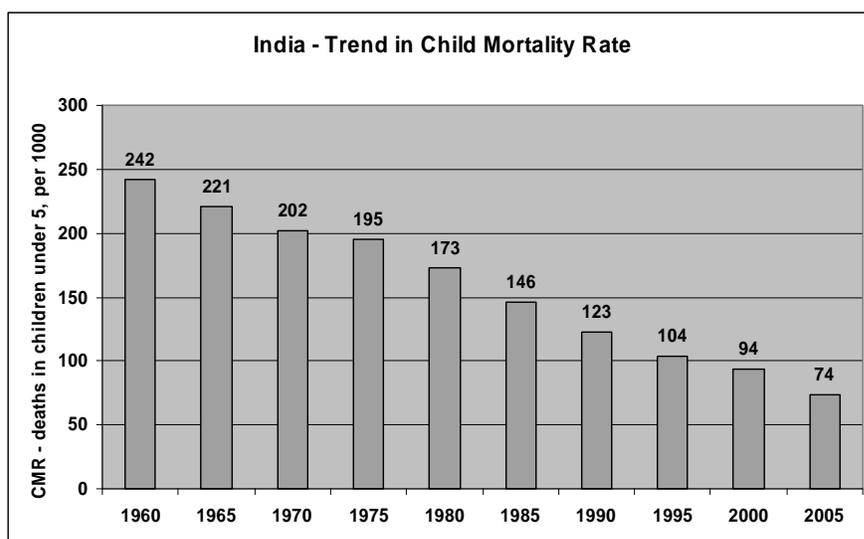


Figure 14. India – CMR over time.²¹³

India’s efforts to reduce morbidity and mortality for children include poverty reduction initiatives, improvements to sanitation facilities and access to clean water, improved nutrition, and efforts at comprehensive immunizations.²¹⁴ All of these areas are emphasized in the United Nations Millennium Development Goals to which India is a signatory. Additionally, India’s health ministry is working to improve measures for treatment of diarrheal diseases with oral rehydration therapies (ORT) and treatment of acute respiratory infections (ARI), the two leading causes of child death beyond the neonatal period. To address neonatal mortality, there is also a focus on improving pre-natal care and the number of births attended by skilled providers. Additionally, immunizations in India have vastly improved in the last decade.²¹⁵

²¹³ United Nations Population Prospects Database. 2006.

²¹⁴ UNICEF at www.childinfo.org.

²¹⁵ World Health Organization, WHOSIS.

Contributing to the problems of diarrhea and the overall spread of disease is the lack of adequate sanitation and water sources. India is making slow, but steady, improvement in increasing access to improved water sources and improved sanitation facilities for its growing population (Figure 15). But the lack of coverage in improved sanitation facilities is concerning and has significant negative implications for population health. Improvements in sanitation, in particular, are generally low cost and require little technology or infrastructure investment, however getting governments to increase their commitment has been difficult.²¹⁶

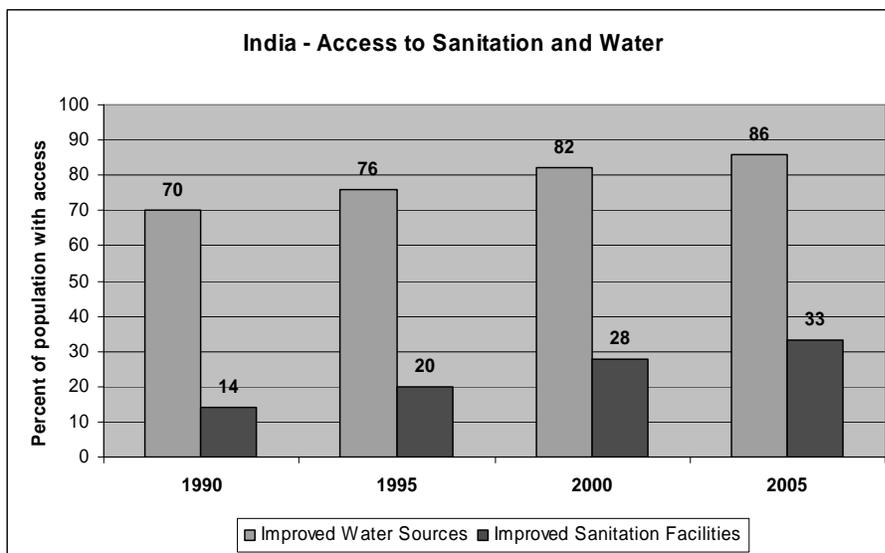


Figure 15. India – Population with Access to Water and Sanitation.²¹⁷

²¹⁶ Authors of the Millennium Project report on Water and Sanitation attribute this to fact that most people find it difficult to communicate about topics such as “open defecation.”

²¹⁷ World Bank. World Development Indicators Database.

Nutrition is also a critical component of child health. Child nutrition is a function of many variables, but the knowledge and resources available to the mother during pregnancy can impact nutritional outcomes.

The care received during pregnancy is very important to good health outcomes, and care during delivery is also important, especially with regard to maternal mortality. While India does not report on the physician ratios with each state, the percent of live births attended by a skilled professional can provide some indication of the accessibility of skilled health professionals. Forty-seven percent of births in India are attended by a skilled health professional, with 38% of births in rural areas attended and 74% of urban births attended (Figure 16). The differential between high income and low income families is even more pronounced. Only 19% of low income mothers have skilled assistance during delivery while 89% of high income mothers have that support.

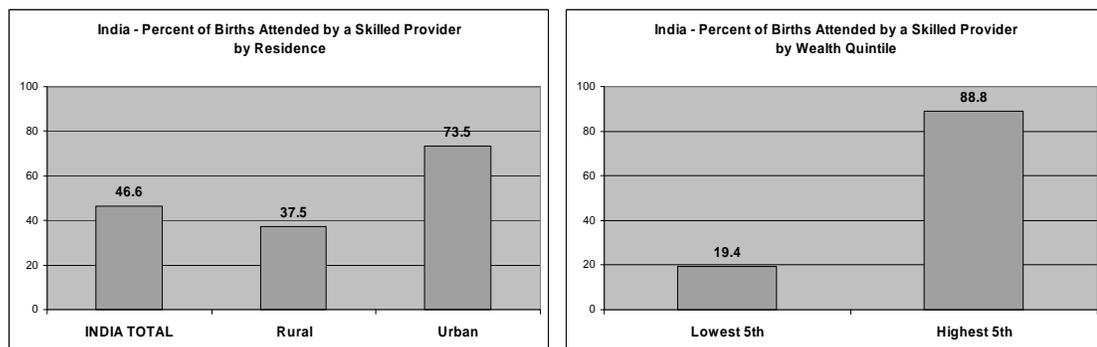


Figure 16. India – Percent of Births Attended by Skilled Providers by Residence and Wealth Quintile.²¹⁸

The care that pregnant women and new mothers receive can impact their own health, the health of their children, and the likelihood of their children surviving to

²¹⁸ NFHS-3.

adulthood. Decreased child morbidity and mortality would potentially impact fertility rates and help mitigate India's challenges with population growth.

As demonstrated in the global analysis, while child health indicators provide an indication of fertility levels, socioeconomic indicators for women can also impact fertility rates.

6.4. Women's Socioeconomic Status

Typically population data in almost every country indicate that females have longer life spans than males, but this does not hold true for India. India is one of just a minority of nations where life expectancies for men and women are virtually the same (male 63, female 64) (Figure 17).^{219, 220} This reduced life expectancy is indicative of the multitude of health and socioeconomic biases facing women, biases that ultimately impede improvements in measures that correspond with reduced fertility rates.

Some of the systematic biases in the health sector, and in the socioeconomic structure of Indian society as a whole, have diminished women's traditional advantage of longevity. In India, women have traditionally been viewed as economic burdens, and many families have a strong preference for sons. Women are often denied access to education, especially in rural areas, and this impacts the welfare of their children, fertility rates and overall population health.²²¹

²¹⁹ World Morality Report 2005 – from UNDP (p.208-9). The United Nations Development Programme (UNDP) rates India's life expectancy of 64 years *unacceptable*. World Morality Report 2005 – from UNDP (p.208-9).

²²⁰ As an example, the UN's 2006 World Population Prospects Database shows that for the 2000-2005 period there were only nine countries where females had less than a one year advantage in life expectancy over men (or where male life expectancy exceeded female life expectancy).

²²¹ Velkoff and Adlakha.

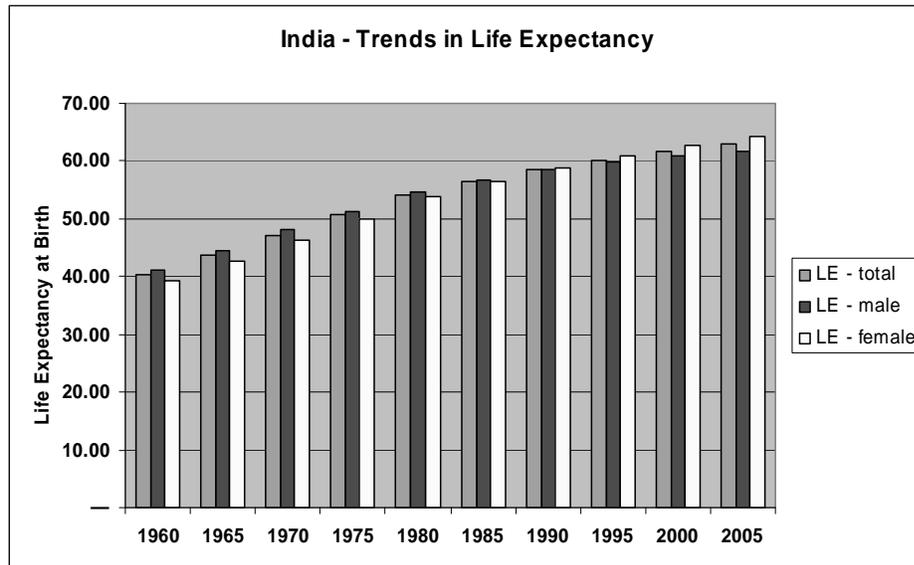


Figure 17. India – Trends in Life Expectancy at Birth.²²²

The global analysis demonstrated a strong relationship between fertility and the socioeconomic status of women, particularly as it relates to education. India's 2002 *National Plan for Action for Education for All* set national educational targets based on international goals monitored by UNESCO.²²³ In addition, a constitutional amendment in 2002 declared education for all children ages 6 through 14 to be a fundamental right, and established compulsory education for India's youth. However, the impact of these changes has been disappointing. Of the estimated 200 million children in the 6 through 14 age range, only 120 million are enrolled in school, and only 72 million of the enrolled students actually attend.²²⁴

²²² United Nations Population Prospects database. 2006.

²²³ The Education for All (EFA) goals were set forth in April 2000 during the World Education Forum in Dakar, Senegal (164 countries participated).

²²⁴ Securing Rights.

The distribution of, access to, and quality of education varies significantly based upon both gender and geography – with rural dwellers and women receiving far less education. Rural women are the worst off, with less than half of them considered literate.²²⁵

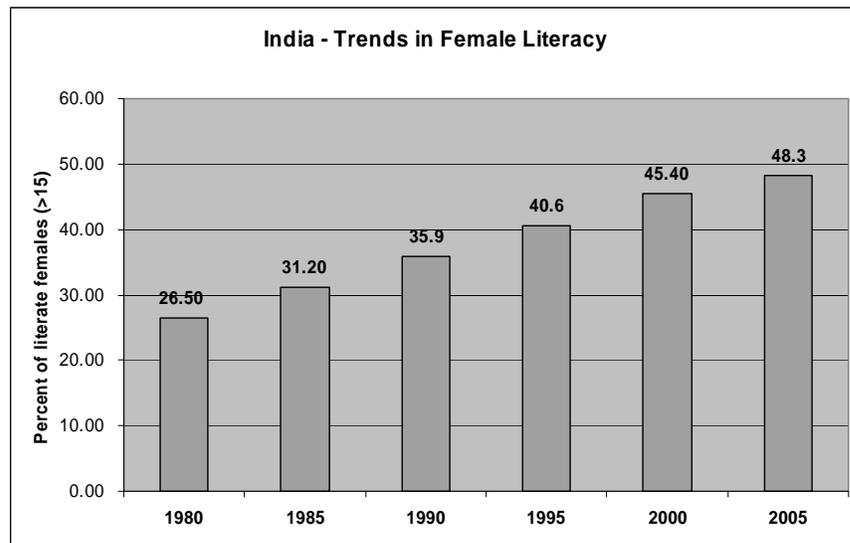


Figure 18. India – National Trends in Female Literacy.²²⁶

Female literacy is particularly critical for both improved child health outcomes and decreased fertility. Studies in India show that the proportion of literate women in a population has a positive impact on the whole community. Parashar notes that “a large number of literate women in a village may influence other women’s capacity to seek and take advantage of state-provided healthcare by negotiating for better access to health

²²⁵ Parashar.

²²⁶ United Nations Statistics Division.

information, services, skills, and technologies as well as continual support of responsive local-level medical personnel.”²²⁷

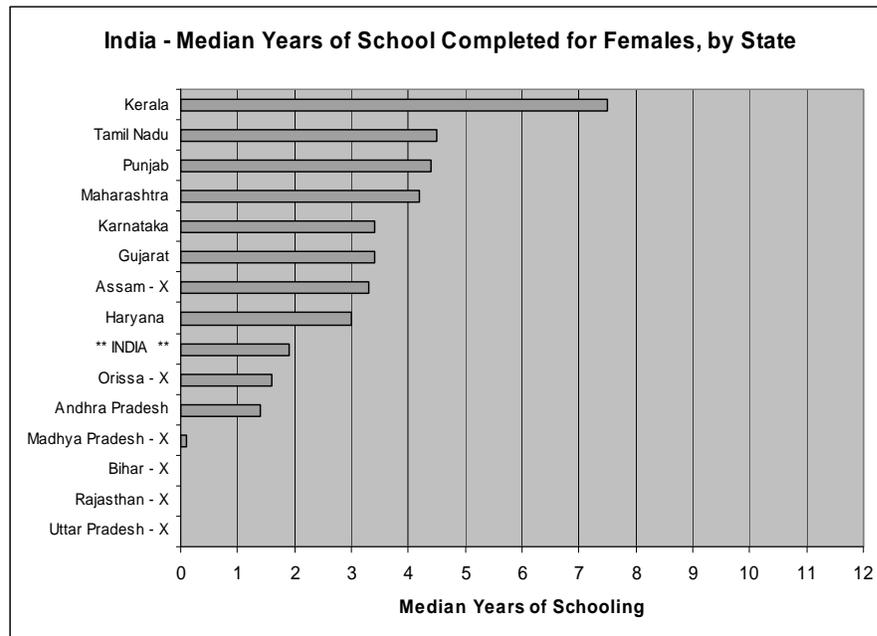


Figure 19. India – Median Years of School Completed by state.²²⁸

Figure 19, above, shows the low levels of educational attainment for females within India and also demonstrates the significant variance among states. Women in India are seeing some improvement in their educational opportunities relative to men. In 1990 the female-to-male ratio in primary and secondary education was only 69.81. In 2005, this had risen to 88.65.²²⁹ As with other measures, this national figure masks

²²⁷ Parashar; See also V Das, RK Das and L Coutinho, Disease Control and Immunization: a sociological inquiry. *Economic and Political Weekly*. February 19-26 (2000): 625-632.

²²⁸ NFHS-3.

²²⁹ World Bank. World Development Indicators.

disparities between and within states due to geographical, social, economic, and gender differences.²³⁰

There are no widely-available female-specific indices for income across countries, but an assessment of the economic prosperity of the nation as a whole can provide some insight into the economy in which women enjoy a share. The fact that India's GNI per capita has steadily increased in recent decades is a positive indicator (Figure 20). But this national improvement, once again, undoubtedly hides disparities within gender, social and geographic groups within the country. Females are not sharing equally in the national economic advancement as one study estimated that women in agricultural roles received 40-60% of a male's wages and, at best, women in other sectors see 80% of men's wages even when equally educated.²³¹

²³⁰ UNICEF. http://www.unicef.org/india/children_2359.htm

²³¹ Madhu Kishwar and Ruth Vanita, eds. *In Search of Answers: Indian Women's Voices From Manushi* (London, 1985).

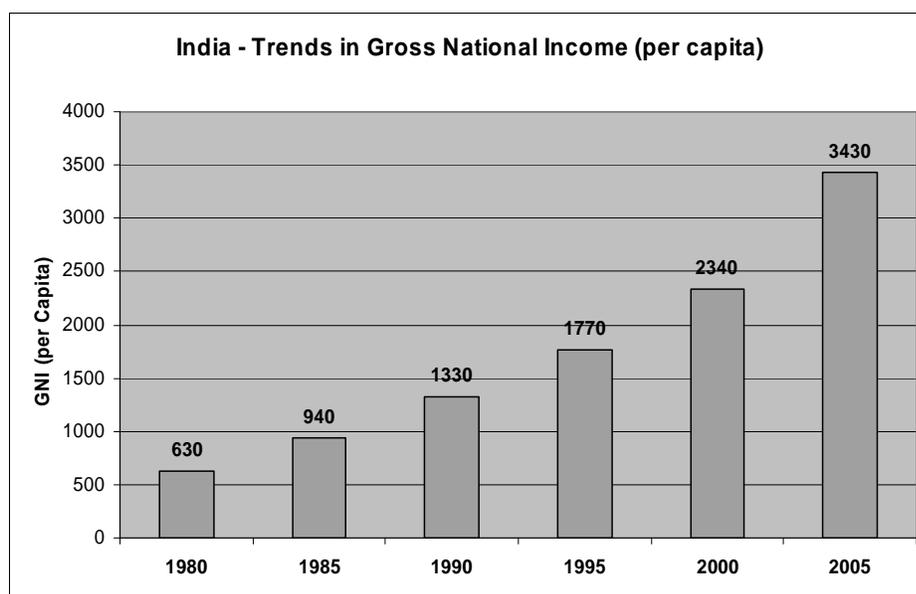


Figure 20. India – Trends in GNI.²³²

6.5. India – Country-level Analysis of Model

Having briefly reviewed India’s background, health infrastructure and programs, health status and socioeconomic characteristics, the examination conducted at the global level is now performed at the country level.

This analysis is conducted using 13 states for which the necessary data were available. The included states represent approximately 85% of the population (2001 census), and draw from all six geographic regions within India. Seven of the states, Assam, Bihar, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, and West Bengal are categorized as *less developed* and represent approximately 59% of the population included in this study. There are six *more developed* states included and they constitute

²³² World Bank. World Development Indicators Database.

41% of the included population (Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, and Tamil Nadu).

The analysis uses the data points for the years 1990 and 1999, which coincide with the conduct of India's first and second National Family Health Surveys (NFHS-1 and NFHS-2).²³³ The limited data set limits the power of this analysis but provides for some indication of the model's potential usefulness for this country. The only variable included in the foregoing analysis that is not available at the state level for India is the number of physicians per 1000 population. To accommodate for this missing data, the child health model will be run first with only the other three child health variables, and then will be run again using an alternate variable that reflects the availability of skilled manpower in India's health infrastructure.²³⁴ The variations among these two alternate versions will be explored as appropriate to determine what impact the missing variables may have on the outcome.

Before evaluating the model, the independent variables were tested for potential collinearity. None of the correlations exceeded the threshold of 0.8. Most ranged between 0.42 and 0.65. The highest correlation was between sanitation and illiteracy at 0.73, and the lowest between sanitation and maternal mortality at 0.21. All variables meet collinearity criteria for inclusion in the model.

²³³ The included states represent all 6 regions and include: Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

²³⁴ The alternate variable reflecting availability of trained health personnel is the percent of births assisted by skilled medical personnel.

The initial results of these regressions are shown below (Tables 18 and 19), however all models run with child health variables and socioeconomic variables have major limitations with significance level, as is discussed below.

Table 18. India – Country-level analysis results (13 states - 1990 and 1999 data).²³⁵

| INDIA | TFR & CDR | TFR & CMR | TFR & Child Health Model (w/o phys/1000) | TFR & Child Health Model (w/attended births) | TFR & SES Model |
|-----------------------------|----------------|----------------|--|--|-----------------|
| Without control variables | $r^2=0.2419^*$ | $r^2=0.5701^*$ | $R^2=0.6314$ | $R^2=0.6132$ | $R^2=0.5521$ |
| With SES controls variables | $R^2=0.5579$ | $R^2=0.6739$ | $R^2=0.7406$ | $R^2=0.6715$ | n/a |

* all variables significant at the 0.05 level.

Table 19. Global analysis results for comparison.

| GLOBAL | TFR & CDR (r^2 , R^2) | TFR & CMR (r^2 , R^2) | TFR & Child Health Model (R^2) | TFR & SES Model (R^2) |
|---------------------------|-----------------------------|-----------------------------|------------------------------------|---------------------------|
| Without control variables | $r^2=0.0687$ | $r^2=0.7498$ | $R^2=0.7717$ | $R^2=0.5923$ |
| With control variables | $R^2=0.5995$ | $R^2=0.7848$ | $R^2=0.7846$ | n/a |

²³⁵ Sources include the NFHS1, NFHS-2, and NFHS-3. Maternal mortality figures come from Pilot Study 2003 and Mari Baht 2002 (using SDAM - sex differentials in adult mortality method). State income numbers come from Government of India Ministry of Statistics and Programme Implementation. Per Capita Net States Domestic Product at current prices. Available from http://mospi.nic.in/16_pensdpcur8081ser.htm

At first glance, there appears to be good agreement between the outcomes at the global and country levels. However, the model that proved useful at the global level is not as useful for this country because, despite the strength as a complete model, *most of the included variables do not prove to be significant* (Table 20). In fact, in all regressions run using the child health model, the only variable showing significance at the 0.05 level is maternal mortality. And for the socioeconomic factors, the only significant variable is female illiteracy. When the child health model is run with the socioeconomic control variables, both maternal mortality and literacy are statistically significant.

Given the relatively limited data set used in this study, increasing the significance threshold to 0.1 is feasible. Allowing a broader threshold for significance to accommodate the relatively small data set used, the only change seen is that sanitation is significant in the child health model with out socioeconomic controls, but that significance disappears when the literacy variable is introduced.

Table 20. p-values for Global and India Analyses

| GLOBAL p-values | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|----------------------------|--|--|---|--|
| Without control variables | CDR – 0.000 | CMR – 0.000 | Nut – 0.048 San – 0.000 Phys – 0.000 Matlmort– 0.000 | Lit – 0.000 GNI – 0.000 |
| With control variables | CDR – 0.009 Lit – 0.000 GNI – 0.000 | CMR – 0.000 Lit – 0.000 GNI – 0.000 | Nut – 0.033 San – 0.000 Phys – 0.000 Matlmort– 0.000 Lit – 0.000 GNI – 0.000 | n/a |

| INDIA p-values | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|---------------------------|--|--|--|--|
| Without control variables | CDR – 0.011 | CMR – 0.000 | Nut – 0.934 San – 0.070 Matlmort– 0.000 | Lit – 0.001 GNI – 0.578 |
| With control variables | CDR – 0.597 Lit – 0.002 GNI – 0.787 | CMR – 0.009 Lit – 0.015 GNI – 0.587 | Nut – 0.477 San – 0.781 Matlmort– 0.005 Lit – 0.013 GNI – 0.193 | n/a |

India model – significance at the 0.1 level

These results prompt further exploration of the importance of these specific variables as predictors of fertility change in India. Additional modeling was conducted to isolate the effects of maternal mortality and female illiteracy. Table 21 shows the results, all of which are significant. Maternal mortality ($r^2 = 0.5583$) and female illiteracy ($r^2 = 0.5461$) alone each prove to be solid indicators of fertility in India. However, both are slightly weaker than child mortality alone at $r^2 = 0.5701$. When these two significant variables are modeled together, however, the strength improves to $R^2 = 0.7136$, notably stronger than CMR.

Table 21. India – country level analysis – CMR, maternal mortality and illiteracy impacts.

| TFR & CDR | TFR & CMR | TFR & Maternal Mortality alone | TFR & Illiteracy alone | TFR & Maternal Mortality & Illiteracy |
|----------------------|----------------------|---|-----------------------------------|--|
| $r^2=0.2419$ | $r^2=0.5701$ | $r^2=0.5583$ | $r^2=0.5461$ | $R^2=0.7136$ |

All results significant at the 0.05 level.

| TFR & CMR & Maternal Mortality | TFR & CMR & Illiteracy | TFR & CMR & Maternal Mortality & Illiteracy |
|---|---------------------------------------|--|
| $R^2=0.6143$ | $R^2=0.6694$ | $R^2=0.7176$ |
| -CMR significant at 0.1 level -Matl Mort not significant | -All significant at 0.05 level | -CMR not significant -MatlMort significant at 0.1 level -Illit significant at 0.05 level |

Further exploring the application of the variables in this model, CMR is included in combination with the two dominant health and socioeconomic variables. Modeling CMR with maternal mortality is stronger than CMR alone but maternal mortality is not significant even at the 0.1 level. Pairing CMR with literacy, however, significantly improves the CMR-alone model at $R^2 = 0.6694$, and all variables significant at the 0.05 level. All three variables together produce an $R^2 = 0.7176$, but CMR is not significant, and the result is not statically better than the model without CMR. This indicates that in this country, CMR does not add anything substantial to a predictive model which uses maternal mortality and illiteracy as indicators of fertility levels.

Despite the fact that the child health model itself proves to have less validity in this country than it did at the global level, the application and testing of child health and

socioeconomic variables as indicators of fertility change provides valuable information to policy makers. This analysis provides actionable information that would not be provided by the usage of population mortality or child mortality measures alone.

The models evaluated here do not attempt to identify direction of causality, demonstrating only that there is a statistically significant relationship among the selected variables. The models indicate that the following all happen in concert: (1) maternal mortality decreases, (2) female literacy increases, and (3) fertility rates decrease. It is possible that as fertility rates decline and each woman has fewer children that the risks for complications in childbirth decrease. But the same argument would be less powerful in looking at the literacy impact because literacy is typically achieved prior to the prime childbearing years. So using these variables in combination, the causal direction may be that as the health system provides more support in prenatal care and maternal education, and the female population becomes more literate and able to seek needed information and care, that the improved health and social status of women puts downward pressure on fertility patterns. Although causal direction is outside the scope of this research, further exploration of this dynamic in the future would be informative.

Based upon this analysis, policy decisions and resourcing that focus on improving maternal survival and female literacy will have potentially significant effects on fertility rates and move India toward its established goals in population management.

Application of this finding within the context of India's current infrastructure and policy environment is discussed in the following section.

6.6. India – Policy Application and Discussion

Population Policy

Beginning with India's series of 5-year plans back in 1951, the federal government has integrated population policy with developmental planning. However, some of the steps taken are considered draconian. In the 4th 5-year plan (1972-77) the government instituted forced sterilization; a move that ultimately toppled the government in power. They subsequently moved to voluntary family planning programs and the establishment of maternal and child health programs. However, the New Population Policy (NPP) of 2002, while affirming the commitment to informed choice in reproductive decisions, instituted a disincentive program whereby electoral rights were suspended in states with high population growth.²³⁶

India is working toward using investments in health improvements and socioeconomic advances as a means to control population growth; however, its investments are uneven and often continue to place resources in the more developed areas of the country while discriminating against areas in most need of those resources. Fortunately, the language being used in government planning emphasizes the fact that disparities in morbidity and mortality are issues of social injustice, rather than merely systemic disadvantages.²³⁷

The results of this analysis can support India's population management agenda by helping focus its interests in health improvements and socioeconomic advances to those

²³⁶ UNESCAP, National Population Policy of India. http://www.unescap.org/esid/psis/population/database/poplaws/law_india/india1.htm.

²³⁷ Ibid.

areas that will have the greatest impact on fertility. In this case, those areas are maternal mortality and female literacy.

Health and Social Policy

Improvements in population health go hand in hand with many other aspects of socioeconomic development. This section includes a discussion of the policy efforts that India has made to improve their performance in measures of child health and women's socioeconomic status and how the findings in this analysis can make those efforts more effective. Efforts and investments that are focused and evidence-based hold a promise of positively impacting fertility rates through their combined effects and proving valuable in the management of population growth and the formulation of future population policy.

In the literature and studies on India's health programs, a constant theme is the emphasis on family planning.²³⁸ In fact, some sources report that the government's hard line approach to family planning (due to concerns about overpopulation) is viewed by many as a deterrent to use of the public health system.²³⁹ Good health is associated with reductions in fertility rates, and yet instead of making overall health status the top priority, the system puts such heavy emphasis on family planning that many women are discouraged from seeking healthcare because they do not want to defend their fertility choices to providers who have other priorities. This is an interesting policy dilemma. Any deterrent to seek or access care during pregnancy can exacerbate problems with

²³⁸ NFHS-3; See also, Leela Visaria, Shireen Jejeebhoy and Tom Merrick. From family planning to reproductive health: challenges facing India, *International Family Planning Perspective*, Vol. 25, Supplement (January 1999). See also Velkoff and Adlakha.

²³⁹ Velkoff and Adlakha.

maternal mortality that is shown by this analysis to be a significant factor in fertility change (Figure 21).

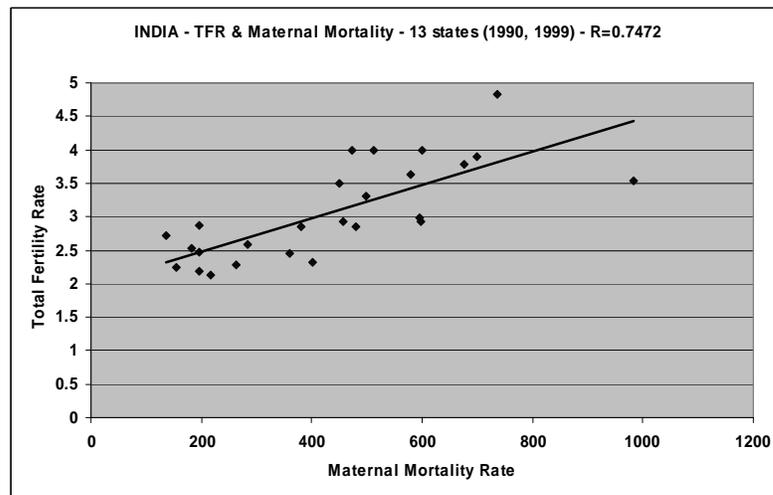


Figure 21. India – TFR and Maternal Mortality Correlation.

India’s policies on population growth now emphasize family planning and the aggressive use of contraception, but may not adequately acknowledge the socio-cultural factors that drive fertility decisions.²⁴⁰ Contraceptive use is shown to be successful in deterring unwanted pregnancies, but for the rural and impoverished population of India, the desired fertility is still high, and therefore family planning efforts alone only promise limited success. In this case, efforts toward improving female literacy that create more informed mothers and can facilitate broader economic opportunities for women could be highly effective in both reducing unwanted pregnancies and changing cultural desires and expectations for higher numbers of children. These impacts would help India move toward its population goals (Figure 22).

²⁴⁰ Among these are strong son preferences, labor, and security.

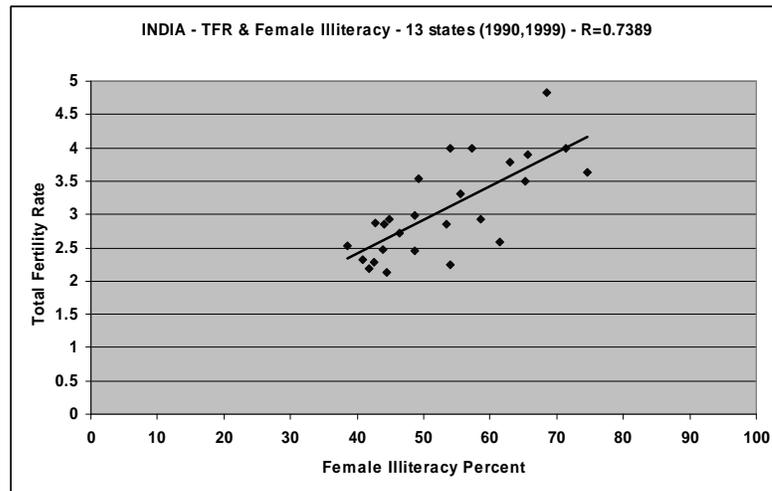


Figure 22. India – TFR and Female Illiteracy Correlation.

In India, particular attention should be paid to the disparities that are prevalent among geographical regions and social groups. These dynamics are important in policy development because, although national statistics may reflect success stories based upon definitions of measures, the real story is more complex. Often as overall development scores improve, there is an accompanying widening of the gap between tiers of society. This is definitely true in India. Many are better off, but many more are not. This holds true when looking at fertility, health, and socioeconomic status for Indians.

India adopted the United Nations’ Millennium Development Goals (MDGs) in September 2000. Subsequently, India’s Planning Commission established its National Development Goals (NDGs) based upon the 8 goals, 18 targets, and 48 indicators of the UN MDGs.²⁴¹ However, the Indian government’s health efforts have not been broadly successful in making improvements, even though many of their indicators show

²⁴¹ Securing Rights.

advancement toward these internationally accepted goals. Much of the discrepancy comes from the large disparities within the population. Gains in the welfare and status of the privileged classes statistically overshadow the multiple and repeated failures for the poor and disadvantaged.

India is considered to be making good progress in its efforts to fight poverty through national health and education mandates, as well as federal protections for underprivileged castes and tribes. Focus in all these areas are supported by the results of this research. In fact, India has placed special emphasis on literacy, nutrition, maternal mortality, and child mortality.²⁴² However, these health and social sector reforms fall to the provincial governments for implementation.²⁴³ Although India's national poverty reduction goals are far more aggressive than the MDGs, they are not part of a comprehensive approach. And the internal disparities do not come to light in the reported successes based upon most international standards (Figure 23).²⁴⁴

²⁴² All these areas except nutrition show as statistically significant as indicators of fertility changes, but improvements in nutrition have major implications outside of its correlation with fertility.

²⁴³ MDGMonitor.org –January 2008 – factsheet India

²⁴⁴ Securing Rights.

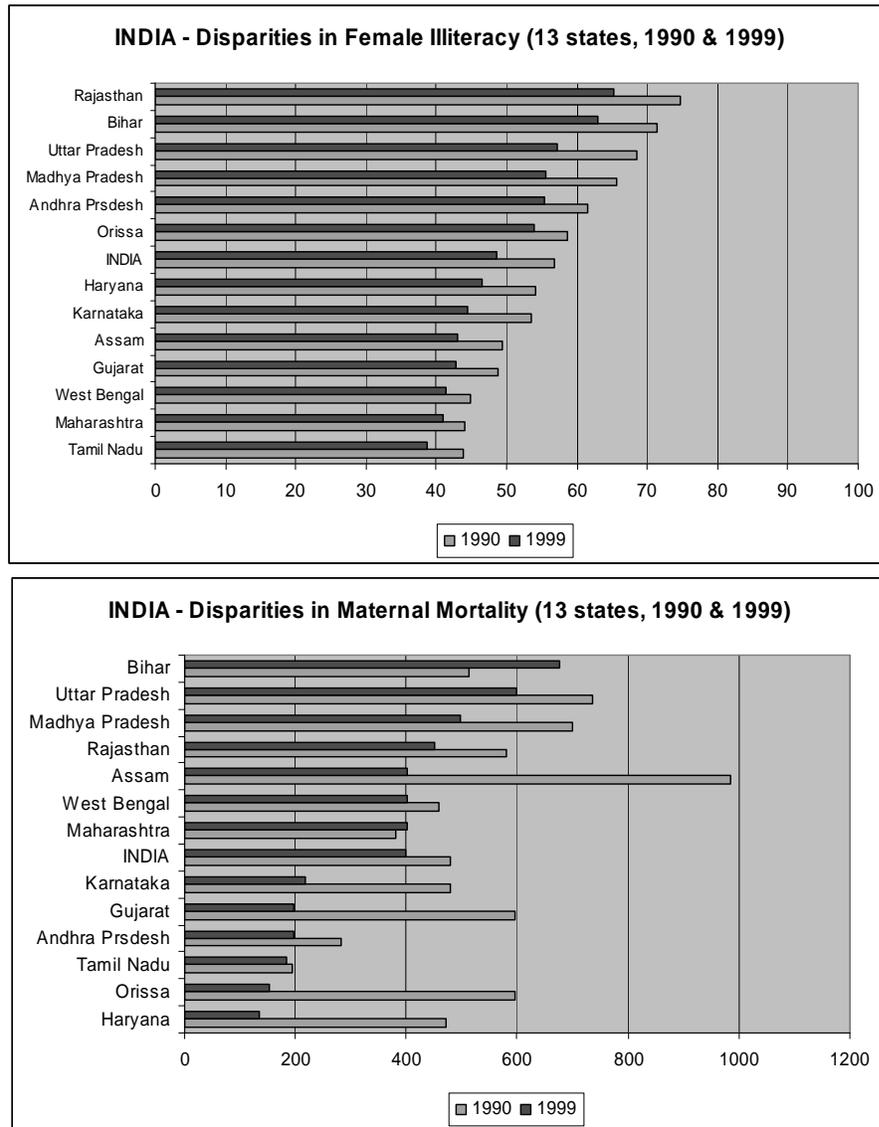


Figure 23. India –Internal disparities in female literacy and maternal mortality.

Critics of the government’s approach for local administration of programs are calling for a realignment of responsibilities for central and state governments, and are demanding a reversal in the downward trend of investment in rural development, which

was 14.5% of GDP in the 1980s and is now only 5% of GDP.²⁴⁵ The government lacks a much-needed focus on the poorest sectors of the country. Some attribute this to the fact that the policymakers are generally from the higher castes and do not fully appreciate the dire state of disadvantaged groups, including women, rural dwellers, and the scheduled castes and tribes.

A 2005 report by the Planning Commission of the Government of India discusses the disparities that Indian states are facing.²⁴⁶ It categorizes eight states as being *forward* states (typically, more developed) and seven states as being *backwards (less-developed)* states. The *more-developed* states contain 40% of the population, and the *less-developed* states 55%. The *more-developed* states generally fall above the national average in literacy and other measures, while the *less-developed* states typically fall below national averages in all development measures. Income has been growing in *more-developed* states while often declining in *less-developed* states.

This dynamic of *more-developed* and *less-developed* states creates something akin to *two Indias*. The two groups are at two different places in the demographic transition, and the solutions and policies for each will need to be designed and implemented in ways unique to their problems.²⁴⁷ Demographically, economically, and socially, India is two countries. Any expectation that a single solution will be adequate to close the gap between the *haves* and the *have-nots* is unlikely to find wholesale success.

²⁴⁵ Securing Rights

²⁴⁶ Kurian.

²⁴⁷ Kurian.

Addressing the issues of child health and the status of women, especially in the *less-developed* states, will have a significant impact on fertility rates and will better serve the national goal to limit population growth. Policies that improve literacy for women and strengthen health programs to reduce maternal mortality will not only improve health and social measures in their own right, but may also significantly impact population growth and facilitate the achievement of India's population goals.

The efforts underway to continually refine India's population policies are a definite improvement over some of the strong-handed policies of the past. However, there appears to be a lack of appreciation for the discrepancies within the country and the requirement for different approaches based upon the socio-cultural aspects of the regions and states. India's Supreme Court upheld the right of governments to withhold electoral participation for exceeding a two-child policy. This is evidence that India must re-assess its approach to planning and policy for population control. Loss of status of the underprivileged is likely to have an opposite effect. Aligning the interests of population planners with health and social policy planning and implementation will further programming and promote success in all sectors.

Policies that promote investment in improving health and education levels, especially regarding women and children, in the high fertility regions and states of India is a strong and viable route to long-term and sustainable change in fertility rates. Applying the model which uses only India's female illiteracy rate and its maternal mortality rate, it is possible to assess the degree to which reductions in female illiteracy and maternal mortality can impact changes in fertility. Holding illiteracy constant, a

decrease in one maternal death (per 100,000 live births) would result in a 0.0016 reduction in the total fertility rate. In other words, one less maternal death, per 1,000 live births, would reduce TFR by 0.16 births per woman (holding illiteracy constant). Similarly, an improvement of 10% in female literacy (holding maternal mortality constant) would result a drop of 0.3 in the TFR. If India's 2005 female literacy rate of 48.3% were to increase by 30 percentage points to 90% female literacy (as found in Mexico), the total fertility rate would theoretically drop by 0.9 children per woman (holding maternal mortality constant).

These findings, and the implications for policymaking, demonstrate the value of applying health and socioeconomic models as indicators of fertility change. Child mortality measures correlate to fertility changes, but the CMR does not provide actionable information. Policymakers who consider health and social impacts on fertility can use the results to direct resources and design policy to address concerns that have the strongest impacts across multiple policy areas. With competing priorities in any policy sector, the ability to prioritize based upon broad and multiple impact areas can help in the prioritization process and allow countries to get the best results for their investment.

7. Mexico

Mexico's steadily improving economy and progressive social policies provide an opportunity to assess the relationship between fertility and health indicators in a country with a higher level of socioeconomic development than most countries challenged with population growth. Its federal structure and good data collection and reporting mechanisms provide an opportunity to evaluate the health and socioeconomic factors which impact fertility rates.

7.1. Background

Western civilization began merging with traditional cultures in Mexico during its 300 years of Spanish rule beginning in 1492. Independence was achieved in 1810, and the Mexican Revolution in 1910 marked the start of decades of internal unrest that ended with the election of President Lázaro Cárdenas (in 1935), who led Mexico's transformation from the revolutionary era into industrialism and 40 years of steady economic growth.²⁴⁸ Mexico's current constitution dates to February 1917. Although under authoritarian regimes for much of the 20th century, today Mexico is a

²⁴⁸ Tim L. Merrill and Ramón Miró, eds. *Mexico: A Country Study*. Washington: GPO for the Library of Congress, 1996. Accessed through <http://countrystudies.us/mexico/63.htm>; see also CIA World Factbook. Mexico. Accessed April 2008. <https://www.cia.gov/library/publications/the-world-factbook/print/mx.html>

representative, democratic, federal republic with 31 states and one federal district, made up of 2,444 municipalities (see map, Figure 24).²⁴⁹

Economy

Mexico is the largest Spanish-speaking country in the world and is categorized as an *upper middle* income country by the World Bank. It has a free market economy in the trillion dollar class.²⁵⁰ Since the elections of 1988, which saw a peaceful transition of power to an opposing political party, Mexico has been integrating economic policies with progressive strategic development and social policies.

An economic crisis and devaluation of the peso in 1994 threw Mexico into economic turmoil and a severe recession.²⁵¹ The government responded quickly and the economy regained strength by the turn of the century. As inflation has declined, the government has been investing more money into social programs, aiding continued growth and improvements in quality of life throughout Mexico, although there continue to be significant inequities in income distribution.²⁵²

Mexico's economy is largely service-based with 69.9% of GDP coming from the service sector, 26.3% from industry, and only 3.9% from agriculture.²⁵³ However, 18% of the workforce is in agriculture, 24% in industry, and 58% in services (in 2003). While

²⁴⁹ PAHO. Mexico Country Study. Health Situation Analysis and trends summary. http://www.paho.org/English/DD/AIS/cp_484.htm. Accessed February 2008; see also CIA World Fact Book.

²⁵⁰ CIA.

²⁵¹ CIA.

²⁵² While national averages are improving, the gap between the richest and poorest states has remained constant between 1960-2000. See Rodrigo Garcia-Verdu, Income, mortality and literacy distribution dynamics across states in Mexico: 1940-2000. *Cuadernos de Economia*, (42) (2005): 165-192; see also PAHO.

²⁵³ 2005 figures from CIA.



Figure 24. Map of Mexico.

the unemployment rate is only 3.7%, as a result of recession in the 1990s underemployment is now estimated to be as high as 25%.²⁵⁴

Foreign remittances constitute the second largest source of foreign revenue. Mexico has the highest outflow of migrants in the world. In rural areas, half of all household income comes from foreign remittances.²⁵⁵ This dynamic has significant implications for the economy and the design of social policy to curb the outflow of migrants and improve opportunities within the country.

Population

Mexico has an estimated population of 108 million people, with more than 70% living in urban areas.²⁵⁶ The Mexico City area has a population in excess of 18 million people, making it the largest metropolitan area in the Western hemisphere.²⁵⁷ Internal migration from rural to urban areas has been increasing as people seek economic opportunities. The government has made job creation a top priority and is designing social policies with the intent to control the internal migration patterns.²⁵⁸ But current

²⁵⁴ 2007 estimate from CIA.

²⁵⁵ United Nations. Executive Board of the United National Development Programme of the United Nations Population Fund. DP/FPA/CPD/MEX/5. Oct 15, 2007. Country Programme document for Mexico., also note that 77% of migrants are undocumented.

²⁵⁶ CIA.

²⁵⁷ U.S. Department of State. Bureau of Western Hemisphere Affairs. February 2007. Background Note: Mexico. Accessed 24mar08. <http://www.state.gov/r/pa/ei/bgn/35749.htm>.

²⁵⁸ Soto Lopez, A. 1991. Population Policy: speeches and actions. *Temas Poblac*, (192): 47-50; also Ocampo Lopez, E. Memoria del Seminario sobre la Poblacion y el Desarrollo Regional y Urbano, Aguascalientes, AGS, Septiembre de 1982, [compiled by] Mexico. Consejo Nacional de Poblacion [CONAPO]. Mexico City, Mexico, CONAPO, 1984 Jul: 81-112.

observers critique the Mexican government's ability to effectively implement labor legislation as stated in the government's policy stance.²⁵⁹

With declining birthrates and longer life expectancy, 30.1% of Mexico's population is under the age of 15 and 5.9% is over the age of 65 years.²⁶⁰ Life expectancy at birth has risen to 76.63 years and the fertility rate nationally is 2.39. Within-country variations are based upon region and the urban-rural divide.

Education is a high priority for the government. The literacy rate is 91% for those over the age of 15, with relatively minor variation between genders. Literacy generally defined as the ability to read and write; and in Mexico the female literacy is estimated at 89.6%, while male literacy is at 92.4%.²⁶¹ Government policy states that education is mandatory for children from 5 through 15 years of age, but 77.4% percent of that population was enrolled in 2005 largely due to the socioeconomic costs of sending children to school.

More than 76% of Mexico's population is Catholic. The Roman Catholic Church plays an influential role in religious, cultural, and social contexts within the country. The Roman Catholic Church opposes artificial birth control methods and its influence is particularly acute in the areas of population policy and reproductive health issues, including contraception, sex education, and abortion. The dynamic between the Catholic Church and policy-makers is a delicate one, and a former Secretary General of Mexico's Population Council notes that the government tries to avoid conflict between the Church

²⁵⁹ Patricia Fernandez-Kelly and Estela Rivero. *The State and Internal Migration in Guadalajara and West Baltimore*. Princeton University. Conference on African Migration in Comparative Perspective, Johannesburg, South Africa, June 2003.

²⁶⁰ 2007 estimates from CIA.

²⁶¹ These are 2007 estimates from the CIA.

and the State.²⁶² However, a 2005 poll of Catholics in Mexico found that 96% support government provision of contraceptives, 93% support sex education in public schools, and 82% oppose the Church's involvement in politics.²⁶³ These figures indicate that the Church's influence on population policy is declining.

Health System

The majority of Mexico's health system falls into the country's social security (Sector Salud or SS) program that covers formal sector workers and their families, who in 1995 constituted about half of the population. About 80% of those covered by social security are employed in the private sector and receive their healthcare through IMSS (Instituto Mexicano del Seguro Social).²⁶⁴ Another seventeen percent of the population covered under the SS program is government employees, who are insured through the ISSSTE (Instituto de Seguridad y Servicios Sociales para los Trabajadores del Estado or the Institute of Security and Social Services for State Workers). The remaining 3% of social security beneficiaries (under SS) come from the petroleum industry, which is covered by PEMEX, or the Departments of Defense or Navy, which are covered by SEDENA. All of these programs are funded through contributions from the government, employees, and employers (if a private employer).²⁶⁵

²⁶² Mary Jo McConahay, Mexico's population planners walk a fine line to reach their goal. Pacific News Service. (Jan 1999).

²⁶³ Population Council – National Survey of Mexican Catholics' values and reproductive health opinions and practices. 2005. www.popcouncil.org.

²⁶⁴ PAHO Mexico Country Study.

²⁶⁵ PAHO; see also Ruth Levine, "Improving the Health of the Poor in Mexico" in *Case Studies in Global Health*. Series Editor: Richard Riegelman. (Boston: Jones and Bartlett, 2007); see also World Association of World Studies, Stanford University. Mexico: Public health. http://wais.stanford.edu/Mexico/mexico_publichealth8803.html.

The unemployed are generally uninsured and receive health services through Salubridad (another component of Sector Salud), which is responsible for public health programs in Mexico and is funded by the government through the social security programs.^{266, 267} The current physical health infrastructure took shape in the 1970s with an effort by IMSS to build rural health clinics. In 1993, social spending increased and the government invested in building hundreds of hospitals and thousands of clinics and rural health units.²⁶⁸ But despite increasing investments, the system was accessible to only a portion of the population because simply investing in infrastructure does not adequately address the complexities of access and health behaviors which may deter use of health systems.

Mexico's *National Development Plan of 1995-2000* marked a shift in emphasis toward making equity of access to health-related services a national priority. The plan included vast system reorganization targeting the expansion of coverage areas and improvement in the quality of health services provided. Then, in 1997, the *Program of Education, Health and Feeding* was launched to target those in extreme poverty. This program was a strategic attempt to simultaneously address multiple components of poverty, including health, education, and income. The program, originally called PROGRESA, was very successful. It has since expanded to a broader segment of the

²⁶⁶ Basic services may include health promotion activities, preventative care, outpatient care, sanitation support, family planning support, prenatal and newborn care, nutritional support, immunizations, management of diarrheal disease, antiparasitic treatments, and care of respiratory infections, hypertension and diabetes. (PAHO Mexico Country Study).

²⁶⁷ World Association of World Studies, Stanford University.

²⁶⁸ Levine.

population and is now called *Oportunidades*.²⁶⁹ Significant improvements in health and nutrition were documented.²⁷⁰

Most recently, a 2001 reform of Mexico's General Health Law established a system of social protection in health, including a component called *Seguro Popular* that aims to provide health insurance for virtually the entire population and will be implemented over a 7 year period.²⁷¹

7.2. Fertility

The total fertility rate (TFR) for Mexico began to fall in the late 1970s and declines have been relatively rapid and sustained (Figure 25). At the current rate of decline, Mexico should be at replacement levels within a decade. However, this reduction at the national level masks variance among states.

²⁶⁹ PAHO; see also Levine.

²⁷⁰ Levine.

²⁷¹ PAHO; see also Emmanuella Gakidou, Rafael Lozano, Eduardo Gonzalez-Pier, Jesse Abbott-Klafter, Jeremy T. Barofsky, Chloe Bryson Cahn, Dennis M. Feehan, Diana K. Lee, Hector Hernandez-Llamas, Christopher J.L. Murray, Health System Reform in Mexico 5 – Assessing the effect of the 2001-06 Mexican health reform: an interim report card. *The Lancet* 368(2006): 1920-1935.

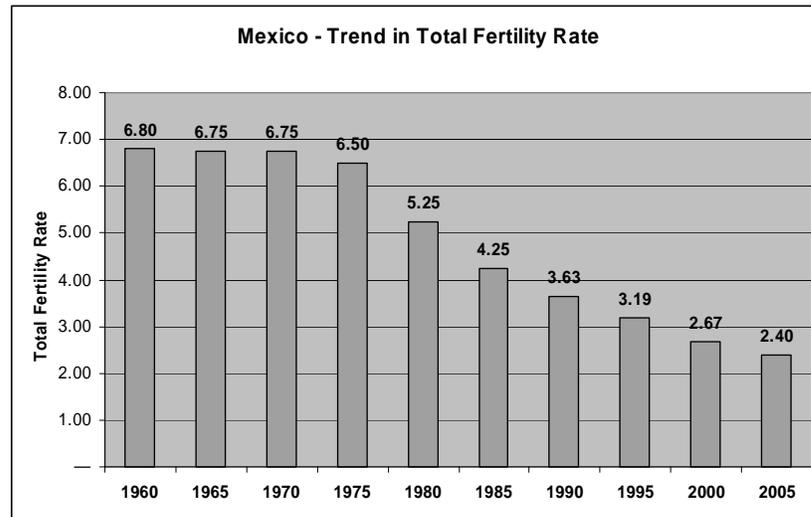


Figure 25. Mexico – Trends in Fertility Rate.²⁷²

The figure below (Figure 26) shows fertility rates by state for 1965 and again for 2000. Of the 16 states that had fertility rates above the national mean in 1965, 15 were still above the mean in 2000. Rates have significantly declined in all states, but the lagging states in 1965 continue to lag today, which indicates that there are factors that make these states fall behind in the demographic transition.

²⁷²United Nations Population Prospects Database 2006.

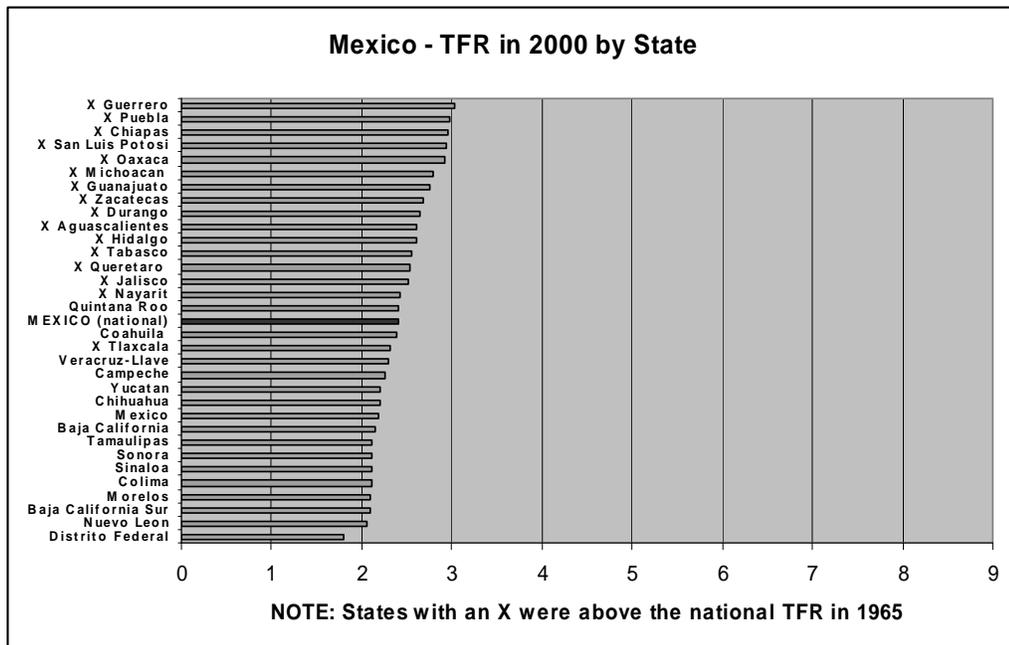
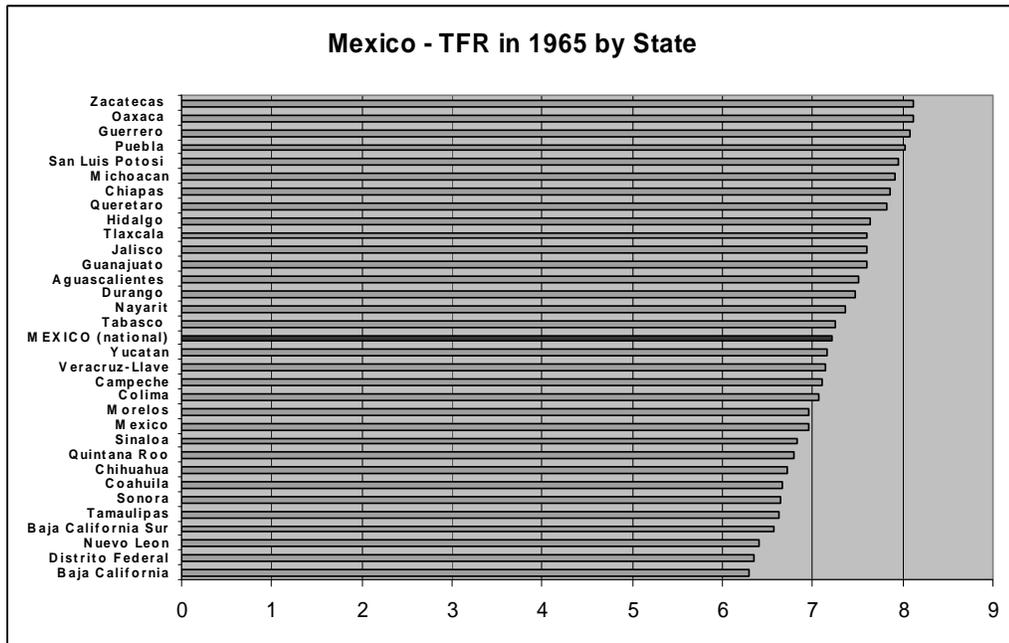


Figure 26. Mexico – Fertility Rates by State, 1965 and 2000.²⁷³

²⁷³ Rodolfo Turian, Virgilio Partida, Octavio Mojarro and Elena Zenuga. Fertility in Mexico: trends and forecast. United Nations. Available from <http://www.un.org/esa/population/publications/completingfertility/RevisedTUIRAN-PARTIDApaper.PDF>. Accessed 2008.

7.3. Health

Only 19% of Mexico's disease burden is currently attributed to communicable diseases (Figure 27). This indicates a good level of success in public health initiatives and control of communicable disease.

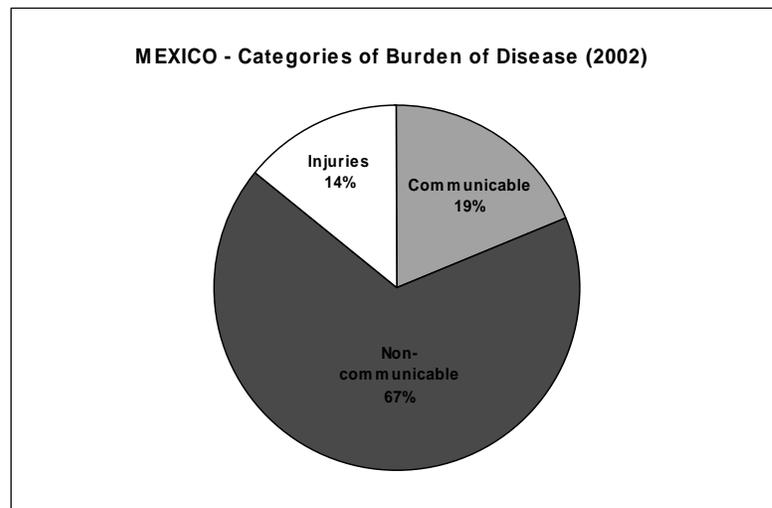


Figure 27. Mexico – Categories of Burden of Disease (total population). ²⁷⁴

The burden of disease for children under the age of 5 is primarily from communicable diseases.²⁷⁵ More than half of all deaths for children under age 5 are attributed to causes related to birth (these might include pre-term birth, sepsis, asphyxia, among other causes).²⁷⁶ The relatively low attribution to contagious disease may be an

²⁷⁴ World Health Organization (2002). <http://www.who.int/healthinfo/bod/en/index.html> . Accessed February 2008.

²⁷⁵ World Health Organization Core Health Indicators for the year 2000. The under 5 burden of disease includes neonatal causes.

²⁷⁶ World Health Organization Core Health Indicators for the year 2000.

encouraging sign for the public health system. Mexico is among the 20 countries with the best mortality record keeping, so statistics in this area are expected to very reliable.²⁷⁷

Of the seven highly-populated low- and middle-income countries that account for 94% of all child deaths worldwide, Mexico is the only one expected to reach the international goals for reduction in child mortality by 2015. And the improvements at the national level appear to be holding true even for the higher mortality regions in Mexico.²⁷⁸

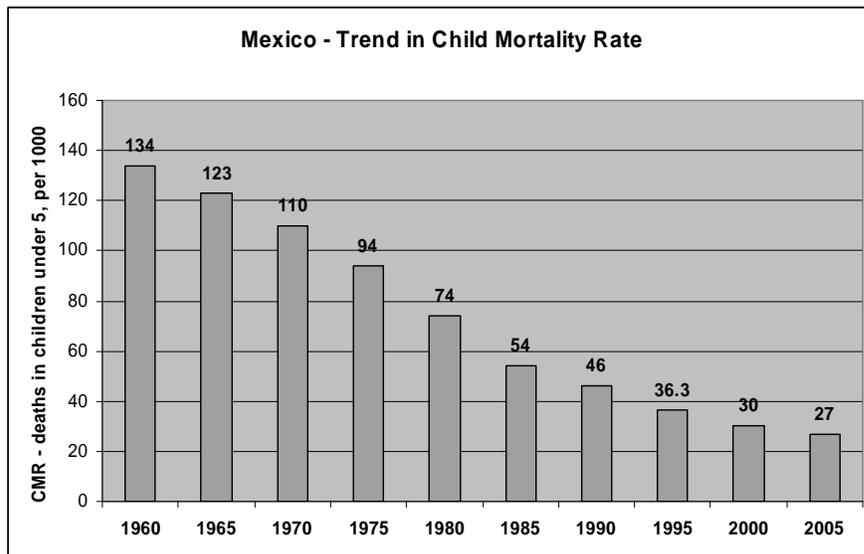


Figure 28. Mexico – Trend in Child Mortality Rate.²⁷⁹

The child mortality rate (CMR) in Mexico has dropped substantially and reflects Mexico’s increasingly proactive social policies (Figure 28). But inequities do exist, and

²⁷⁷ Jaime Sepulveda, Flavia Bustreo, Roberto Tapia, Juan Rivera, Rafael Lorenzo, Virgilio Partida, Lourdes Garcia-Garcia, and Jose Luis Valdespino. Health system reform in Mexico 6: Improvement of child survival in Mexico: the diagonal approach. *The Lancet (online)* (Dec 2006): 2017-2026.

²⁷⁸ Sepulveda et al.

²⁷⁹ United Nations World Population Prospects Database 2006.

are probably most prominent in Mexico's indigenous population, where infant mortality is twice the national rate.²⁸⁰ The 2005 World Mortality Report produced by UNDP rates Mexico's policies toward child mortality as *unacceptable*.²⁸¹

Mexico's relatively mature public health system is reflected in the high rates of immunizations for vaccine preventable diseases.²⁸² But some common childhood infections remain a problem, with 9% of child deaths attributed to pneumonia and 5% to diarrhea.²⁸³

Access to improved water sources and sanitation facilities can help prevent the spread of diarrheal diseases. In Mexico, the water and sanitation infrastructure is the responsibility of the individual municipalities and is not a function of the health system as it is in some countries.

²⁸⁰ PAHO.

²⁸¹ UNDP – World Mortality Report 2005. pp. 270-1. Note that the UNDP's World Mortality Report does not provide strict definition of what constitutes *acceptable* or *unacceptable* policies, stating only that these classifications are made based upon periodic inquiries of the governments.

²⁸² PAHO.

²⁸³ PAHO; see also World Health Organization.

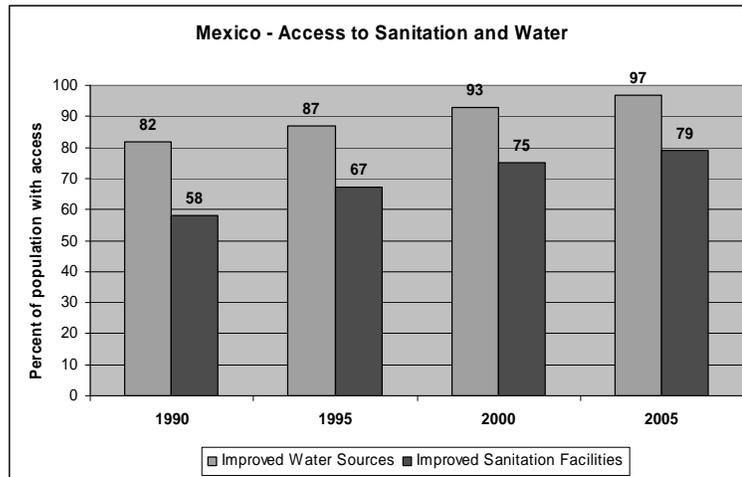


Figure 29. Mexico – Percent with Access to Water and Sanitation.²⁸⁴

Relatively high rates of coverage for both water and sanitation are reflective of Mexico’s well-developed infrastructure, and coverage continues to steadily increase. With 70% of the population living in urban areas, the 100% access to improved water sources in urban areas (and 91% coverage for sanitation) is good news (Figure 29). However, the 30% of the population living in rural areas are not faring as well. The rural population is disproportionately poor and they reside in poorer states and municipalities, creating multiple disadvantages to improving public health. Only 41% of the rural households have access to improved sanitation facilities, leaving them at increased risk for disease (Figure 30).

²⁸⁴ World Bank. World Development Indicators Database.

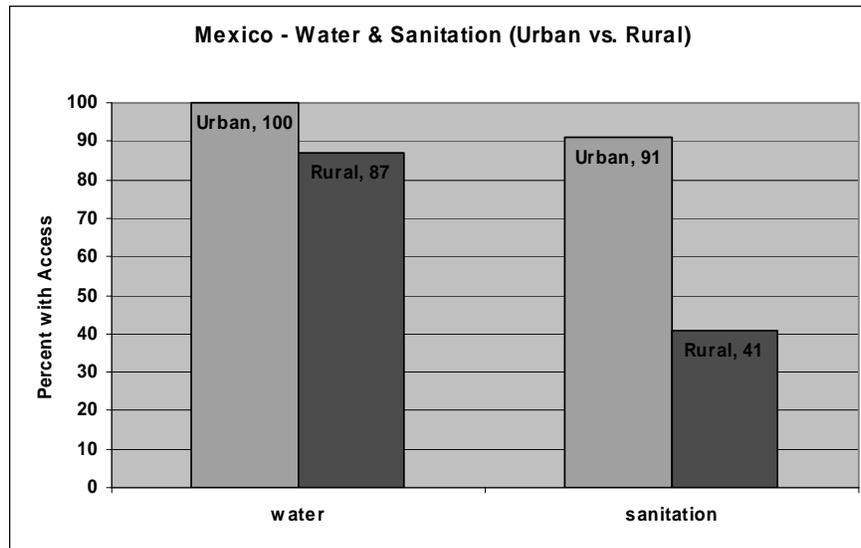


Figure 30. Mexico –Access to Water and Sanitation, Urban vs. Rural (2004).²⁸⁵

Mexico’s infrastructure plays other roles in population health. Availability of skilled providers is particularly important to improving child health and survival. Mexico as a whole has an estimated 12.5 physicians per 10,000 population, but the distribution is highly skewed, ranging from 7.3 in the state of Mexico to 28.6 in the Federal District (Figure 31).

²⁸⁵ WHO/UNICEF Joint Monitoring Programme (JMP) for water supply and sanitation www.wssinfo.org.

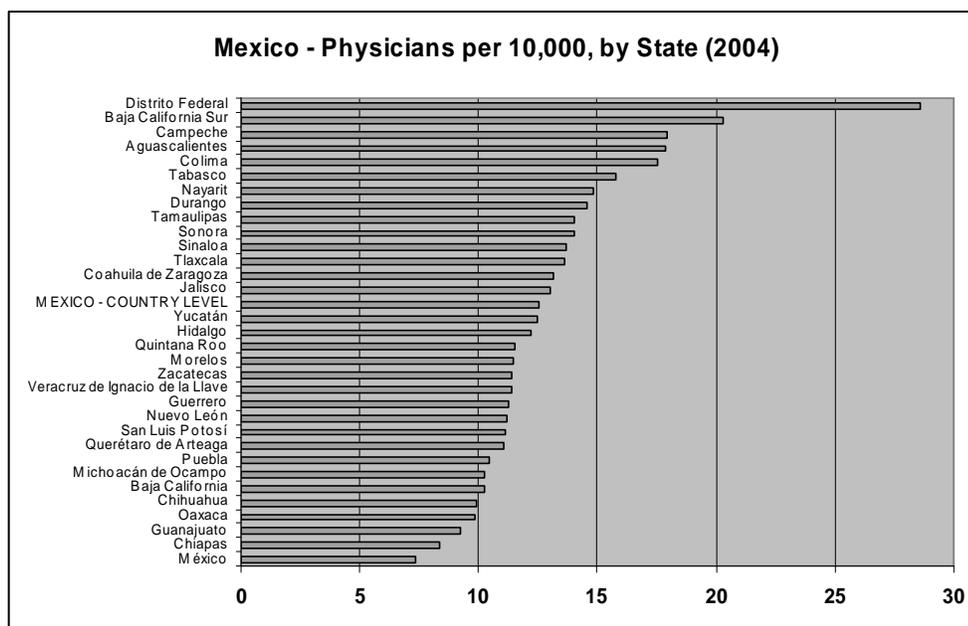


Figure 31. Mexico – Physicians per 10,000 (2004).²⁸⁶

Accessing care, when it is available, may be a function of the quality of care available or a function of a family’s past reliance on and experiences with the health system, but it may also be a function of a family’s ability to afford care. A key component to adequate and timely use of health services is the socioeconomic status of the family, and particularly the mother (regarding the care of children).

7.4. Women’s Socioeconomic Status

Research has shown the socioeconomic status is often reflected in the life expectancy within a population.²⁸⁷ Life expectancy for women in Mexico is comparable to that of many developed countries (Figure 32). The shift from communicable diseases

²⁸⁶ Indicadores Basicos de Salud, 2000-2004.

²⁸⁷ Robert G. Evans, M.L. Barer and Theodore R. Marmor, *Why are some people healthy and others are no? The determinants of health of populations* (Piscataway, NJ: Aldine Transaction, 1994). Also Laurie Wermuth, *Global inequality and human needs: health and illness in an increasingly unequal world* (New York, NY: Allyn & Bacon, 2002).

to chronic diseases has shifted the disease burden from the young to the old and reflects extended life spans overall.



Figure 32. Mexico –Trends in Life Expectancy.²⁸⁸

Improvements in the health system and national infrastructure have played a significant role in improving the health of women. But Mexico’s commitment to a robust education system is also relevant, since women’s literacy (Figure 33) has been shown to have a significant impact on socioeconomic status and fertility levels. In 2005, Mexico invested 7.3% of its GDP in education, and efforts at decentralization aim to improve system performance and accountability.²⁸⁹

²⁸⁸ United Nations Population Prospects Database, 2006.

²⁸⁹ U.S. Department of State.

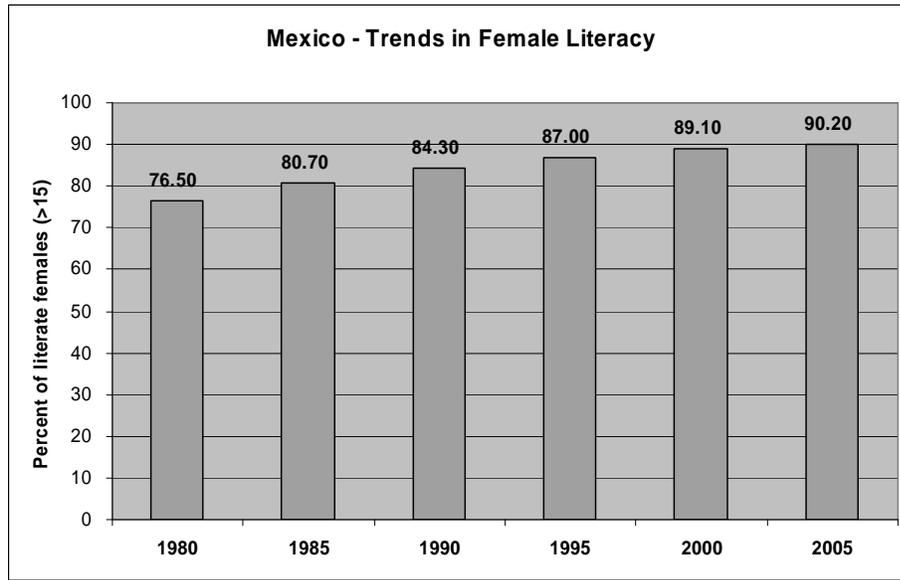


Figure 33. Mexico – National Trends in Female Literacy.²⁹⁰

The broad-spectrum *Program of Education, Health and Feeding* targeted the most disadvantaged segments of society in an attempt to reduce inequities. Despite the success of the program, significant gaps exist among the *haves* and the *have-nots*. But, overall, female literacy is high and continues to increase.

There are not widely available female-specific indices for income across countries, but an assessment of Mexico’s economic prosperity as a whole can provide some indication that women are participating in the economy (Figure 34).

²⁹⁰ United Nations Statistics Division (UNSTATS).

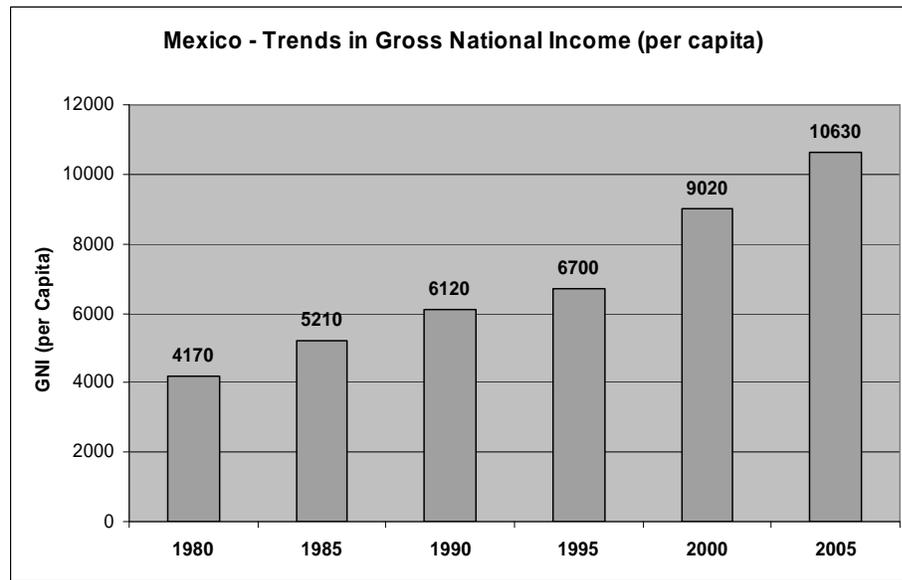


Figure 34. Mexico – Trends in GNI.²⁹¹

Following an economic crisis in the mid-1990s, the Mexican economy has rebounded well. The government has significantly expanded its participation in free trade arrangements. The government has also been very conscientious about investing the benefits of economic growth in the country’s social infrastructure, including health and education. However, lack of job opportunities, underemployment, and internal and external migration are major concerns to strategic economic growth.

These areas of concern disproportionately affect the poorer segments of Mexican society. The gap in income between the wealthiest quintile and the poorest quintile has barely budged in the last decade (see Figure 35).²⁹² Long-term economic growth will require the narrowing of this gap and the sharing of the benefits of Mexico’s growing economic status.

²⁹¹ World Bank. World Development Indicators.

²⁹² World Bank. World Development Indicators

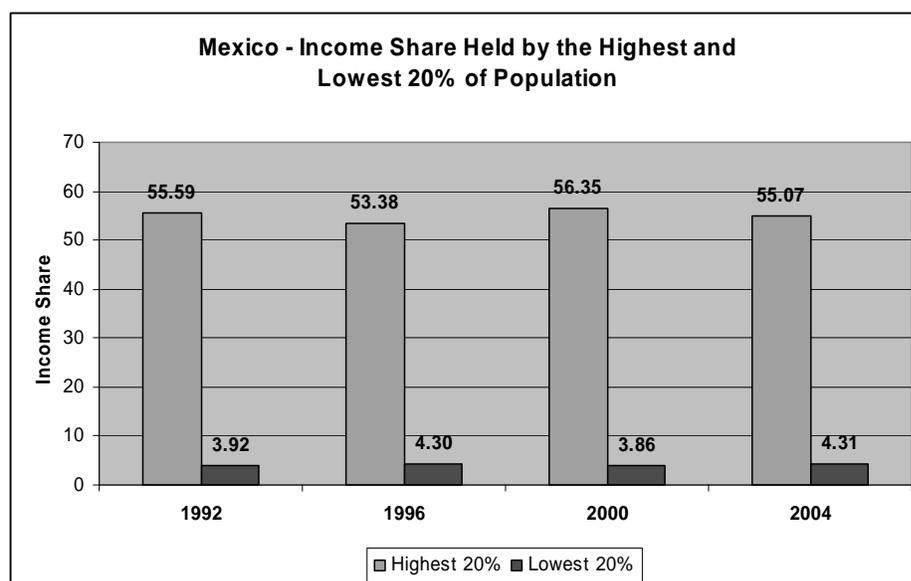


Figure 35. Mexico – Income Shares for the Highest and Lowest Quintiles.²⁹³

Despite sizable increases in health status and literacy levels and decreases in fertility rates at the national level, policymakers must work toward a more equitable distribution of resources and opportunities to improve the health, literacy, and fertility levels for all groups within Mexico. Mexico’s national policies must continue to focus on issues of fair distribution of resources in order to bring the trailing states and impoverished segments of society up to par with the best performing states.

7.5. Mexico – Country-level Analysis of Model

This section will present a country-level analysis of the relationships between fertility and population mortality, child mortality, health indicators and socioeconomic factors using the global model developed in the earlier chapters of this manuscript. The analysis includes the 31 states for which all datasets were complete for the selected

²⁹³ World Bank. World Development Indicators.

indicators. The Federal District was not included in the analysis since it lacked complete data. Data were available for the years 2000 and 2004, with the primary source for state-level data being the Indicators of Basic Health 2000-2004, produced by the Undersecretary for Innovation and Quality, Directorate of General Health Information, Secretary of Health. The lack of data for additional years limits the power of this analysis, but even these few years of data should provide some insight into the country-level applicability of the global child health model.

The only variable that is modified from the global analysis is the literacy measure. The state-level breakdown of female literacy was not available for the data points used here. In its place, population literacy by state will be used. While not ideal, the fact that the male/female literacy rates are relatively close allows this to be used as an estimation of female literacy rates. However, since the variance might be wider in the poorer states, this may impact the results.

Before evaluating the model, the independent variables were tested for potential collinearity. None of the correlations exceeded the threshold of 0.8. The highest correlation was between sanitation and illiteracy at 0.71. All variables meet collinearity criteria for inclusion in the model.

The initial results of the regression are displayed below (Table 22). It is important to note that the only variables that were significant in every model in which they were included were CMR and Literacy.

Table 22. Mexico- Country-level analysis results (31 states – 2000 and 2004 data).²⁹⁴

| MEXICO | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|-----------------------------|---------------------------------|---|--|---------------------------------|
| Without control variables | $r^2=0.0553$ | $r^2=0.5904$ CMR significant | $R^2=0.5446$ Nut, MatlMort, San significant | $R^2=0.3603$ Lit significant |
| With SES controls variables | $R^2=0.3972$ Lit significant | $R^2=0.6466$ CMR and Lit significant | $R^2=0.6114$ San, Lit and GDP significant | n/a |

Table 23. Global analysis results for comparison.

| GLOBAL | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|---------------------------|----------------------|----------------------|-------------------------------------|----------------------------|
| Without control variables | $r^2=0.0687$ | $r^2=0.7498$ | $R^2=0.7717$ | $R^2=0.5923$ |
| With control variables | $R^2=0.5995$ | $R^2=0.7848$ | $R^2=0.7846$ | n/a |

All variables significant at 0.05 level.

Assessing each model independently, we first see that the relationship between TFR and CDR (Crude Death Rate) is not significant and any statistical strength the model achieves is due solely to that addition of socioeconomic variables, particularly literacy (Table 24). Individually, the Child Mortality Rate model continues to be a strong predictive model. The addition of the socioeconomic variables further strengthens the model, showing that only literacy has statistical significance. This clearly supports *Hypothesis 1*, which was also supported by the test at the global level.

²⁹⁴ Secretaria de Salud, Subsecretaría de Innovación y Calidad, Dirección General de Información en Salud, Indicadores Basicos de Salud 2000-2004. See also FAO – Perfiles Nutricionales por Países Mexico. United Nations, August 2003. See also Encuesta Nacional de Salud Nutricion 2006.

Table 24. p-values for Global and Mexico Analyses

| GLOBAL p-values | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|----------------------------|--|--|---|--|
| Without control variables | CDR – 0.000 | CMR – 0.000 | Nut – 0.048 San – 0.000 Phys – 0.000 Matlmort– 0.000 | Lit – 0.000 GNI – 0.000 |
| With control variables | CDR – 0.009 Lit – 0.000 GNI – 0.000 | CMR – 0.000 Lit – 0.000 GNI – 0.000 | Nut – 0.033 San – 0.000 Phys – 0.000 Matlmort– 0.000 Lit – 0.000 GNI – 0.000 | n/a |

| MEXICO p-values | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|----------------------------|--|---|---|-----------------------------------|
| Without control variables | CDR – 0.066 | CMR – 0.000 | Nut – 0.000 San – 0.000 Phys – 0.983 Matlmort– 0.031 | Lit – 0.000 GDP – 0.074 |
| With control variables | CDR – 0.064 Lit – 0.000 GDP – 0.134 | CMR – 0.000 Lit – 0.004 GDP – 0.991 | Nut – 0.000 San – 0.007 Phys – 0.623 Matlmort – 0.324 Lit – 0.032 GDP – 0.205 | n/a |

In this application of the models, the Child Health Model is strong but not as strong as the Child Mortality Model. The physician ratio does not prove to be a significant factor in fertility change in this country. When the socioeconomic variables are added to the model, the overall strength improves but we observe an interesting dynamic that with the inclusion of literacy and GDP (both of which are significant here) nutrition and maternal mortality cease to be statistically significant. This may indicate that the impact of these two variables are captured by changes in literacy and therefore lose significance with that addition to the model. Thus the most resilient health factor

from this model is access to improved sanitation which is significant both with and without socioeconomic variables.

In modeling the socioeconomic factors alone, only literacy proves to be significant, but the model is not a strong one.

The Child Health Model (minus Physician ratio) proves to be a strong model but fails to perform as well as CMR alone. However, the value in use of the model is in identifying actionable policy venues in which to direct attention and resources. In the case of Mexico, it appears that investment in education may, indeed, trump investment in health concerning impact on fertility. The application of this model would support particular focus and investment in sanitation infrastructure and access, as this is shown to have a significant impact on fertility in addition to its documented impact on health overall.

Due to the relatively short time period between the 2000 and 2005 data sets available for Mexico, further analysis is performed to assess the relationships among the *changes* in the variables during this time frame to determine if there are any notable variances. Using the same data, the *change* from 2000 to 2005 was calculated for each state and each variable, producing a data set with only 31 points for regression. Identical regressions were performed using this set. Results are in Table 25 below.

Table 25. Mexico-Country-level analysis results (data representing *change* from 00-04, n=31).

| MEXICO | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model | TFR & Sanitation |
|-----------------------------|--|---|--|--|---|
| Without control variables | $r^2=0.0100$ CDR not significant | $r^2=0.2117^*$ CMR significant at 0.05 | $R^2=0.3056$ San significant at 0.1 | $R^2=0.1778$ Lit significant at 0.1 | $r^2=0.2158$ San significant at 0.05 |
| With SES controls variables | $R^2=0.1821$ Lit significant at 0.1 | $R^2=0.2309$ None significant | $R^2=0.3320$ San significant at 0.1 | n/a | n/a |

In all cases, the models run with the reduced data set, showing *change* between years, are weaker than the previous models. This is to be expected, as there are fewer data points and change variables are more subject to random influences. With the revised data set, the CDR regression shows CDR to be insignificant by itself and the dynamic with the addition of socioeconomic variables is similar to the previous run in that what little strength the model has comes from Literacy. CMR alone is significant at the 0.05 level, but the inclusion of the socioeconomic variables confound those results, and both models are relatively weak. In the Child Health Model, the only significant variable is Sanitation, regardless of inclusion of SES variables. A separate regression using only Sanitation shows an increase in significance level for the variable and a correlation (r) that is significantly lower than that of the Child Health Model. As with the earlier run of the SES model, only Literacy is significant, but the strength of this model is notably weaker.

Using the reduced data set applying the *change* between the data years, it is apparent that Sanitation is a critical factor for influencing fertility rates in Mexico. This

supports the findings from the initial regression for the Child Health Model, which also indicated that Sanitation was a significant factor. The SES Model, while reduced in strength, continued to show Literacy as that only significant variable, as in the earlier regression. Although the earlier relationship with nutrition is no longer seen, the two set of models support the importance of Sanitation and Literacy as key areas of policy focus in impacting fertility rates.

The analysis for Mexico supports the results of the global analysis in that child mortality (CMR) has a significant relationship to fertility while population mortality (CDR) has none, supporting Hypothesis #1. However, the Child Health model developed at the global level performs only moderately well in Mexico. It serves to identify those characteristics representing child health that will likely have the greatest impact on influencing fertility rates. Through the application of the model it is apparent that among the health indicators, sanitation is the key component for policymakers to consider. The fact that change in Sanitation alone performs better than the SES-model supports the importance of health variables as indicators of fertility change. These regressions show that the impact of changes in Sanitation levels overshadow changes in literacy when modeled together, but among the socioeconomic factors, investments in improving literacy can most strongly influence fertility rates.

Additionally, variations on this model may be explored in the future based upon the specific state-level data reported within Mexico. The design of the global model was developed with consideration to data constraints in global data sets. On the national level within Mexico, it may be possible to reassess some of the health and socioeconomic

variables excluded at the global level to determine their applicability unique to Mexico's situation. This would facilitate a country-specific model to serve the interests of national and local policy makers.

7.6. Mexico – Policy Application and Discussion

Population Policy

Traditionally, Mexico's approach to population growth was *pro-natalist*.²⁹⁵ The influence of the Catholic Church with its opposition to modern birth control methods was likely a factor in the cultural embrace of large families that continued long after the society shifted from an agricultural to an industrialized economy. Even today a delicate balance between the tenets of Catholic teachings and the development of secular state policies must be maintained.

For decades now, Mexico has used strategic social policies to encourage the Mexican people to exercise free choice in limiting family size. Their socially-based programs that respect human rights and value personal choice have been well-received. The government provides a range of free birth control options, has implemented media campaigns encouraging smaller families, and provides sex education in the schools (despite church opposition).²⁹⁶ Through the provision of information and health resources, and combined with economic challenges that dis-incentivize large families,

²⁹⁵ Ocampo Lopez, 1984.

²⁹⁶ McConahay, 1999.

Mexico has significantly reduced its fertility rate and has met its goal of reducing overall annual population growth to 1%.²⁹⁷

Government health clinics provide women with a full range of free birth control methods (from pills to sterilization) and accompanying education and counseling.²⁹⁸ The government has also launched numerous marketing campaigns that promote the idea of small families being associated with an improved quality of life. There have also been campaigns targeting men's responsibilities for birth control, reframing the *machismo* that often dominates Mexican culture.²⁹⁹

Current population policy attempts to be proactive about demographic transition, and particularly focuses on the issues of external migration and the changing age structure of the population.³⁰⁰ Specifically, this includes strengthening institutional capacities for reproductive services in the health sector, updating methodology and materials on population education, and developing local level strategies that incorporate socioeconomic variations within the country.³⁰¹ Programs are being implemented to continue to reduce growth moderately, to increase the integration of family planning into all appropriate government programs, to retain the population in areas where outmigration is high, and to modify internal migration behavior to better absorb the

²⁹⁷ In the 1980s, Mexico set a goal of 1% population growth by the year 2000. They did not meet this original timetable, but by 2005 a growth rate of 1.1% was achieved (Ocampo Lopez).

²⁹⁸ McConahay.

²⁹⁹ McConahay.

³⁰⁰ United Nations. Executive Board of the United National Development Programme of the United Nations Population Fund. DP/FPA/CPD/MEX/5. Oct 15, 2007. Country Programme document for Mexico.

³⁰¹ Ibid.

shifting population³⁰² The Mexican Government is working with the United Nations Population Fund to achieve a set of population outcomes by 2012. Among the measures are institutional capacities for evaluating development policies, increasing participation of civil society in exercising human rights and accessing quality social services, and strengthening participation in a democratic culture.³⁰³

Health and Social Policy

Mexico's recent and current approaches to the provision of health care have been built around comprehensive social programming aimed at reducing poverty by increasing access to and utilization of health resources, improving nutrition, providing health education, and breaking the cycle of poverty by keeping children in school. Collectively, this program is greater than the sum of its parts, as the various components of the program work with one another to an exponential effect. There are documented improvements in health outcomes through PROGRESA, but the government hopes that the greatest advantage will be stopping the *intergenerational transmission* of poverty. A child who is healthy will likely enjoy better health throughout life and will ultimately be more productive.³⁰⁴

The expansion of the social security health coverage to cover virtually all of the country's population is a worthwhile endeavor that will help mitigate inequalities within the country. There will be many challenges in moving the program from its conceptual

³⁰² Ocampo Lopez.

³⁰³ United Nations. Executive Board of the United National Development Programme of the United Nations Population Fund. DP/FPA/CPD/MEX/5. Oct 15, 2007. Country Programme document for Mexico.

³⁰⁴ Paul Gertler, Final Report – The impact of PROGRESA on Health. International Food Policy Research Institute, Washington, D.C (November 2000).

basis to full implementation, but if Mexico's past performance on broad social programs such as PROGRESA is any indication, they will find a way to reach even the most disenfranchised members of its population. But the challenges certainly will not end with improved coverage. Mexico also must adapt to the changing challenges as they continue to shift from a high burden of communicable diseases to a higher burden from chronic diseases, and as they plan for the aging of the population that is occurring as a result of improved health status and longer life spans.

Significant improvements in Mexico's sanitation infrastructure were made through the 1991 Clean Water Programme, which worked to address water chlorination and sewage management. This federal program included provisions for the improvement of waste disposal mechanisms, sewage treatment plants, and drainage systems. Sewage water was banned for use in irrigation and municipalities emphasized the construction of latrines.³⁰⁵ In 1998, the Inter-American Development Bank (IADB) underwrote a US\$560 million sustainability program for water and sanitation efforts in Mexico's rural areas and the country continues to invest in its sanitation infrastructure to meet the established MDG goals.³⁰⁶ Mexico's continuing efforts to increase access to improved sanitation facilities will not only improve public health but also impact fertility rates.

The evaluation of the child health model and socioeconomic indicators shows that investment in literacy is a critical component in reducing fertility, and that improving the

³⁰⁵ Jaime Sepulveda et al. 2006.

³⁰⁶ Inter-American Development Bank. Sustainability of Water Supply and Sanitation Services in Rural Communities. December 16, 1998. Also available through www.iadb.org/exr/doc98/apr/me1161e.pdf

sanitation infrastructure may also aid in moderating population growth. Both of these correlate strongly to fertility as individual indicators (Figure 36).

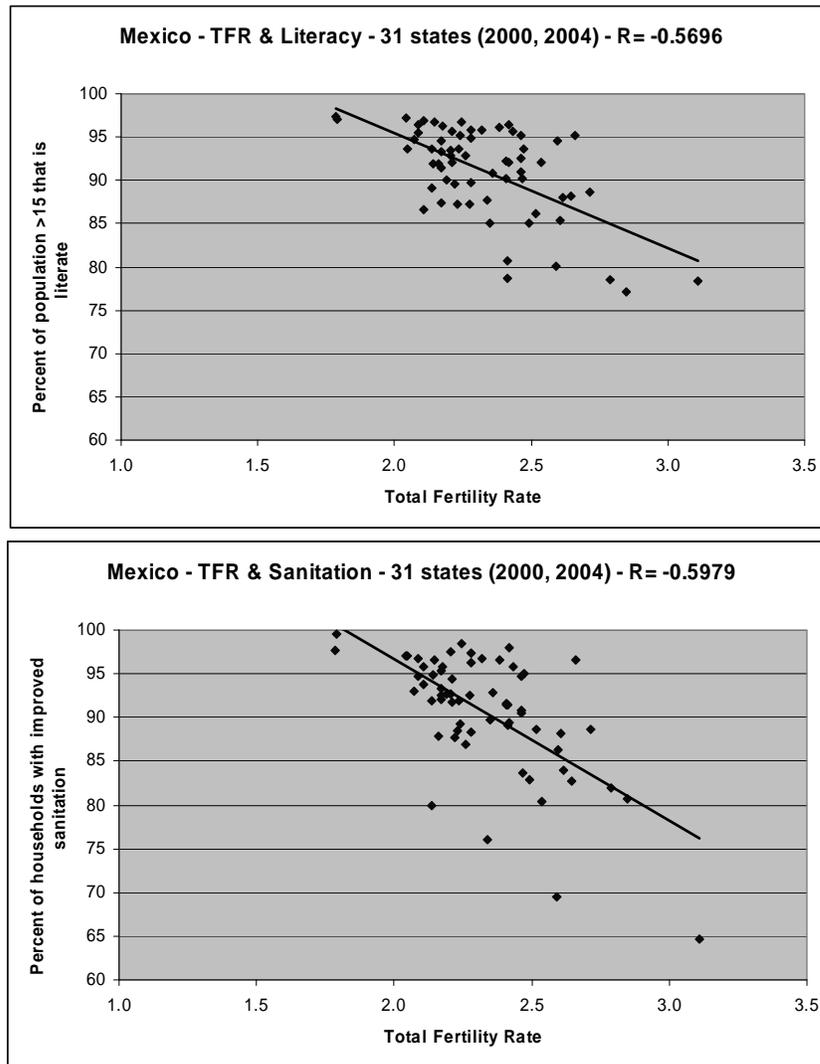


Figure 36. Mexico – TFR correlations with Literacy and Sanitation.

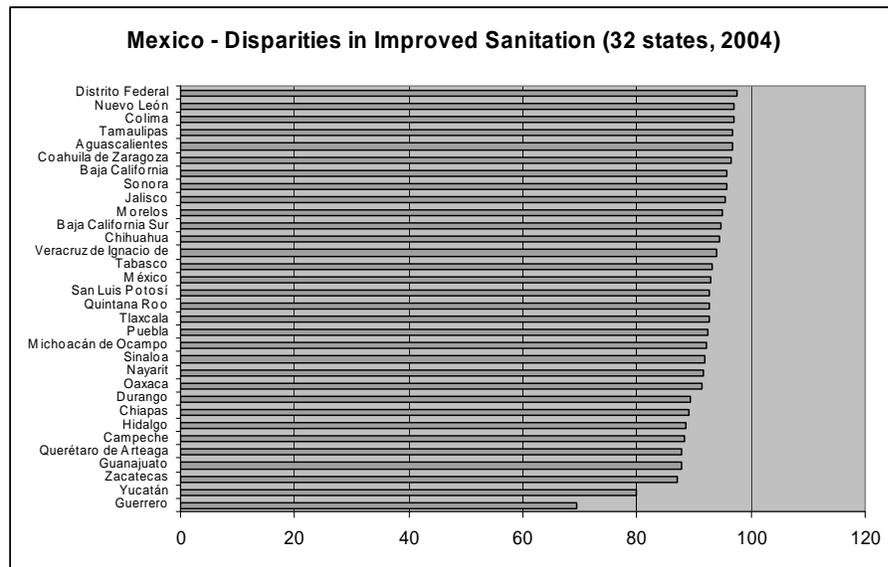
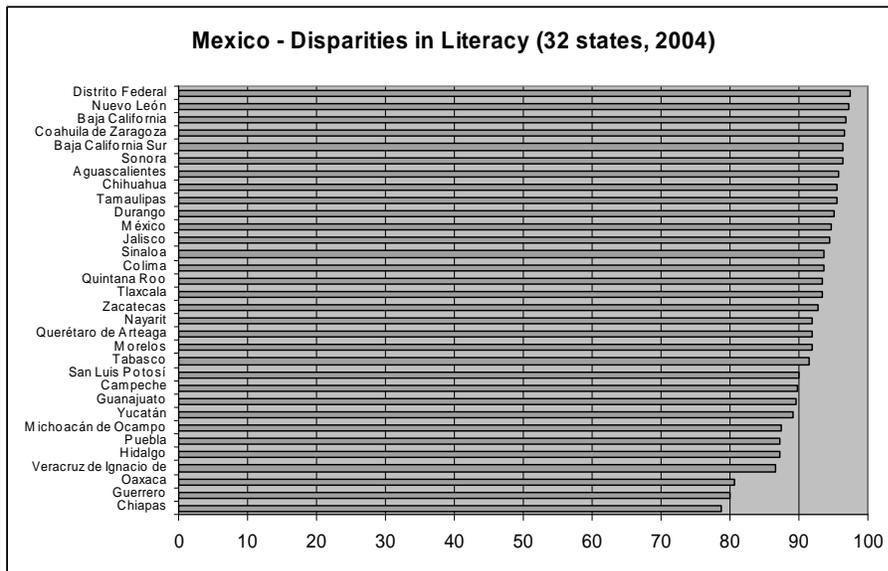


Figure 37. Mexico – disparities among states in literacy and sanitation.³⁰⁷

As was the case in India, Mexico must focus attention on disparities among segments of society (Figure 37). Geographical disparities are very distinct but there are also differences among income groups. Since 1998, Mexico has made progress in

³⁰⁷ INEGI. Censo de población y vivienda 2005. <http://www.inegi.gob.mx/lib/olap/general/MDXQueryDatos.asp>

targeting at-risk population for health and social programming. In the initial years of PROGRESA, participating communities experienced a 12% reduction in the incidence of illness in children, and increases in secondary school enrollment for both girls (11-14%) and boys (5-8%).³⁰⁸ The PROGRESA and *Oportunidades* programs have shown strong initial successes but the ultimate benefits cannot be evaluated for a generation.

Mexico's *Oportunidades* is battling poverty and disadvantage on many fronts to include healthcare, nutrition, education, and income. Policymakers seem to have bridged the gap between sectors and developed a comprehensive and unified model that tackles multiple contributors to poverty simultaneously. The concept behind this program and its initial success demonstrates the importance of tapping into a dynamic mix of indicators to solve complex social problems such as population growth. Poverty and high fertility rates are highly correlated. Just as the component parts of poverty are being addressed in Mexico, so can the component parts of fertility rates and population growth. By modeling health and socioeconomic indicators rather than just mortality measures, policymakers can identify the specific factors that have the greatest impact on fertility and take focused and deliberate action in manipulating these contributing factors to mitigate fertility rates in support of population policies.

³⁰⁸ Paul Gertler. Final Report – The impact of PROGRESA on Health. International Food Policy Research Institute. Washington, D.C. November 2000. Also Levine, 2007.

8. The Philippines

Although having experienced significant political, social and economic upheaval, in recent years the Philippines has seen improved stability that facilitates the planning and implementation of new health and socioeconomic policies. It has a federal structure and a government infrastructure with the capacity to provide good regional level data to support the exploration of regional differences in health and fertility.

8.1. Background

The Philippines became a self-governing commonwealth after being ceded to the United States following the Spanish American War. It gained its independence in 1946 following World War II and became the Republic of the Philippines. In the years since, the country has struggled with political and economic stability, as well as challenges with a Muslim insurgency in its southern provinces. It is currently a democratic federal republic with 81 provinces and 136 chartered cities. These are distributed among 16 geographic regions (some autonomous) (see map, Figure 38).³⁰⁹

³⁰⁹ CIA World Factbook.

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Figure 38. Map of the Philippines.

Economy

The Philippines is the twelfth most populous country in the world. It has an estimated GDP per capita of \$3,300 (2007) and has an economy that is dominated by the services sector.³¹⁰ Almost 55% of the Philippine GDP comes from services, with 14% from agriculture and 31% from industry. The labor force of an estimated 36.22 million people is employed 50% in services, 35% in agriculture, and 15% in industry. The economy has grown rapidly in recent years, with the rate of growth reaching 7% in 2007. But a stronger and more sustainable economic performance will be required to allow the Philippines to adequately address its severe issues of poverty and mal-distribution of wealth.³¹¹

Classified as a *lower middle* income country by the World Bank, the Philippine government is faced with an array of economic challenges. Compared to other Southeast Asian countries, the country performs poorly in most socioeconomic indicators.

Experiencing years of government corruption since its independence, the once-promising economy faltered under the Marcos regime (1965-86) that embezzled billions. Decline and recession later followed in the late 1980s and 1990s. Efforts at economic recovery were hindered by the Asian financial crisis and the Philippines had negative economic growth in 1998. The current president, Gloria Macapagal-Arroyo, has been proactive in economic policies and is building momentum that shows hope for continued growth.³¹²

³¹⁰ CIA World Factbook

³¹¹ CIA World Factbook.

³¹² National Economic and Development Authority website. See also CIA World Factbook. See also NSCB.

Population

The Philippine population includes more than 92 million people, 63% of whom live in urban areas.³¹³ An estimated 34% of the population is under the age of 15 years, with just over 4% over the age of 65 years. Life expectancy at birth is relatively good at 70.8 years, with females at 73.85 years and males at 67.89 years. Nationally, the total fertility rate is estimated at 3.0, with some regions as high as 4.2. The population growth rate for 2008 is estimated at 1.728%.³¹⁴

Literacy rates in the Philippines are very good for a lower middle income country with 92.6% of the population able to read and write, and virtually identical literacy rates between men and women at the national level. National reports from the 1990s show that the literacy gap between rural and urban areas was closing and both are reported above 90% for both men and women. However, significant variations exist among regions, with the Federal District at almost 100% literacy and the Autonomous Region of Muslim Mindanao just under 70% overall.³¹⁵

Catholicism is the dominant religion in the Philippines with more than 80% of the population identified as Roman Catholic.³¹⁶ Five percent of the population identifies as Muslim, the second most populous religious designation. As in Mexico, the Catholic Church significantly influences many social policies within the country.

³¹³ World Bank WDI. 2005 data.

³¹⁴ CIA World Factbook. See also World Bank WDI indicators.

³¹⁵ National Statistic Coordination Board (NSCB). http://www.nscb.gov.ph/secstat/d_educ.asp

³¹⁶ CIA World Factbook.

Health System

The Philippines adopted a primary care approach to health in 1979 and integrated public health and hospital services in 1983. Despite these efforts to adopt a modern healthcare philosophy, the government has no comprehensive approach for ensuring access to services, with one of the major barriers being cost. Government health services are primarily funded through general taxation; with 47% of all health care payments made out-of-pocket by the patient.³¹⁷ The Philippine Social Security program that is aimed at regularly employed urban workers is estimated to only provide coverage for less than half of workers.³¹⁸ This significant absence of health coverage and high cost of health services are estimated to account for 25% of cases of new poverty in the Philippines each year.³¹⁹

The Medium-Term Philippine Development Plan 2004-2010 outlines the government's main strategy for improving accessibility and affordability of health coverage. In this plan the issue of health care has been elevated to an issue of social justice giving it greater priority in funding initiatives. The goals of the health sector are now designed to parallel the World Health Organization framework. The current health initiative has been labeled *FOURmula One for Health* and was launched in August 2005. To date, there appears to be little actual progress in the health reform partially due to the devolution of basic services, such as health, to local officials. Local control of programs and resources creates obstacles to national programming and comprehensive planning

³¹⁷ NSCB.

³¹⁸ Countrystudies.com - Philippines

³¹⁹ NSCB.

and execution that may be beneficial in a country that lacks the mainstays of a modern health program.

Perhaps one of the greatest obstacles facing the health system is the vast and ongoing exodus of health personnel. Philippine-trained doctors and nurses have left the country in exceedingly high numbers especially in recent years. Shortages of providers in the West create many opportunities overseas. To illustrate the magnitude of the problem, the largest hospital in the Philippines has 25% of its nursing staff depart each year.³²⁰

8.2. Fertility

The total fertility rate (TFR) for the Philippines has declined steadily and is now estimated at 3.0 (Figure 39), and is approaching the rates of several higher income countries (including Malaysia at 2.93, Israel at 2.85, and South Africa 2.8, which all have GDP at least three times that of the Philippines).³²¹

³²⁰ National Statistics Coordination Board (NSCB). Republic of the Philippines. <http://www.ncsb.gov.ph>

³²¹ CIA World Factbook. (2007 estimates)



Figure 39. Philippines – Trends in Fertility Rate.³²²

The gaps among the regions have been closing over the last decade with a smaller range among the regional fertility rates (Figure 40). However, there continue to be states that are lagging behind.

³²² World Bank - WDI.

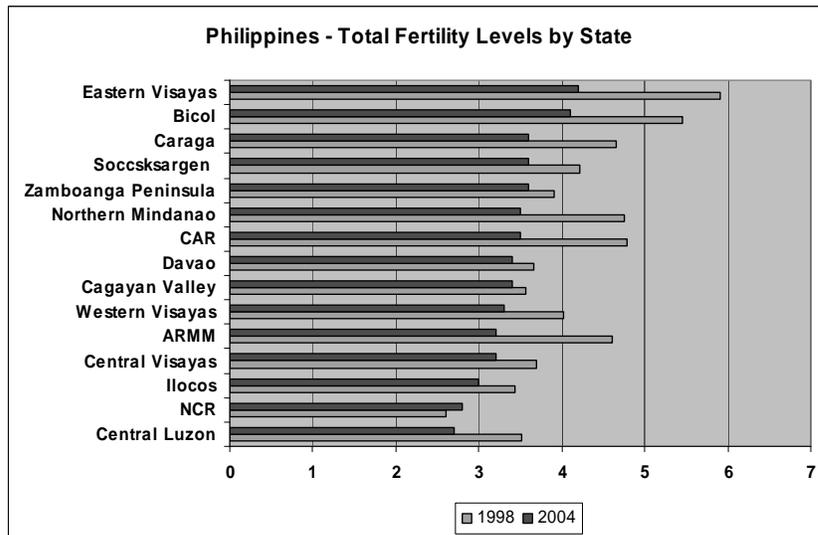


Figure 40. Philippine’s Fertility Levels by Region (1998/2004).³²³

8.3. Health

For the total population, the Philippine health status a prevalence of non-communicable diseases (58% of disease burden) (Figure 41).

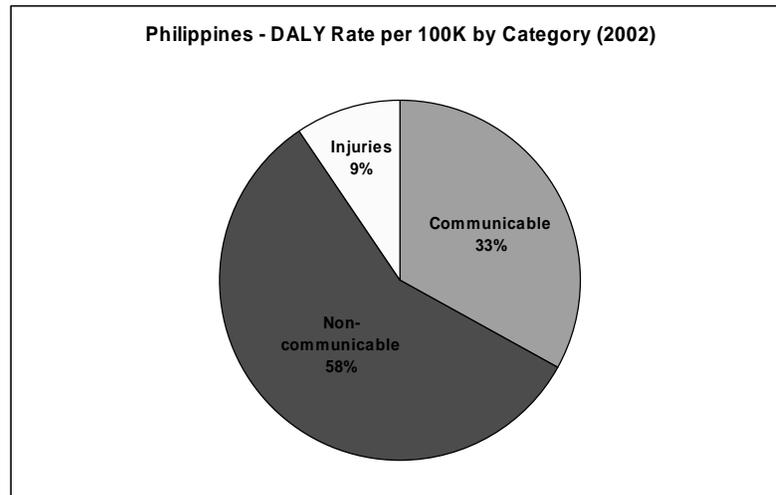


Figure 41. Philippines – Categories of Burden of Disease (total population).³²⁴

In recent decades, disease burden has moved from communicable to non-communicable diseases. This, along with the lengthening life expectancies for Filipinos, creates increased demands for scarce health resources from the aging population. Adequately planning and implementing child and maternal health programs will require trade-offs with these competing priorities.

The child mortality rate in the Philippines has dropped to 33 deaths per 1000 live births after a steady decline particularly in the last 15-20 years (Figure 42). Despite these improvements, the UNDP rates the Philippines' policies on CMR as *unacceptable*.³²⁵



Figure 42. Philippines – Trend in Child Mortality Rate.³²⁶

³²³ NSO, NDHS 1998; Quickstat. Also De La Paz and Colson, Population, Health, and Environment Issues in the Philippines, Washington, D.C.: Population Reference Bureau (2008).

³²⁴ World Health Organization. 2002. <http://www.who.int/healthinfo/bod/en/index.html> . Accessed February 2008.

³²⁵ UNDP. World Mortality Report 2005.

³²⁶ World Bank WDI Indicators.

Efforts to implement a coordinated health program targeting improvement of population health indicators are just beginning. The *FOURmula One for Health* program promises to lay a framework for future health efforts with its emphasis on the four key areas of health financing, health regulations, health services delivery, and good governance. Improvements in these areas will provide the infrastructure for a health system that will eventually support targeted health intervention programs; but innovative nation-wide health interventions are unlikely in the immediate future as the government works toward capacity building in this sector.

Indicators in some of the basic child health measures have improved in the last decade, but not as rapidly as could be accomplished in an environment with greater government stability, economic growth, and strategic health programming. The first dose of measles vaccine was provided to an estimated 92% of children nationally in 2006, up only 2% since 1996. From 1990 to 2000, child morbidity due to pneumonia and acute respiratory infections doubled.³²⁷

The Philippines' oral rehydration treatment (ORT) program began in the 1980s and since then, child mortality and morbidity from diarrheal disease has declined. One study attempted to correlate the introduction of the ORT program to the reduction but was unsuccessful due to the multiple intervening variables that also saw improvement in recent decades.³²⁸

³²⁷ Philippines Department of Health, <http://www2.doh.gov.ph/noh2007/NOHWeb32/NOHperSubj/Chap4/PneumoniaARI.pdf>

³²⁸ Cesar G. Victora, Jennifer Bryce, Olivier Fontaine, and Roeland Monasch. Reducing deaths from diarrhoea through oral rehydration therapy. *Bulletin of the World Health Organization*. 2000 78(10). Pp. 1246-55. [http://libdoc.who.int/bulletin/2000/Number%2010/78\(10\)1246-1255.pdf](http://libdoc.who.int/bulletin/2000/Number%2010/78(10)1246-1255.pdf)

Among those improving indicators are the improvements in access to improved water sources and sanitation facilities. Since 1990, the access to improved sanitation in the Philippines has increased steadily, though more rapidly in urban areas than in rural areas. Despite advances in the sanitation infrastructure, the access to safe water has actually decreased nationwide (Figure 43). Most of this decline is seen in the urban areas, which was at 95% access in 1990 and has dropped nearly 10% since then. This may be attributed to the internal migration where Filipinos are moving into urban areas faster than the infrastructure can expand to accommodate their needs. The Philippine government must reverse this decline in access to sanitation in order to help improve health, alleviate poverty, and potentially mitigate fertility growth.

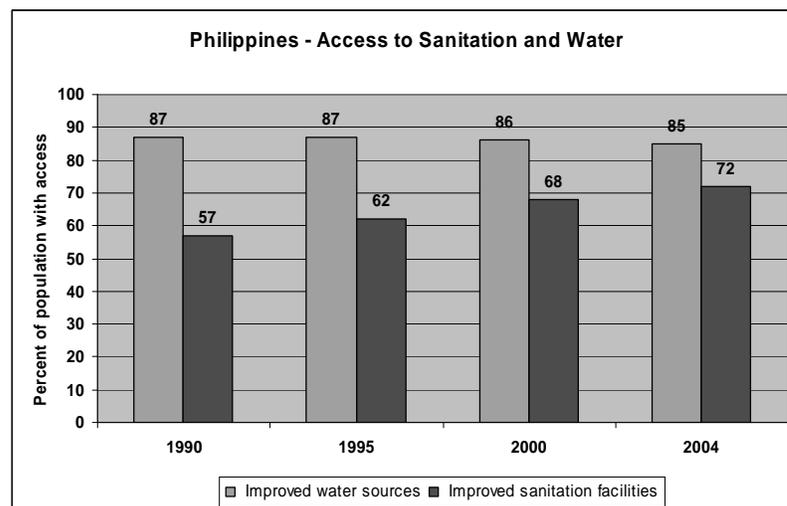


Figure 43. Philippines – Access to Water and Sanitation.³²⁹

Investments in nutrition programs for children can also decrease child morbidity and mortality. An estimated 27% of Filipino children were underweight in 2003.³³⁰

³²⁹ World Bank. World Development Indicators Database.

Variations among regions range from highs near 34% in Region 1 and ARMM to a low near 16% in Cordillera. Improvements have been seen in all regions, but are smaller in socioeconomically disadvantaged regions.

Systemic health resources and access to those resources can significantly impact child morbidity and mortality. Regional data on the physician ratio are not available for the inclusive period of this study, but the percent of births attended by physicians can provide some indication of the access that women have to physician care. Nationally, the Republic of the Philippines has just over 40% of deliveries attended by a physician. Regionally, the National Capital Region (NCR) performs best in this measure, which is one of only three regions, including Caraga and Central Luzon, which is above the national mean (Figure 44).³³¹

³³⁰ Food and Nutrition Research Institute - 6th National Nutrition Survey - Facts and Figures 2003: Part II – Anthropometric.

³³¹ Health and Vital Statistics Division, Civil Registry Dept., NSO,

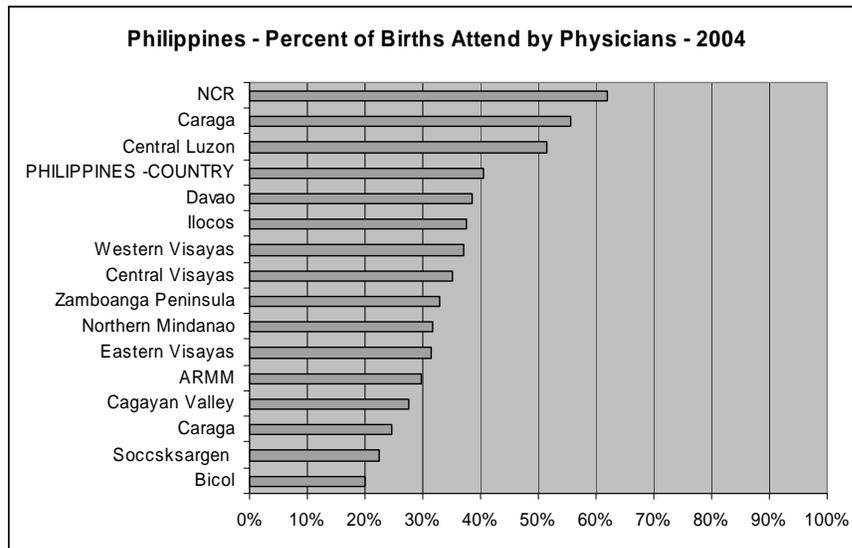


Figure 44. Philippines – Percent of birth attended by physicians (2004).³³²

Adequate and timely care can significantly impact the health of both the child and the mother. But the status of the mother in society at-large can also be a determining factor in the well-being of children.

8.4. Women’s Socioeconomic Status

The life expectancy of a population often reflects the socioeconomic levels within a particular region or country.³³³ Life expectancy for women in the Philippines has steadily increased in the last fifty years and is now 73 years (2005 data) (Figure 44), well above the world average of 68.3 years. Women live four years longer than men, on average, and their rate of improvement in life expectancy is moving roughly in sync with the improvement for Filipino men.

³³² Health and Vital Statistics Division, Civil Registry Department, NSO, Philippines. .

³³³ Evans, Barer and Marmor; Also Wermuth.

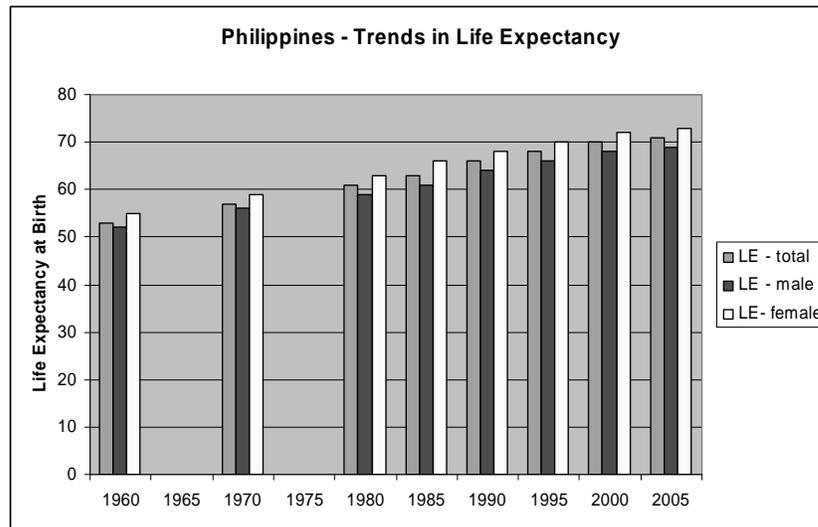


Figure 45. Philippines –Trends in Life Expectancy.³³⁴

The education system in the Philippines is modeled from the U.S. system (stemming from U.S. colonization). The federal funding is focused on the primary level, which aids in ensuring basic literacy and functioning of the population, and the Philippines achieved universal primary enrollment in 1970.³³⁵ Due to reduced federal funding of education beyond the primary level, only 70% of secondary schooling and 12% of tertiary schooling is funded by the government. Female literacy is nearing or exceeds 90% in almost every region (Figure 46). The notable exception is the Autonomous Region of Muslim Mindanao (ARMM), which also scores lowest in variables such as GNI, maternal mortality, CMR, IMR, and sanitation. AARM was carved out of other existing regions in Mindanao in 1989 to address long standing desires

³³⁴ World Bank – WDI indicators.

³³⁵ World Education News and Reviews. November/December 2004. Education in the Philippines. Available from www.wes.org

for Muslim self-governance.³³⁶ Although under self-rule, it has few resources and relies on funding from the federal government.

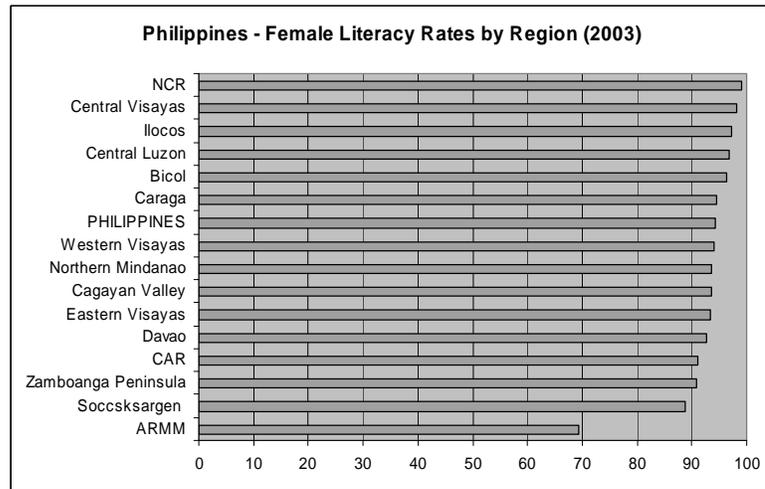


Figure 46. Philippines – Female Literacy by Region (2003).³³⁷

Female-specific indices for income across countries are currently not widely available; however the measure for Gross National Income may provide some indication of the economic participation of women.

³³⁶ Republic Act No. 6734; AARM government website, <http://www.armm.gov.ph>

³³⁷ NSCB Statistics, Education. Available from <http://nscb.gov.ph>

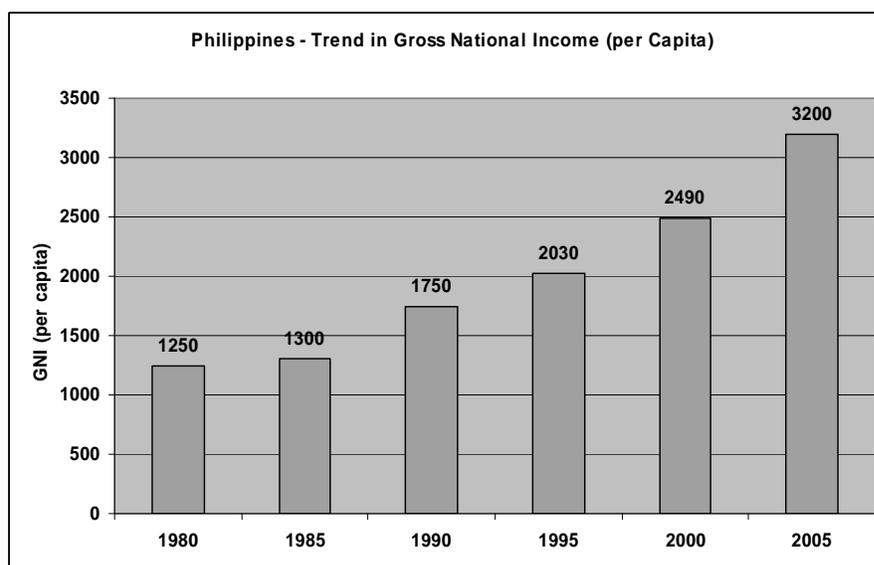


Figure 47. Philippines – Trends in GNI.³³⁸

The Philippine economy has gained strength in recent years and has seen increases in Gross National Income since 2000 (Figure 47). This growth holds promise for improvements in infrastructure and investments in the health system, but the government must show that the current growth can be sustained before major new investments are likely. Despite the national economic growth, Filipino’s are not sharing equally in the benefits of economic development. The ratio between the highest and lowest earning quintiles has been virtually stagnant for the last 20 years, if anything, it is getting slightly worse (Figure 48).

³³⁸ World Bank. World Development Indicators.

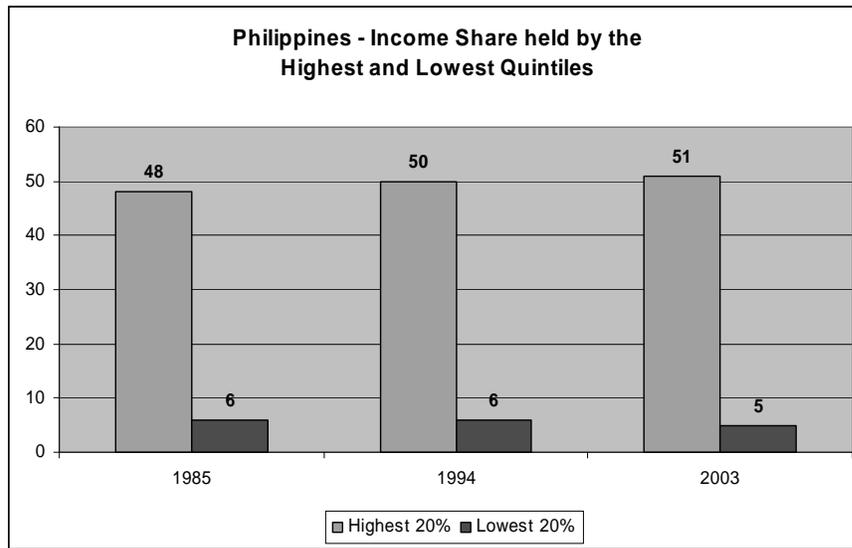


Figure 48. Philippines – Income Shares for the Highest and Lowest Quintiles.³³⁹

With more than half of the nation’s income in the hands of the top quintile, the needs of the country’s most disadvantaged may not receive the attention and investment that is required to mitigate the gap. The National Capital Region scores the highest in virtually every health and socioeconomic indicator. This may mean that those who have the greatest opportunity to enact policy change may have the fewest incentives to do so. National policies must address the challenges of the fair distribution of resources in order to improve child health and socioeconomic status, and impact fertility rates in the most disadvantaged regions.

8.5. The Philippines – Country-level Analysis of Model

The foregoing summary of the historical and economic background of the Philippines, as well as a review of the country’s status in select health and socioeconomic

³³⁹ World Bank. World Development Indicators.

indicators, lays the groundwork for repeating the analysis that was previously performed at the global level.

This analysis is conducted using fifteen regions for which the required data were available. There are two data points for each indicator, and they are drawn from year groups 1998-2000 and 2003-2005. Sources for this data include the National Statistical Coordination Board (NSCB), the National Statistics Office (NSO), the National Nutrition Survey, the National Census, and the National Demographic and Health Surveys, among other resources.

The limited data set limits the power of this analysis but will provide some insight into the potential use of the model for this country. One variable used in the global analysis is not available for the Philippines for this timeframe. Instead of using the physician ratio, the percent of physician-attended births was included in the study.

The initial results of the regressions are shown below (Table 26 and 27). The only model in which all variables are significant is the child mortality model. None of the other models have any statistically significant variables.

Table 26. Philippines- Country-level analysis results (15 regions – 98-00 and 03-05 data).

| PHILIPPINES | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|-----------------------------|---|--|---|---|
| Without control variables | $r^2=0.0649$ not significant | $r^2=0.4090$ CMR significant at 0.05 | $R^2=0.4918$ MatlMort significant at 0.1 | $R^2=0.2010$ Inc significant at 0.05 |
| With SES controls variables | $R^2=0.2043$ Inc significant at 0.05 | $R^2=0.5239$ CMR significant at 0.05 Lit significant at 0.05 | $R^2=0.5423$ MaltMort significant at 0.1 | n/a |

Table 27. p-values for Global and Mexico Analyses

| GLOBAL p-values | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|-----------------------------|--|--|---|--|
| Without control variables | CDR – 0.000 | CMR – 0.000 | Nut – 0.048 San – 0.000 Phys – 0.000 Matlmort– 0.000 | Lit – 0.000 GNI – 0.000 |
| With control variables | CDR – 0.009 Lit – 0.000 GNI – 0.000 | CMR – 0.000 Lit – 0.000 GNI – 0.000 | Nut – 0.033 San – 0.000 Phys – 0.000 Matlmort– 0.000 Lit – 0.000 GNI – 0.000 | n/a |
| PHILIPPINES p-values | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
| Without control variables | CDR – 0.174 | CMR – 0.000 | Nut – 0.293 San – 0.721 Phys – 0.200 Matlmort– 0.075 | Lit – 0.693 Income – 0.039 |
| With control variables | CDR – 0.746 Lit – 0.942 Income – 0.044 | CMR – 0.000 Lit – 0.043 Income – 0.107 | Nut – 0.301 San – 0.257 Phys – 0.959 Matlmort– 0.053 Lit – 0.208 Income – 0.205 | n/a |

Philippines Models – significance determined at the 0.1 level

With few variables showing as significant, even at the 0.1 level, bivariate correlations were run between all variables to check for multi-collinearity, which can often create a situation where a model is strong even though none of the variables are significant. From this, it is found that one correlation exceeds the threshold of 0.85, that being the relationship between CDR and Female Literacy ($r=0.8756$). The only model in which both these variables appear is the model with CDR with SES controls which is not anticipated to be a strong model in any case and is not critical to evaluating the usefulness of the Child Health and SES models overall. Correlations among the health variables range from 0.2596 to 0.6057, and are not high enough to consider exclusion based upon collinearity.

When each health variable is regressed independently with TFR, each is significant at the 0.05 level, with maternal mortality significant at the 0.001 level. When any two or more of the health or socioeconomic variables are joined in multiple regressions, at most one variable retains significance. The strongest predictor variable among the health variables is maternal mortality, and but it does not perform better than CMR in relation to fertility, even when socioeconomic factors are controlled for (Table 28).

Table 28. Philippines – CMR and Maternal Mortality comparison.

| PHILIPPINES | TFR & CMR | TFR & Maternal Mortality |
|-----------------------------|---|--|
| Without control variables | $r^2=0.4090$ CMR sign at 0.05 | $r^2=0.3694$ MatlMort sign at 0.001 |
| With SES controls variables | $R^2=0.5239$ CMR sign at 0.05, Lit sign at 0.05 | $R^2=0.4654$ MatlMort sign at 0.001 Inc sign at 0.05 |

This result may mean that there is a better variable, or set of variables, to model for health in this country, the effects of which are captured in the cumulative impacts of the selected variables in the existing model. Among the health indicators evaluated here, maternal mortality appears to be the most relevant area to address for Filipino policymakers.

As with the data sets for Mexico, the spread of five years between data points is relatively small. Therefore, further evaluation was conducted to assess the impact of *change* in the variables over that period. The results are displayed in Table 29.

Table 29. Philippines-Country-level analysis results (data representing *change* between reporting periods - n=15).

| PHILIPPINES | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model | TFR & Income Alone |
|-----------------------------|--|--|-------------------------------------|--|----------------------------------|
| Without control variables | $r^2=0.0001$ None significant | $r^2=0.0568$ None significant | $R^2=0.0957$ None significant | $R^2=0.2888$ Inc significant at 0.1 | $r^2=0.1838$ None significant |
| With SES controls variables | $R^2=0.3095$ Inc significant at 0.1 | $R^2=0.3004$ Inc significant at 0.1 | $R^2=0.3286$ None significant. | n/a | n/a |

These results clearly show that family income levels are a key driver of fertility *change* in the Philippines. This dynamic was not observed in the previous run of these models, although income did prove to be significance outside the influence of health variables. None of the individual health variables (nor the education variable) are significant in any model with this dataset focusing on change over time. Even maternal mortality, the only significant health variable earlier, loses significance. However, both the CMR model and Maternal Mortality model, when socioeconomic factors are controlled for, explain about 30% of the variance in the fertility rate.

Running a regression with family income alone proves to be a weak model with no statistical significance. Overall, regardless of the strength of each of the individual models applied to this dataset, the only significant variable assessed with respect to fertility change is the change in family income, but only when acting in concert with other indicators.

Overall, maternal mortality proves to be the strongest variable among the child health indicators, similar to the findings in Mexico. But within the Philippines there are apparently other factors at work that mitigate the overall effectiveness of the existing model. Exploration of better health or socioeconomic variables to model are outside the scope of this research, but this finding is informative nonetheless, and should prompt future analysis in this area. Further testing of potential health models will inform policymakers as to specific areas of intervention in which to direct their resources and efforts.

Once again, *Hypothesis 1*, that child mortality is a better indicator than population mortality is supported (although in assessing *change* over time in this dataset the difference is not statistically significant and neither CDR nor CMR are significant in those models). *Hypothesis 2* is not supported by the model as it exists, but the high R-squared value indicates that there are variables at play that work through the selected variables to impact fertility. Further exploration could identify those and inform policy. *Hypothesis 3* is supported in that inclusion of female literacy and family income strengthen the ability of CMR to predict fertility rates, but in the Philippines literacy is not as strong a predictor as it was in the other countries that were examined. Perhaps the longstanding high literacy rates throughout the country diminish its impact particularly when combined with other variables that reflect advances in development that overshadow any influence of literacy.

8.6. Policy Application and Discussion

Population Policy

The Commission on Population (POPCOM) was founded in 1969 and over the decades its structure, direction and effectiveness has varied through the Philippine's periodic change of leadership³⁴⁰ A Six-Year Directional Plan was implemented from 1998-2003.³⁴¹ This was followed by the Medium Term Philippine Development Plan (called *Angat Pinoy 2004*). Through these efforts, the Philippine government set a path to provide preferential treatment to the most disadvantaged Filipinos.

³⁴⁰ POPCOM Directional Plan. <http://www.popcom.gov.ph/pdf/PPMPDirectionalPlan.pdf>

³⁴¹ Philippine Population Management Program (PPMP)

The country's goal was to achieve a replacement fertility rate of 2.1 by 2004 (note that this has not been achieved). Its primary health focus in this effort has been within the realm of family planning and contraception programs, as studies in the late 1990s indicated that there was a one child gap between desired fertility (2.7) and actual fertility (3.7).³⁴² Ultimately the government's official position stems from the 1987 constitution, which "gives couples the responsibility to decide how many children to have in accordance with their religious beliefs and the demands of responsible parenthood for sustainable development."³⁴³

Many critics of the government note that the language and policies of the government are very vague due to the strong influence of the Roman Catholic Church. Much of the official documentation follows internationally endorsed concepts for population management, but implementation of the policies are lacking. One report noted that artificial contraceptives had been completely removed from publicly funded health centers (due to pressure from the Church), severely impairing the ability of Filipinos to exercise informed and free choice in family planning.³⁴⁴ This disproportionately affects the poorest sectors of the country.

Health and Social Policy

Unity is lacking between the Philippine government's policies and their programs regarding population management through health policy. The Philippine Department of

³⁴² National Statistics Office, Department of Health, Philippines. *National Demographic and Health Survey 1998*. Manila: NCO and MI.

³⁴³ Republic of the Philippines. Constitution. 1987. Article II, Declaration of Principles and State Policies, Sections 9, 12, 14, 15 and 16.

³⁴⁴ UPI Asia Online. Population Debate in the Philippines. May 2008. www.upiasiaonline.com

Health's Family Planning program states that one of its basic principles is that "each family has the right and duty to determine the desired number of children they might have and when they might have them."³⁴⁵ The concept that fertility decisions should be made by families and not forced by the state is a positive notion with respect to human rights.

However, the health programs of the government do not provide the information and resources that promote informed decision-making and facilitate the will of the people to limit family size. The Secretary of Health, Dr. Manuel M. Dayrit, has made it clear that the government objects to the provision of contraceptives. In a letter to the editor in the Philippine Daily Inquirer, that reflects official sentiment, Dr. Dayrit states that, "it has never, at any time been my job or the job of the Department of Health to buy contraceptives."³⁴⁶ He goes on to "demystify" the perception that contraceptive are an important component of "women's health, women's rights and health families."³⁴⁷ While contraception is but one component of family health, the complete dismissal of its role in the health of women and their ability to achieve desired fertility contradicts internationally accepted family planning perspectives as endorsed by the World Health

³⁴⁵ Republic of the Philippines, Department of Health, Family Planning Health Program. http://www.doh.gov.ph/programs/natural_FP

³⁴⁶ Manuel M. Dayrit, Secretary of Health, Letter to the Editor, Philippine Daily Inquirer, September 17, 2004. http://www.doh.gov.ph/national_FP

³⁴⁷ Ibid.

Organization.³⁴⁸ A primary driver in the Philippine government's rejection of artificial birth control is the strong influence of the Roman Catholic Church.³⁴⁹

The Health Department's currently published family planning program is dated, and continues to cite goals that were set for 2004. As would be expected, these goals include reductions in maternal mortality, infant mortality, and total fertility.

Interestingly, the plan also spells out goals of increasing contraceptive prevalence rates and the proportion of modern family planning methods in use.³⁵⁰ This contradicts the current official policy stated by Dr. Dayrit.

It is possible that the relative lack of family planning resources, which would assist families in translating changes in *desired* fertility into changes in *actual* fertility, contributes to the lack of significance in the analysis of the data for the Philippines.

Despite the constraints in statistical significance, the analysis does indicate the Philippines may be able to best impact fertility through health policy which focuses on maternal mortality and the conditions which contribute to those rates. The Philippine government addresses maternal mortality under its child health initiatives.

Philippine policy related to child health and welfare is more philosophically unified and less controversial than its position on family planning policy. On a broad scale, the efforts of the government fall under the *Philippine National Development Plan for Children* (referred to as "Child 21"). This framework strives to address many of the components that are outlined by the United Nations and the MDGs. They include

³⁴⁸ World Health Organization, Promoting Family Planning, http://www.who.int/reproductive-health/family_planning/index.html

³⁴⁹ A.N. Herrin, Lack of consensus characterizes Philippine population policy., Philippine Institute for Development Studies, Makati City, Philippines. 2003 Jun. 4 p. (Policy Notes No. 2003-03)

³⁵⁰ Department of Health, Family Planning. http://www.doh.gov.ph/programs/family_planning/profile

maternal mortality, infant mortality, child mortality, immunization, malnutrition, and safe water and sanitation. Education and literacy are also components of the plan.³⁵¹

Of note is the fact that the framework for these initiatives is structured and sponsored by the Philippine Council for the Welfare of Children (CWC), with a mission to cross sectors in the achievement of its goals. Available documents on the health section of the plan lay out multiple objectives for the program but seem to lack specifics of resourcing, accountability and how these goals will be operationalized.

The Child 21 plan originally set medium-term goals to be met by 2004, and long-term goals to be met by 2025. None of the Ministry websites (at this time) address the failures in meeting the goals set for 2004 or how the plan should be changed to ensure progress toward the improvement of child health in the Philippines.

Overall, the Philippine government has acknowledged challenges in the health and social sectors. They also state a desire to reduce fertility rates. However, their approaches appear to fail to link the impact of various health and socioeconomic components to changes in fertility. The Philippine government has stated goals and objectives for improvements in virtually all the categories that the international community has identified as contributing to fertility change. They have developed and/or implemented programs that address specific indicators addressed in this study.

The Philippines appears to lack a comprehensive approach to implementing their stated policies, particularly across sectors. The interdependence of the many health and socioeconomic variables requires a comprehensive approach to both planning and

³⁵¹ Council for the welfare of Children, <http://www.cwc.gov.ph/child21-progress.html>

execution of policy. Resolving the many complex socioeconomic challenges that the Philippines is facing will require dedicated resources and comprehensiveness to achieve a sustained impact. To date, the Philippines efforts appear to be more rhetorical than actionable.

9. Results, Discussion, Conclusions, and Recommendations

Results

This research achieved several tasks. First it evaluated the relationship between fertility and mortality as traditionally reported in the existing literature base. Then, using the global data set assembled here (n=143 countries), the relationship between fertility and child mortality was tested and found to be relatively strong with an $r^2 = 0.7312$ (95% confidence interval).

Next, finding that the leading measure for health status, the DALY, was not well-suited for this research, variables related to child health were evaluated for potential inclusion in a model to represent the dynamics of child health. From a set of 13 potential variables, a *child health* model was created.³⁵² This model was subsequently evaluated as an indicator of fertility change for comparison against the use of the child mortality rate alone. Due to scattered missing data, as well as missing values for entire variables in the early years of the evaluation range, the evaluated data set had to be reduced and the ultimate testing of the four predictor variables was carried out using 293 complete cases.

The *child health* model was found to be strong, with $R^2 = 0.7717$. However, because the status of women in society is known to play an important role in both fertility and child health, the independent contributions of several socioeconomic variables must

³⁵² Variables included in the model are sanitation, maternal mortality, physicians per 1000, and nutrition.

also be considered. Therefore, the model was controlled for the impacts of female literacy and national GNI, which were identified as the socioeconomic variables most related to women and to child health in this data set. With the addition of these controls, the *child health* model was slightly strengthened, resulting in $R^2 = 0.7846$ (95% confidence interval). Due to the reduction of the data set that occurred in the creation of the Child Health Model (i.e., missing data required that some countries be dropped from the analysis), the *child mortality* regression was re-run using the identical data, resulting in $r^2 = 0.7498$.

Table 30. R-squared values for Comparison (using identical cases).³⁵³

| | TFR & CDR | TFR & CMR | TFR & Child Health Model | TFR & SES Model |
|---------------------------|--------------|--------------|--------------------------|-----------------|
| Without control variables | $r^2=0.0687$ | $r^2=0.7498$ | $R^2=0.7717$ | $R^2=0.5923$ |
| With control variables | $R^2=0.5995$ | $R^2=0.7848$ | $R^2=0.7846$ | n/a |

This research finds that at the global level the *child health* model, controlled for women's socioeconomic status, performs slightly stronger as an indicator of fertility change. However, with a 95% confidence interval, the difference between the TFR & CMR model and the TFR & Child Health model, when both are controlled for SES, is not determined to be statistically significant, and this study fails to support the hypothesis

³⁵³ n = 293 cases. 95% confidence interval.

that health measures (as represented by this model) are a better indicator of fertility change than mortality measures alone.

Country Study Observations

The health and socioeconomic models evaluated at the global level were applied to three countries with a diversity of income and development levels. Although limited data sets in all three countries weaken the power of the regression analyses in all three cases, the results are informative for the design of future models for health and/or fertility.

In all cases presented, the strength of the Child Mortality Rate (CMR) over the Crude Death Rate (CDR) as an indicator for fertility change was firmly established. However, the performance of the child health model varied and the significance of the variables within the model also varied (see Table 31).

These country-level evaluations make it clear that the country-level view and the global views can differ significantly. In all cases, the application of the model was informative in the identification of those factors that are most relevant within each unique setting. Expansion of the variables initially considered (in essence, repeating the winnowing process that had first been conducted at the global level) could assist in designing predictor models that are tailored to the unique aspects of each country.

Table 31. Summary of findings.

| | Hypothesis #1 CMR stronger than CDR | Hypothesis #2 Health Model stronger than CMR | Hypothesis #3 Health/Mort stronger than SES alone | Comments |
|-------------|---|---|--|--|
| GLOBAL | Supported | Not supported | Supported | Statistically equivalent |
| INDIA | Supported | Not supported | Not supported | Maternal mortality and female literacy was strongest model. Models equivalent. |
| MEXICO | Supported | Not supported | Supported | Sanitation alone was statistically equivalent to CMR. |
| PHILIPPINES | Supported | Not supported | Supported | Significance issues. Maternal Mortality was strongest health variable but not stronger than CMR. |

Discussion

The absence of a single viable indicator for health is a major constraint to being able to truly represent the comprehensive health impacts that are hypothesized to predict fertility change. The DALY, despite its flaws, shows promise toward accomplishing this end, and as it becomes more refined, consistent, and robust, researchers may find that its comprehensive reflection of population health will provide many additional insights into population behavior, including fertility change.

That both mortality and health measures are strong predictors of fertility change is not surprising. Health is closely tied to death, and changes in morbidity patterns will

certainly create changes in mortality patterns.³⁵⁴ When applied specifically to child mortality and morbidity, the dynamic is magnified because of the proximity of birth and death. This facilitates the behaviors of replacement and anticipatory loss because families experiencing child loss are likely to still be in a child bearing stage, and the social and economic utility of children would be relatively constant in such a short timeframe. In this sense, child mortality is more elastic than population mortality and an increase in the child mortality rate will likely create an increased demand for additional children.

At a minimum, the results indicate that the use of a child health model performs no worse than mortality as an indicator for fertility change at the global level.³⁵⁵ That comparability reflects the close association of the two. The failure of the child health model to be a *significantly stronger* predictor of fertility change, as was hypothesized, may be due to several factors.

Primary among these is, of course, that the premise upon which the hypothesis is based is flawed. It could be that population health, generally, and child health, specifically, are neither more reflective nor more responsive to health changes in a population than mortality measures alone. However, there is some evidence to the contrary. Although data for the DALY is extremely limited, we can get a glimpse of what it may hold by looking at the single year for which country level data have been published (n=192, 2002). A correlation between the country-level TFR and the country-

³⁵⁴ Using the data set for this research, the child mortality rate and child health model have an $R^2=0.8207$.

³⁵⁵ Child health models at the country level need to be tailored to reflect the most significant child health variables for each country and then evaluated to determine their utility as indicators of fertility change in those countries.

level all-cause DALY rate (per 100,000 population) is $r = 0.8229$, and between country-level TFR and the country-level Communicable Disease DALY rate is $r = 0.8318$. These regressions are calculated using the 143 countries that served as the baseline for this research (with a 99% confidence interval). Both relationships are significantly stronger than that between TFR and CMR. A multiple regression between the country-level TFR and all the three components of the country-level DALY rate (communicable, non-communicable and injury) has an $R^2 = 0.7944$ (with a 99% confidence interval).

The DALY data currently lack a temporal dimension that precludes its use for broader testing, but this preliminary evidence shows that there is reason to believe that a validated measure for morbidity provides a more comprehensive reflection of the population health situation and thus provides a better indicator for fertility change. The use of such a measure has potential to inform health policy on interventions and programs that will not only improve health status, but also impact population growth.

As demonstrated in the preceding country level analyses, many countries are dealing with an array of issues surrounding population growth. One of the countries had, at one point, used the rather draconian measure of forced sterilization to control fertility levels and bring down growth rates. Although all three of these countries now officially endorse individual choice in reproductive decisions, the case studies illustrate some interesting dynamics in the effectiveness of different approaches.

The most challenged of these countries is India. As the second most populous country in the world and one of the poorest countries outside of Africa, even its moderate growth rate exacerbates its range of socioeconomic difficulties. Despite the growing

evidence base that shows that improvements in health and socioeconomic status have a strong influence on fertility rates, India's national policies have not fully embraced, either in planning or implementation, efforts that target fertility rates within a socioeconomic context.

The cornerstone of India's health system is its family planning program, and citizens have expressed a reluctance to seek health care because they feel berated about their fertility decisions. Additionally, India continues to endorse coercive and punitive measures to influence fertility decisions, including the withholding of electoral rights for high fertility states. India has yet to design and implement policies that seek to improve health, education, and social standing, all of which impact fertility decisions at the most fundamental level.

The most progressive of the countries studied by far, Mexico does not come into its modern policy development from a history of strict population control approaches. Historically pro-natalist, and still strongly influenced by the dominance of Roman Catholic teachings against birth control, the Mexican government approached population control in a more socially responsive way than most other less developed countries. With a growing economy that provided financial resources, Mexico invested heavily in social programs. Under the guidance of forward-thinking economists, the country implemented a cross-sector cash transfer program that simultaneously addressed health, education and social poverty factors with the intent of breaking the intergenerational transmission of poverty that lends itself to high levels of fertility. The outcomes have been extremely

positive and programs are now expanding and evolving to target the neediest areas of society and mitigate inequities.

The Philippine approach to population growth seems wrought with contradiction. This may well stem from both political and economic instability in recent decades. As its economy strengthens, the promise for greater investment in social infrastructure and programming is encouraging. The current government appears to be actively planning for health improvements that would help mitigate growth rates. Interestingly though, the government lacks commitment on provision of contraceptives, a critical component of family planning, women's and child health, and population growth. Both the Philippines and Mexico have strong Roman Catholic influences in the arena of social policy; however, where Mexico has found common ground that still allows them to promote artificial birth control, the Philippines maintains policies opposed to artificial means of contraception. Without a commitment to health infrastructure and programming that provides the basic resources that allow families to translate *desired* fertility into *actual* fertility, the Philippines may be sabotaging its own goals of reducing population growth. Many of the factors addressed in this research center around changing families' desired fertility levels. Changing desired fertility levels without a means to bring actual fertility in alignment with it may be an exercise in futility.

All three countries have long roads to travel in their attempts to control growth patterns, particularly in their most underserved and impoverished regions. But these country studies demonstrate that investment in health and other social barriers can have an impact on fertility rates and, thus, influence population growth. However, determining

which programs and investments yield the greatest results toward this end is the challenge of policy-makers.

Within health policy, determining which health measures bear most heavily on fertility outcomes will provide a basis for designing effective policies to target population growth at its core. Success in this effort will preclude the need for governments to impose heavy-handed or socially oppressive population control policies.

For countries like India, for which almost half of the disease burden stems from communicable diseases, neonatal conditions, and nutritional deficiencies, and for which child mortality rates are unacceptably high, health policy needs to focus on the most basic measures to improve population health, such as providing information and resources about reproductive health. The nation must redistribute its precious resources to mitigate the vast chasm between the advancing and declining states. This is a situation where a rising tide raises all ships. By improving the status of its most disenfranchised populations, the welfare of the nation as a whole will improve. While the more affluent states improve their health status, decrease child mortality, and drop to replacement fertility levels, collectively India will continue to struggle with population growth and potentially restrained economic advancement based upon the situation in poorer states.

Mexico seems to have identified and implemented socioeconomic policies that look at population issues as a composite of many socioeconomic indicators. Issues of health, education, and poverty are highly interrelated and ultimately none will significantly improve without commensurate improvements in the others. Mexico is also making headway in targeting the disparities within the country. Although substantive

change is not yet seen in Mexico's statistics, policymakers are actively directing resources and designing policies to address these inequities. Change of this magnitude comes slowly, and today's policy makers must make informed and evidence-based decisions that put their countries on the right track, even if measurable change is a decade in the making.

The Philippines, despite having higher income and development levels than India, suffers from political, social, and economic upheaval. But as the government gains stability and its economy grows, the outlook is improving. Finding common ground with proponents of pro-natalist policies will allow Filipinos to achieve lowered actual fertility rates will be critical. But lower rates of desired fertility are achieved and maintained through solid population health programming and social development. In this country, policymakers and politicians must collaborate to bring political will in line with sound policies needed to achieve common goals that will improve the status of the Filipino people.

Conclusions

Although the child health indicators evaluated here were not statistically stronger than child mortality measures in indicating fertility strength, their importance was validated in that they were generally comparable to mortality measures. Even as comparable measures statistically, use of health measures has the advantage of being traceable to policy venues that lend themselves to action. Knowing that child mortality is increasing or decreasing without understanding why does little to inform a strong policy

agenda. But knowing that, for example, lack of sanitation and the resultant diarrheal diseases are major contributors to morbidity and mortality of children, and that this impacts fertility rates, allows policy makers to direct efforts and resources into interventions to reduce the effects of these targeted health issues.

The health of children has multiple determinants, and the strength of specific indicators can vary given the other social, economic, and political factors that shape a country or region. Nutritional levels, access to improved sanitation facilities, and decreases in maternal mortality are among those health-related factors found most relevant in the models evaluated here. Most consistent throughout the three country-level analyses is the strength of maternal mortality's relationship with fertility, which indicates that particular focus in areas that improve maternal survival can have potentially significant benefits in mitigating fertility rates.

Of course, health advocates in all countries are likely already postured to promote interventions to address significant health threats and disease burdens. But all policy makers find themselves juggling competing interests. And governments must use both quantitative and qualitative information to inform their decisions about the allocation of scarce resources. The relative importance of health programs can be buoyed by tying them to other critical national interests. For those countries that have made mitigation of population growth a high priority, health programming can come to the fore as a key component of a cross-sectoral solution. This has been seen in Mexico's PROGRESA program. Rather than compete against other programs for emphasis and funding priority,

health policies became one of the most important pieces of a comprehensive solution not only within the health sector but in national population policies and economic strategies.

The application of health measures as indicators of fertility change adds value in two ways. It facilitates the linkage of changes in fertility levels to specific contributing factors, whereas mortality measures alone do not. These linkages can inform good health policy decisions. Additionally, by associating health status to population growth, health advocates can elevate the importance of health policies among the many competing national priorities. Basically, countries can get more bang-for-their-buck through investment in health programs since investment in health helps address challenges in other sectors as well.

Recommendations for Future Research

Countries that are facing challenges of population growth, whether nationally or regionally, should actively incorporate population health measures in evaluating fertility change. Child health measures are particularly relevant, given the impact that child morbidity and mortality have on *anticipatory loss* and *replacement* behaviors. Keeping children healthy and enhancing survival into adulthood removes some of the socio-cultural and economic motivators that encourage higher fertility.

Efforts must continue to be made to refine health status measures such as the DALY. Validating the measures across time and in many countries is critical, and once this type of information is widely available longitudinally, countries will be able to more accurately relate changes in fertility, and in other social and economic behaviors, to

variations in health status, disease prevalence, and effectiveness of health interventions. These efforts will be significant in informing not only health policy decisions, but policy and programming decisions across most sectors of government.

Many potentially significant health-related variables that were considered for this research had to be excluded due to lack of adequate data. As the capacity of governments to collect critical population and health data improves, those variables should be evaluated in this context. Fortunately, with the focus on the Millennium Development Goals these datasets are growing continually. Each country should evaluate health measures to determine their impact on fertility rates within their unique situations. Policy-makers can leverage the results to positively impact both health and population policies.

The regression models employed in this research make no attempt to evaluate or imply causality. Further work to identify causal factors, both primary and intermediate, as well as direction, would be useful in designing policy and programming.

Additionally, as the data sets expand, and more longitudinal data becomes available, there would be value in exploring the relationship between child health changes and fertility changes by incorporating a generational lag. Evaluating these data with a minimum of a 15 year lag would approximate generational change in which attitudes and beliefs adjust based upon experiences of the previous generation. In other words, if child survival impacts fertility decisions because parents trust that survival has improved, those impacts may not be apparent immediately.

There are extensive opportunities for continued evaluation of the impact of health on fertility change. As monitoring of potential indicators increases and data improve in both quality and availability, evaluation of health measures will be valuable tools for policy makers in countries in many stages of development. The outcomes of ongoing research in this realm will inform politicians and policy-makers by improving the evidence-base for prioritization in resourcing health interventions among the multitude of competing policy interests. This will ultimately allow the design of health policies that will not only improve the health within each society, but also impact important outcomes such as fertility and population growth.

Appendix A – Acronyms

ARI – Acute Respiratory Infection

CBR – Crude Birth Rate

CDR – Crude Death Rate

CENEPI – Brazil’s National Epidemiology Center

CMR – Child Mortality Rate

DALY – Disability Adjusted Life Year

GBD – Global Burden of Disease

GDI – Gender-related Development Index

GDP – Gross Domestic Product

GEM – Gender Empowerment Measure

GNI – Gross National Income

FAO – Food and Agriculture Organization of the United Nations

FUNASA – Brazil’s National Health Foundation

HDI – Human Development Index

HDR – Human Development Report

ILO – International Labour Organization

IMR – Infant Mortality Rate

IMSS – Instituto Mexicano del Seguro Social

IPU – Inter-Parliamentary Union

ISM – Indian System of Medicine (India)

ISSSTE – Mexico’s Institute of Social Security and Social Services for State Workers

ITU – International Telecommunication Union

MDG – Millennium Development Goal

NDG – National Development Goals (India)

NPP – New Population Policy (India)

OECD – Organization for Economic Development and Coordination

ORT – Oral Rehydration Therapy

PAHO – Pan American Health Organization

PAISM – Brazil’s Program for the Integral Assistance to Women’s Health

PEMEX – Mexico’s Petroleum Industry

PRB – Population Reference Bureau

PROGRESA – The Education, Health and Nutrition Program of Mexico

PPP- Purchasing power parity

PSF – Brazil’s Family Health Program

QALY – Quality Adjusted Life Year

SEDENA – Mexico’s National Secretariat of Defense

SES – Socioeconomic status

SS – Sector Salud (Mexico’s Social Security)

SSAM – Brazil’s Complementary Medical Care System

SUS – Brazil’s Unified Health System

TFR – Total Fertility Rate

UN – United Nations

UNDP – United Nations Development Programme

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNFPA – United Nations Population Fund

UNICEF – United Nations Children’s Fund

USAID – United States Agency for International Development

WB – World Bank

WDI – World Development Indicators

WDR – World Development Report

WHO – World Health Organization

YLL – Years of Life Lost

YLD – Years Lived with Disability

Appendix B – Countries and Regions

Analysis for this research is conducted at the global, regional and country levels. The baseline for consideration in all analysis is the country listing reported by the World Bank. There are 209 countries on which the World Bank (WB) reports. These include 195 member countries and all other economies with populations of 30,000 or more.

There is, however, much data pulled from other sources, and the differences in reported countries and the overall availability of data require that adjustments be made to this baseline country listing for much of the analysis. Exclusion criteria for country-level analyses are provided below.

The definitions of the United Nations Development Regions are also outlined.

World Bank Countries and Regions

For regional-level analysis, the World Bank categorizes countries by income level based upon their 2006 Gross National Income per capita. There are four regions based on income strata. A by-name listing of countries follows at the end of this appendix.

Figure 49. World Bank Income Strata.

| World Bank Region | GNI Criteria | Number of countries (n=209) |
|--------------------------|---------------------|--|
| Low income | \$905 and less | 53 |
| Lower Middle income | \$906-\$3595 | 55 |
| Upper Middle income | \$3596-\$11,115 | 41 |
| High income | \$11,116 or more | 60 |

Country-level Analysis Inclusion/Exclusion

The baseline for consideration is the **209** countries reported in the World Bank World Development Indicators dataset. This listing was then bumped against other key data sources to identify differences in data inclusion and availability. Based upon this comparison, the following 32 WB-listed countries are excluded from country-level analysis because they are not routinely reported by either the World Health Organization or the United Nations.

| | |
|---------------------|--------------------------------|
| Andorra | Faeroe Islands |
| Antigua and Barbuda | French Polynesia |
| Dominica | Greenland |
| Hong Kong, China | Guam |
| Liechtenstein | Isle of Man |
| Marshall Islands | Kiribati |
| Monaco | Macao, China |
| Palau | Mayotte |
| San Marino | Netherlands Antilles |
| Seychelles | New Caledonia |
| St. Kitts and Nevis | Northern Mariana Islands |
| American Samoa | Puerto Rico |
| Aruba | St. Lucia |
| Bermuda | St. Vincent and the Grenadines |
| Cayman Islands | Virgin Islands |
| Channel Islands | West Bank and Gaza |

Due to the relatively recent break-up of the former Yugoslavia, time series data on these 6 newly formed states are not readily available from all sources. Therefore, the following countries are excluded from country-level analysis.

| | |
|--------------------------------|------------|
| Bosnia and Herzegovina | Montenegro |
| Croatia | Serbia |
| Yugoslav Republic of Macedonia | Slovenia |

Following data compilation, the following countries had no reported data for total fertility rate (TFR) for the target periods. Due to the essential nature of this variable, these 24 countries were excluded from the analysis:

| | | |
|-------------------|------------|---------------------|
| Barbados | Fiji | Qatar |
| Belize | Grenada | Samoa |
| The Bahamas | Guyana | Sao Tome & Principe |
| Cape Verde | Iceland | Soloman Islands |
| Comorros | Luxembourg | Somalia |
| Cyprus | Maldives | Suriname |
| Djibouti | Malta | Timor-Leste |
| Equatorial Guinea | Micronesia | Tonga |

Four additional countries were excluded from analysis because they were missing more than 50% of the data points being considered:

| | |
|-------------|-----------|
| Afghanistan | Brunei |
| Bahrain | Lithuania |

Due to reunification and break-up of formerly sovereign states, there is special consideration paid to the following:

Germany – Germany will be represented in its reunified state. In any case where East and West Germany are listed separately, and time series data are missing for one or both of the German Democratic Republic (East) and/or Federal Republic of Germany (West), the data will be displayed as missing.

The former Soviet States – With the declared dissolution of the Soviet Union in 1991, fifteen new states were subsequently established. Each of these states will be included in their current form for country-level analysis.

The former Czechoslovakia – The Czech Republic and Slovakia were established in 1993 following the peaceful dissolution of Czechoslovakia. Both of these states will be included in their current form for country-level analysis.

In summary, from the initial **209** World Bank-reported countries, 32 countries are excluded because they are not reported through all primary data sources, 6 countries are excluded because their relatively recent political restructuring precludes the availability of consistent longitudinal data, 24 are excluded because they do not have fertility data reported, and 4 are excluded due to excessive missing data throughout all variables. There are **143** countries ultimately included in the analysis at the country level. (A complete listing is provided at the end of the appendix).

United Nations Development Regions

Another regional configuration useful for analysis is the United Nations development regions: More developed, Less developed, and Least developed. All the country designations for these regional configurations are listed at the end of this section. Designations for the “more” developed regions and the “less” developed regions are categorized by the UN for statistical convenience. More developed regions include all of Europe, North America, Australia, New Zealand, and Japan. Less developed regions

include all of Africa, Asia (excluding Japan), Latin America and the Caribbean, Melanesia, Micronesia, and Polynesia.

The Least developed countries were defined by the United Nations General Assembly in 2003 and include 50 countries (34 in Africa, 10 in Asia, 1 in Latin America and the Caribbean, and 5 in Oceania). A Least developed country must have a population less than 75,000 and not exceed thresholds for three criteria including low-income levels, human resources weaknesses, and economic vulnerability.³⁵⁶

Figure 50. UN Development Regions.

| UN Development Regions | Number of countries (n=143) |
|---|------------------------------------|
| Least Developed | 37 |
| Less Developed (minus Least Developed) | 62 |
| More Developed | 44 |

Note that countries that have been excluded at the country-level may not be excluded at the regional level if regional calculations are published by the originating sources, such as the WHO, UN or World Bank, and are not disaggregated.

³⁵⁶ Detailed criteria and current thresholds are available at <http://www.un.org/special-rep/ohrls/ldc/ldc%20criteria.htm>.

Figure 51. Country Listing and Regional Configuration.

| <i>WB Countries (n=209)</i> | <i>WB Income Groups</i> | <i>UN Development Regions</i> | <i>Excluded from country-level analysis</i> |
|-----------------------------|-------------------------|-------------------------------|---|
| Afghanistan | Low income | LEAST | X |
| Albania | Lower middle income | MORE | |
| Algeria | Lower middle income | LESS | |
| American Samoa | Upper middle income | | X |
| Andorra | High Income | | X |
| Angola | Lower middle income | LEAST | |
| Antigua and Barbuda | High Income | | X |
| Argentina | Upper middle income | LESS | |
| Armenia | Lower middle income | MORE | |
| Aruba | High Income | | X |
| Australia | High Income | MORE | |
| Austria | High Income | MORE | |
| Azerbaijan | Lower middle income | MORE | |
| Bahamas, The | High Income | LESS | X |
| Bahrain | High Income | LESS | X |
| Bangladesh | Low income | LEAST | |
| Barbados | High Income | LESS | X |
| Belarus | Lower middle income | MORE | |
| Belgium | High Income | MORE | |
| Belize | Upper middle income | LESS | X |
| Benin | Low income | LEAST | |
| Bermuda | High Income | | X |
| Bhutan | Lower middle income | LEAST | |
| Bolivia | Lower middle income | LESS | |
| Bosnia and Herzegovina | Lower middle income | | X |
| Botswana | Upper middle income | LESS | |
| Brazil | Upper middle income | LESS | |
| Brunei Darussalam | High Income | LESS | X |
| Bulgaria | Upper middle income | MORE | |
| Burkina Faso | Low income | LEAST | |

