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Impact on economic  
growth of investing in  
maternal–newborn health

Karl Wilhelmson  
Ulf-G. Gerdtham

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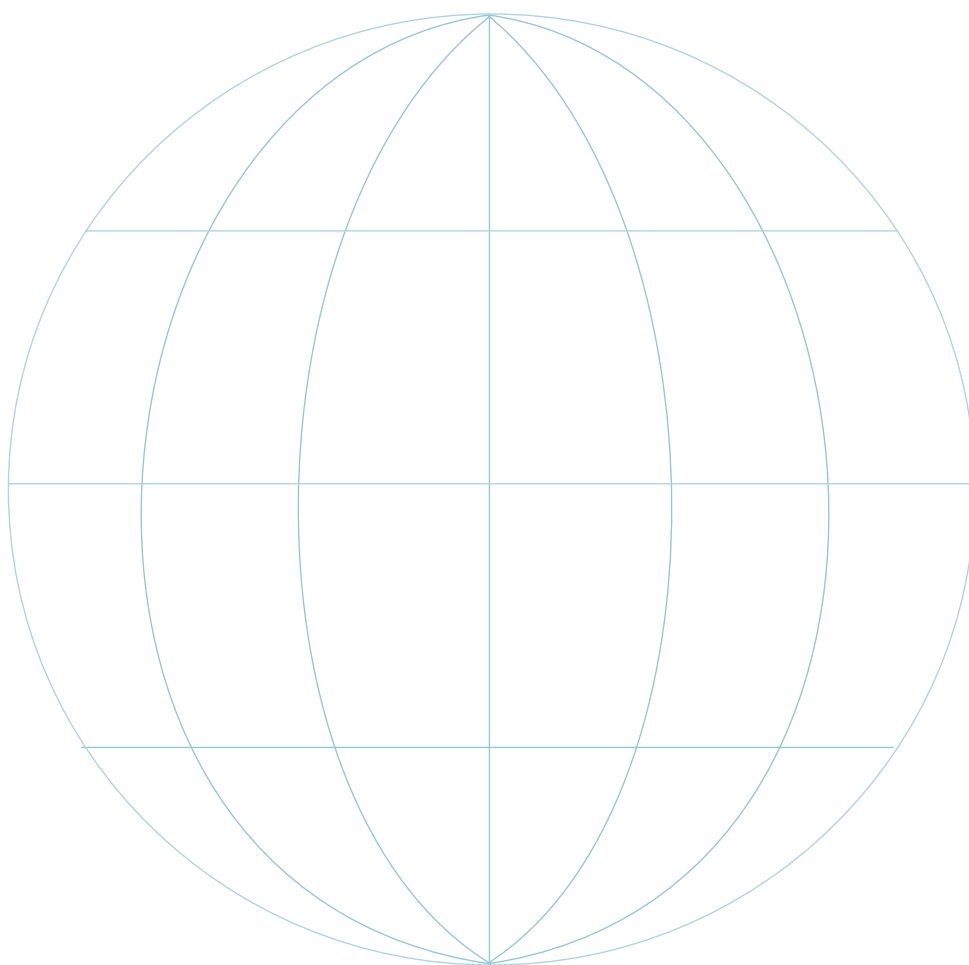
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Moving towards universal coverage  
**Issues in maternal–newborn health and poverty**

Impact on economic growth  
of investing in maternal–newborn health

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## Acronyms

AIDS	Acquired immunodeficiency syndrome
GDP	Gross domestic product
GLS	Generalized least squares
MNH	Maternal–newborn health
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PPP	Purchasing power parity
SDP	State domestic product
WHO	World Health Organization

## Abstract

The aim of this paper is to provide a systematic review of the evidence of the impact on economic growth of investments in maternal–newborn health (MNH). The methodology used for the review includes a systematic search for published literature in relevant electronic databases. In the paper, we review five studies: four empirical and one theoretical. One of the empirical papers measures health by infant mortality. The study finds that a 1/1000-point reduction in the infant mortality rate leads to an increase in the level of State Domestic Product by Indian Rs 2.70 and an increase in the average growth rate per year of 0.145%. Similar results are reported for other health measures in other studies. Our main conclusion, however, is that the area lacks research and that considerably more is needed before any advice can be provided to policy-makers about the contribution to growth of investments in MNH. Specifically, first and foremost, studies are needed that explicitly analyse the impact of MNH on level and growth of output. Second, we suggest the use of more comprehensive MNH measures that consider the health of both mothers and newborns and aspects of ill-health other than death, such as measures of quality of life, functional limitations, mental health and sickness absenteeism. Third, estimates of the effects of MNH on growth need to be controlled for other health dimensions, i.e. aspects that may confound the impact of MNH. Fourth, studies are needed of the effects on determinants of growth in order to understand better the links between MNH and growth. Fifth, studies based on smaller geographical areas within countries and longer time series are needed, in order to obtain more precise estimates and also better estimates of the long-term growth paths. Finally, we suggest compilation of other data sets on microeconomic data, for example, to study effects at firm level of MNH on labour productivity through inability to work, disability, sick days, etc.

**Key Words:** Maternal–newborn ill-health (MNIH), Economic growth, Health, Systematic review







# 1. Introduction

## 1.1 Background

Maternal–newborn ill-health refers generally to health problems related to pregnancy and delivery (1, 2). Maternal–newborn ill-health includes both maternal morbidity and mortality. Maternal morbidity is often defined as any illness or injury caused or aggravated by or associated with pregnancy and childbirth. The five major causes of maternal deaths are haemorrhage, eclampsia, unsafe abortion, sepsis and obstructed labour (3).

Each year, more than half a million women die and 30–60 million suffer severe illness as a result of serious maternal complications (4). The World Health Organization (WHO) estimates that 42% of the approximately 129 million women who give birth annually (according to the United Nations) experience at least mild complications during pregnancy (5, 6). Furthermore, estimates suggest that 15 million women annually develop long-term disabilities attributable to pregnancy-related complications (6). Recent studies in four developing countries show that 58–80% of pregnant women develop acute health problems. Of these, between 8% and 29% develop chronic health problems as a result of pregnancy (7). The *World development report 1993* estimates that 18% of the burden of disease for these women is from maternal causes; an additional 16% is from AIDS and other sexually transmitted infections, which can often lead to or exacerbate problems in pregnancy and childbirth (8).

For the children, infection is the major killer during pregnancy (syphilis) and after birth (syphilis or other bacterial infection). During the first minutes of life, asphyxia as a result of birthing complications can kill the baby if it is not given adequate basic treatment. It is estimated that more than 8 million infants die each year, one half of them within the first month of life and a large proportion within a few days of birth (9). During the first days of life, cold injury (hypothermia) is a major risk, often interacting with low birth weight or infection and low birth weight attributable to intrauterine growth retardation and/or preterm birth: in developing countries, over 22 million low-birth-weight babies are born each year, corresponding to 20% of all births (10). Failure to initiate early and full breastfeeding

contributes significantly to mortality in the newborn period (from birth through the first 28 days of life).

Along with the high risk of death associated with pregnancy and childbirth, women in the developing world are at an even greater risk because of the high-fertility norm. Poverty, social and cultural prejudices, gender-based violence, lack of education and less access to essential health-care facilities also contribute to poor maternal health. Cost, distance and quality of services, cultural barriers (for example, many women prefer to deliver in the privacy of their own homes, perhaps assisted by a relative or traditional midwife) and barriers related to knowledge and education (some may lack knowledge about the potential complications of delivery and about the availability of health care to deal with them) are the obstacles to using essential obstetric care services. Patients who make a timely decision to seek care may still experience delay because of their inaccessibility to health services (11). This outline provides a general idea of the scope of the problem, even if no reliable population-based statistics are available on the causes of maternal mortality and morbidity in most parts of the world.

The vast majority of maternal deaths occur in poor countries, mainly in Asia and sub-Saharan Africa, where infant mortality and morbidity are extreme compared with developed countries (9). Despite international programmes to reduce child mortality, the situation in sub-Saharan Africa has been the most disappointing: 27 of the 30 countries with the highest child mortality are situated in the region. The decline in child mortality in that area has been about half of that in South-East Asia and about a fifth of that in Latin America (12). Unprecedented gains in health have been achieved in the second half of the 20th century (13) but the goal of an under-five mortality rate of 70 per 1000 live births in sub-Saharan Africa by the end of 2000, declared at the 1990 World Summit for Children and the 1994 International Conference on Population and Development, has not been met. In 2000 the rate was 175 per 1000 live births (14).

An understanding of the links between maternal–newborn health (MNH) and poverty and/or economic growth is imper-



ative, so as to be able to assess and improve the situation. Research in the area seems to be inadequate, and a concise review of available knowledge and experience about investing in MNH for poverty reduction and socioeconomic development is not available.

## 1.2 Aim of the study

This paper reviews the evidence of the impact of MNH on economic growth. It focuses on the following questions: (i) what is the evidence of a causal effect of MNH on economic growth? (ii) what is the evidence of a causal effect of MNH on the determinants of growth? and (iii) what is the likely effect on growth of investing in MNH in low- and middle-income countries? We make a search for relevant studies, review methods, data and results and identify gaps in evidence.

## 1.3 Outline of the study

The review is ordered as follows. Section 2 provides a brief description of the theory of economic growth and its principal sources, including MNH. Section 3 describes methods and results of the literature search. Section 4 discusses methods at a general level and Section 5 presents details of the methods and results of each selected study. Section 6 presents conclusions and suggests areas for further research.fer payments (since at the end societal resources do not change). Transfers may be taxes for health-care consumption or reimbursements for income loss attributable to illness. Nonetheless, there is dead-weight loss of taxes, so this would be the cost involved from a societal viewpoint.



## 2. An overview of the theory of economic growth

### 2.1 The factors behind economic growth

The Solow model (15) is the theoretical benchmark for most studies of long-run growth of output (typically measured by growth of real gross domestic product (GDP): the value of all the goods and services produced in an economy during a year) and it explains how saving, investment and growth respond to population growth and technical change. The model is characterized by a production function that explains the level of output and includes two input factors: labour and capital (physical and human capital). Economic growth is then determined by the amount of available capital in the economy, the efficiency with which the capital is used and the degree of its employment. Population growth and increases in physical capital lead to growth if the new resources are employed in the production process of the country. Improvements in the productivity of the human capital and physical capital stocks lead to increased efficiency and enhanced growth. Growth of and investments in human and physical capital increase the capital stock, provided that the investments and growth are greater than the depreciation. Human capital investments consist of education attainment, training and better health. Since the available resources of the economy are not employed at all times, the rate of employment is directly related to economic growth (16).

The model predicts a stable steady-state output growth which is limited to population growth (in equilibrium), meaning that per capita output is constant over time. (Steady-state equilibrium is an equilibrium in which each variable is either constant or growing at a constant rate.) Growth is also influenced, however, by rates of saving and technical change which explain growth in per capita output, i.e. technical changes of total factor productivity determine changes in output growth with unchanged input of labour and capital. Population growth, savings and technical changes are exogenous variables (variables that are not determined in the model). The model also predicts “conditional convergence”, which states that economies with low initial values of per capita output (poor countries) grow faster than countries with higher initial per capita output (rich countries). These predictions follow from the basic assumptions

of a constant-returns-to-scale production function with diminishing returns to capital and labour. This means that increases in, for example, the amount of capital (input of labour unchanged) lead successively to smaller increases in output – the lower the ratio of capital per capita, the higher the return to investing in capital. Using this model, Solow shows that the rates of saving and population growth determine the steady-state level of income per capita across countries but that countries reach different steady-states because of variations in the key factors that determine the level of steady-state.

Following Solow, a number of growth models have been developed on the issue of endogenous growth (i.e. what factors determine the steady-state income levels) in a variety of ways. In these models, technical change may be endogenous and the important issue is to explain the rise in productivity attributable to technical change. Mankiw et al. (17) contributed to the Solow model by including accumulation of human capital, typically in the form of educational attainment. Health has also long been accepted as an important determinant of human capital and hence factor productivity. A basic element of Grossman’s demand-for-health model (18) is that health provides utility not only directly but also indirectly, since it is a key input into many production processes, and health is therefore both a consumption good and an investment good; health differs from other human capital in that it determines the total amount of healthy time available, whereas educational attainment affects the productivity of the time spent on market or non-market activities. Two aspects of the effect of health on productivity have been considered in the endogenous growth literature: the direct effect of health on the production process (e.g. better maternal health can increase productivity by reducing inability to work, disability, sick days, etc.) and the spillover effects (e.g. better maternal health can result in reduced informal care time required by family members and friends who may also be part of the labour force). Better maternal health can also lead to more money being available for children’s health care, education and food, which may lead to improvements in future productivity. Drawing on the theory above and cross-sectional international data,

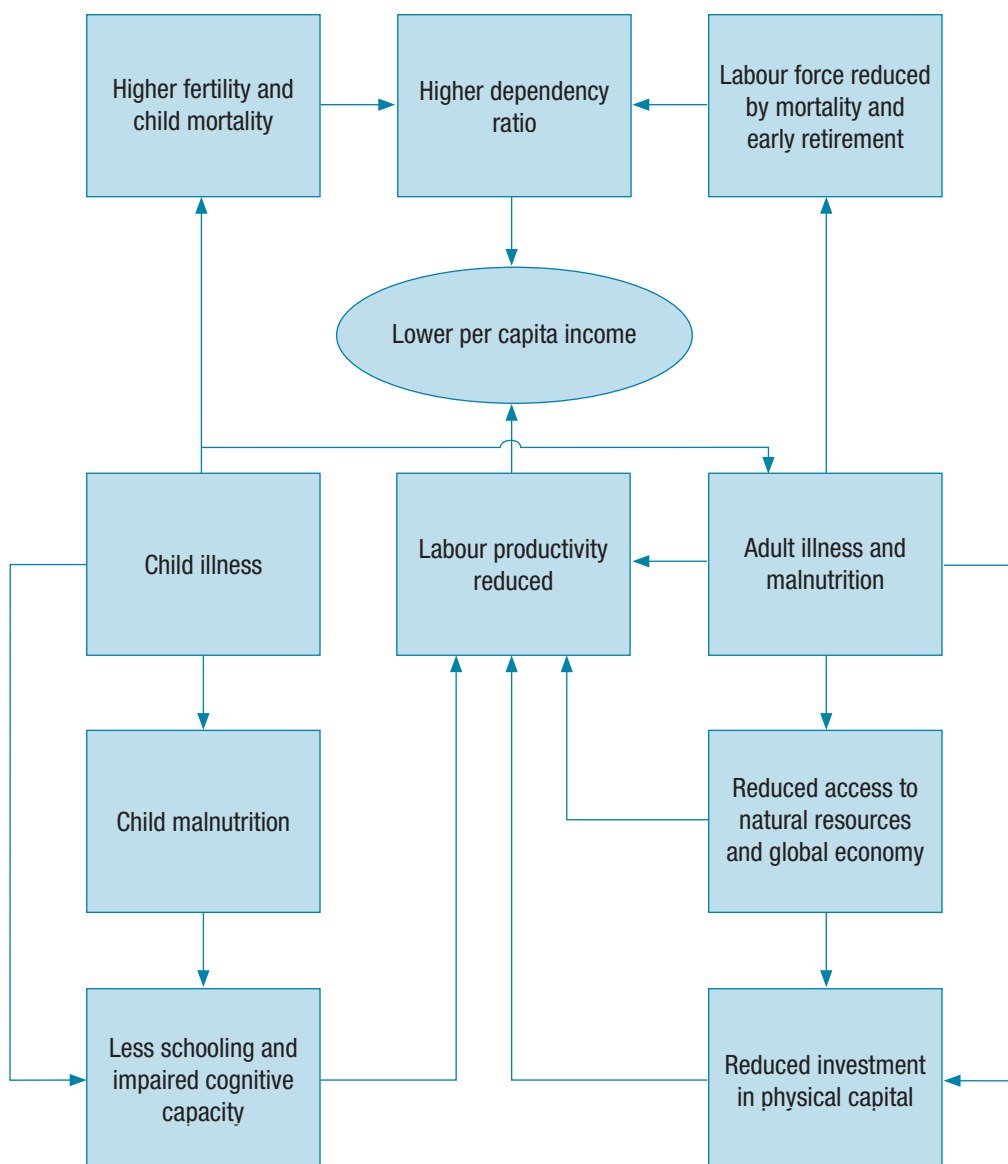


Knowles & Owen (19) show a strong and robust relationship between health capital and per capita income and explain that the effect on income from human capital is greater from health capital than from educational human capital.

There are many potential channels through which health may affect economic growth. Figure 1, adapted from Ruger et al. (20), provides a summary of these factors. Labour force ageing, high fertility and child mortality, as well as reduced

quantity and quality of the labour force (e.g. through mortality and early retirement), increase the dependency ratio (which may be seen as a measure of the unemployment of human capital in the economy), which reduces per capita income. Effects of illness and malnutrition may be divided into child and adult components that determine the level of labour productivity. The adult components have a direct effect on labour productivity and indirect effects through reduced access to natural resources and the economy.

**Figure 1. Factors that may affect economic growth**



Source: adapted from Ruger et al., 2003 (20).

Lower labour productivity also results from reduced investments in physical capital attributable to impaired access to resources and an inability to a direct physical contribution. Child illness affects labour productivity indirectly through less schooling and impaired cognitive abilities caused by malnutrition. Further, an individual's health as a child also partly determines health status as a grown-up.

concentrated on macroeconomic studies and this review therefore focuses on that aspect of MNH.

## 2.2 Maternal–newborn health and economic growth

The impact on economic growth of MNH may be illustrated using Figure 1. The dependency ratio increases and labour productivity decreases in relation to higher fertility, child mortality and child illnesses. Poor households and regions show a high infant mortality rate, which is compensated for by a high fertility rate (giving a higher dependency ratio). The increase in fertility causes families to incur increased costs both for surviving and non-surviving children, which reduces investments in education and health per child as well as for adults (leading to lower labour productivity). This necessarily reduces the formation of human capital. Maternal mortality and morbidity have negative effects both on the dependency ratio and on labour productivity. Higher mortality and morbidity affect income adversely, e.g. by reducing the number of hours worked, which leads to an increased dependency ratio. Maternal illness may be caused by ill-health as a child as well as by illness and malnutrition in adult life (20, 21). [See Islam & Gerdtham (22) for an extensive discussion about the consequences of maternal–newborn ill-health.]

## 2.3 Health and economic growth studies

Microeconomic studies generally focus on the links between human resources (such as educational level) and labour market outcomes (such as wage rates) using individual and household data. Investments in health contribute to the productivity of an individual directly, through, for example, a lower level of sick leave, and also complement education and investments in physical capital, in order to employ fully both types of capital stock. Macroeconomic studies assess the effect of health on national income in comparisons between countries (20). Current research in MNH is



### 3. Methods and results of the literature search

#### 3.1 Search method and selection criteria

A systematic search of electronic databases for work in the area was performed in two steps.

STEP 1. Farooq (22) performed searches in a wide variety of databases within the area of this review. The search was performed using combinations of maternal, infant, neonatal, newborn health and poverty (used for searches in all review areas) with the addition of development, economic development, human development, investment, intervention, poverty reduction and trial, for the time period 1990–2003. Farooq supplied information about these searches and we used the results of her searches as a first step and evaluated the papers selected by her.

STEP 2. We extended the search by using the databases IDEAS, Science Direct (Elsevier), MedLine, InterScience (Wiley), Blackwell, ECONbase, PubMed, Lancet, British Medical Journal (BMJ), the New England Journal of Medicine (NEJM) and the National Bureau of Economic Research (NBER). The time period was 1990–2004, using combinations of maternal, newborn, neonatal, health, economic growth, economic development, poverty, human capital, education, schooling, work experience, life expectancy, technology, productivity, trade, institutions, savings and investments.

After each search step, we performed an initial review of the hits and assessed the papers by evaluating the abstracts and choosing the ones to be included. The assessment followed the procedure indicated in Figure 2.

#### 3.2 The initial search and extended search

STEP 1. After assessment of the papers listed by Farooq, none was included in the review.

STEP 2. The results are presented in Table 1. As a first step, a brief review of the papers in the search was made, leading to a selection of papers to be further evaluated.

After initial assessment, 10 papers were selected for inclusion in the review. Once they had been studied, only five were judged to be relevant: Blackburn & Cipriani (23), Bloom et al. (24), Gupta & Mitra (21), Jamison et al. (13) and Ranis et al. (25). The paper by Blackburn & Cipriani is theoretical where the causality accords with our interest (health→growth) and the potential independent variable is infant mortality. The other four papers are empirical: Gupta & Mitra deal with the analysis of infant mortality and economic growth; Bloom et al. and Ranis et al. use life expectancy as health measures; and Jamison et al. use adult survival rate for males 15 years and over as the health measure. We include these four articles considering that the health measures used are

**Figure 2. Factors for the summary and assessment of each study**

#### OVERALL ASSESSMENT

- Determine: type of paper, study or review, aims, methods, country or countries in the study (low- or middle-income), participants and sample, sampling technique.
- Causality (MNH → economic growth/determinants of economic growth) investigated.
- Definition of health and economic measures.
- Quantitative measures of health and economic impact.
- Assumptions and sensitivity analysis.

#### INCLUSION OR EXCLUSION

- Based on the assessment, determine inclusion of the paper if the country is low- or middle-income, the paper contains health and economic impact measures, the causality is correct and the method used permits quantitative measures to be calculated.

#### ASSESS

- Quantitative health and economic measures.



related to MNH. All five selected articles are discussed in Section 5. The five excluded articles did not deal with MNH or display the causality of interest.

When performing the search, we noted that all of the included articles dealt with health and growth using a macroeconomic approach. To ensure that all efforts were made to find studies at the microeconomic level as well, we performed an additional search where we used combinations of the search words: maternal, infant, neonatal, newborn, health, economic growth, poverty and wage, but no relevant articles were found.

**Table 1. Total hits presented by database**

Database	No. of hits	No. of articles selected	No. of articles for initial inclusion
IDEAS	196	01	00
Science Direct	19	01	01
MedLine	64	05	02
InterScience	89	00	00
Blackwell	03	00	00
ECONbase	318	11	04
PubMed	173	05	01
Lancet	109	06	01
BMJ	03	00	00
NEJM	01	00	00
NBER	01	01	01



## 4. Methodological issues

Econometric analysis of economic growth is fraught with many methodological difficulties that may cast doubts on the validity of the results. These problems are related to data issues and model specification issues. Some of these points are considered below, as background to the discussion of the papers reviewed in Section 5.

### 4.1 Data issues

Most studies of economic growth typically rely on cross-sectional averages of time series data (one observation per country) for a large number of countries (for example, 17, 19, 26, 27). This practice is conventional because it allows the researcher to analyse long-run relationships without having to specify short-run dynamics. Data are often available in national and international databases, (e.g. from the OECD, the World Bank or government agencies) or compiled by the analysts from past work and different sources (e.g. inventory methods whereby physical capital accumulation is calculated using an original value and a discount rate). Rigorous assessment of the quality (accuracy and reliability) of the measured variables included in the growth equations estimated is generally difficult and imposes strict demands on researchers regarding presentation, evaluation and sensitivity analysis. Several authors have observed that the results of growth determinants may depend on the sources and collection methods for the explanatory variables (28, 29) and that the results are sensitive to the choice of data from which growth rates are calculated (30). Data are also likely to be systematically collected for some countries or regions and not for others, which may lead to sample selection problems. Another concern of the area of growth and health is that the studies generally use crude measures of health, because of lack of data on more refined and comprehensive health measures that incorporate both health status and length of life and that span both a reasonable time period and a number of countries. Studies on health often employ some measure of life expectancy or mortality. In the area of MNH and growth, the situation is even worse since we identified no paper that explicitly studies the impact of MNH on growth. We identified a small number of papers with health measures that can be considered to be related to the MNH area. Capturing the full MNH effect on

growth is challenging. To find evidence relevant specifically to an MNH setting, researchers need to find variables that measure MNH as completely as possible. Conceivably, this is very difficult for a number of reasons. First, the definition of MNH is broad, comprising all aspects of the health of mothers and newborns: finding a variable that captures all these aspects is difficult. Secondly, assuming that such a variable is available, controlling for other health effects on growth in the estimation is also important to isolate the MNH effect. The studies in this review use three different health measures: infant mortality, life expectancy and adult survival for males. These measures differ in their coverage of MNH, i.e. infant mortality covers deaths of children but not deaths of young mothers, whereas life expectancy covers both survival of children and mothers but also all other survival, and of course, our third health measure – adult survival rate for males – does not cover either survival of children or survival of mothers, so the effect of MNH in the estimations may be biased when using these measures as a proxy for MNH. In addition, none of the studies considers health status of children and young mothers.

Several recent papers cast doubt on the suitability of cross-section macroeconomic analysis. One obvious problem is the often small sample size, only a few countries or regions, which limits the degrees of freedom in regressions and restricts statistical inference with low power of significance tests. A second problem is that the use of cross-section data makes it impossible to control for unobserved country-specific differences which may lead to bias. Levine & Renelt (31) reported that previous studies based on cross-sections are unstable because unobserved intercountry heterogeneity is correlated with the explanatory variables included in the estimated model. Also, the provision of consistent estimates relies on rather restricted conditions: cross-sectional comparisons implicitly impose the assumption of homogeneous relationships across countries which may appear unrealistic for many reasons, e.g. heterogeneous preferences, production functions (32, 33). A third problem is that pure cross-section studies are static, while the observed differences in growth are the result of both permanent and transitory differences when countries



are in different stages of an adjustment process. A relevant issue is also multicollinearity, i.e. some of the explanatory variables may be highly correlated, such as education and health. The problem arises because it is difficult to determine where the effect is actually coming from (in this case health or education) and may result in statistically insignificant estimates even if the estimator provides unbiased estimates of the true effect.

An alternative to cross-section data is time-series data, but this also means a number of problems, such as the limited time span of the available data which makes it difficult to discern the long-run effect of the explanatory variables, i.e. the growth may be dominated by short-run fluctuations in business cycle effect and not long-run growth variation.

Recent studies on growth use panel data (combining cross-section and time-series data) to overcome some of the above-mentioned problems. One advantage of using panel data is the larger sample size and hence more powerful significance tests. Panel data also allow us to relax the assumption of homogeneous relationships across countries. Moreover, these data enable investigators to include country-specific and time-specific effects, which help to control for the presence of mismeasured or unobserved variables that are correlated with the explanatory variables included in the model (see below). Another advantage is the possibility of analysing dynamic properties of the relationships. A problem in most available panel data sets, however, is that the time dimension is still small, which means that it is not possible to perform detailed analysis of the length of time it takes for a change in, say, a health shock to have its full effect on growth.

## 4.2 Model specification issues

Two well-known general problems concerning model specification are the possibilities of endogeneity and omitted variable bias. The endogeneity bias may arise since investments in MNH itself can be a function of other variables, including economic growth. In the context of this paper, our attention is the effect of health on growth, but causality might run in the other direction (reverse causality): many

studies have shown that economic development is a key determinant of health outcomes (see, for example, 34). A conventional method to reduce the problem of endogeneity is to use the instrumental variable (IV) method. A variable, which may be assumed to be uncorrelated with economic growth but correlated with the endogenous health variable, is used as a substitute, or instrument, for the endogenous variable. The estimator is consistent and can be used in econometric analysis (35, 36). The omitted variable bias arises if these omitted variables are correlated with the variables included in the model, e.g. health and growth. As an example: omitted variables such as cultural, political and social factors may be correlated with both health and growth, which means that it is important to control for such factors in the estimation in order to isolate the effect of health.

Apart from the obvious advantage of a considerable increase in the number of observations and confidence in the statistical results, panel data deal with some of the problems mentioned above, i.e. they enable one to test for country, state or geographical area effects and/or time period effects and it is possible to carry out appropriate estimation in their presence.

Consider the following regression model:

$$Y_{it} = X_{it}\beta + \varepsilon_{it}$$

$$\varepsilon_{it} = v_{it} + \mu_i + \theta_t, \text{ for } i=1,2,\dots,N \text{ and } t=1,2,\dots,T.$$

where  $Y_{it}$  and  $X_{it}$  are vectors of dependent and explanatory variables for country  $i$  in year  $t$ . The error term  $\varepsilon_{it}$  can be decomposed into country effects  $\mu_i$ , time effects  $\theta_t$ , and a random term  $v_{it}$ . The country effects represent all country-specific, omitted variables and the time effects represent all omitted variables that have symmetric effects on all countries. Different ways of modelling these country-specific and time-specific terms give rise to different panel data models. Running an ordinary least squares (OLS) regression assumes that  $\mu_i=0$  and  $\theta_t=0$ . A fixed-effects model assumes that  $\mu_i$  and/or  $\theta_t$  are fixed constants for each country and time period, respectively, in which case

an appropriate panel estimation model is OLS with country-specific and/or time-specific dummy variables. If  $\mu_i \neq 0$  is the correct specification, but a strict OLS regression is estimated, the estimated effect will be biased if  $\mu_i$  is correlated with other explanatory variables. The third possibility is that  $\mu_i$  ( $\theta_i$ ) is itself a random variable. In this case, there is an error-components model – referred to as a random-effects model – that can be estimated using generalized least squares (GLS).

Conventional F-type tests can be used (for the joint significance of the country and time dummy variables) to determine whether the OLS model is rejected in favour of the fixed-effects model. A Lagrange multiplier test for the random-effects models devised by Breusch & Pagan (37), based on OLS residuals, can be used to examine whether the panel GLS model is more appropriate than the strict OLS model. A Hausman test (38) of the fixed-effects model against the random-effects model can be carried out to test the independence assumption of the random-effects model. If this assumption is not valid, random-effects models produce biased coefficient estimates and the fixed-effects model may be preferable. If these effects are uncorrelated with the regressors, then there is a gain to be made by adopting the random-effects model instead of the fixed-effects model. In addition to using statistical tests to choose between fixed-effects, random-effects and strict OLS, there are important conceptual issues that bear on this choice. The fixed-effects model may be more appropriate when the sample constitutes all or most of the population of interest. Random-effects would be more appropriate if the sample is drawn from a substantially larger population. This factor would seem to favour the fixed-effects model in the case of cross-country studies. Greene (39) states that the fixed-effects model is a reasonable approach when one can be confident that the differences between units (countries) can be viewed as parametric shifts of the regression function. If differences between countries are not attributable to parametric shifts, but are more related to variation across countries in the regressors, then fixed-effects models are less attractive (for thorough discussions of panel data see 40–42).

An important advantage of panel data is also that such data allow analysts to examine causality without too strong assumptions to justify relatively arbitrary instruments for health (see discussion above on instrumental variable methods). In cross-sectional analysis it is difficult to find proper instruments for health, i.e. variables that are uncorrelated with growth but correlated with the potential endogenous health variable, although in panel data analysis one can simply instrument the variables by lags in order to avoid the potential endogeneity problem.

In spite of the many advantages of panel data analysis, several tricky problems remain. For example, one particular problem in using the fixed-effects model is that too much of the cross-section variation may be attributed to the dummy variables representing specific countries, rather than to the explanatory variables which attempt to capture the influences of interest (for example, health or MNH). Thus there are worries that fixed-effects approaches may weaken the scope for finding significant effects of variables that are fairly constant over time or that will affect growth only with a long time lag. However, this risk of the fixed-effects models needs to be balanced against that arising from specification errors if relevant dummy variables are not included.





## 5. Methods and results of five selected articles

The five papers reviewed are described below and summarized in Table 2. None of the studies considers MNH explicitly, and the health measures used are only moderately related to MNH.

### 5.1 Economic growth, health and poverty: an exploratory study for India (Gupta & Mitra, 2004)

Gupta & Mitra (21) study the relationship between economic growth, poverty and health. Drawing on standard health economics models that analyse the complex relationships between health capital stock, non-health consumption goods and health care spending, individuals are assumed to engage in health production (health care) until the marginal cost of health production equals the marginal benefits of better health status. Health status is assumed to affect utility indirectly, through increasing labour income, and directly by the value that individuals place on good health per se. However, the individual also values non-health consumption goods, which implies a trade-off between health and non-health goods.

The issues of particular interest for Gupta & Mitra are to ascertain the positive effects at the macro level of (i) health spending and of (ii) health on growth, and (iii) to explore the relationships between poverty and growth and between poverty and health. Some of these relationships are analysed using three alternative models: the first model assumes that the endogenous variables growth, poverty and health are influenced by each other simultaneously. The second model assumes that growth is determined by a set of exogenous variables, while growth (and exogenous variables) influences poverty and poverty (and exogenous variables) influences health. In this (recursive) model, poverty and health do not impact growth but poverty impacts health. The third model assumes that health and growth influence each other and also that both health and growth influence poverty.

Only the results of the third model are reported, and it is estimated using panel data. We are unable to locate the source of the growth data but assume it to be a central or state-level agency in India. Infant mortality rates are collected from the *Compendium of India's Fertility and Mor-*

*tality Indicators* published by the Indian government and based on census results. Gupta & Mitra remark that a morbidity rate is the best health indicator but the most difficult variable to obtain. In the case of India, it is impossible to find the correct denominator (the total population susceptible to a certain disease or to all conditions defined as morbid). Birth and death rates are more reflective of demographic changes and population policy than of morbidity. Thus, infant mortality and life expectancy may be the best measures to capture long-term improvements in health. The data are from 15 Indian states, 1970/1971–1995, and the models include state-specific effects to account for unmeasured state varying variables using fixed-effect and random-effect estimation. Two health indicators are used to check for general trends: infant mortality rate and life expectancy, where the former is retained in the analysis. Two alternative measures of economic activity are used: five-yearly average growth of state domestic product (SDP) and SDP per capita. Poverty is measured by the percentage below the poverty line. Health spending per capita is included in the health models estimated. Exogenous variables are urbanization, infrastructure, industrialization, literacy and initial value of SDP. In the estimation of the structural models (models that display a causal relationship), IV methods are used: the original values of the endogenous variables are replaced by the predicted values obtained from estimation of reduced form equations, i.e. endogenous variables estimated on all exogenous variables in the equation system.

Infant mortality rate had the expected negative effect on growth (not significant) and SDP per capita (significant). Hence, the results indicate that higher infant mortality reduces SDP growth and SDP per capita. The estimated effect on the growth variable is  $-0.145$  and on SDP per capita is  $-2.70$ . We interpret this as follows: a reduction in infant mortality by one 1/1000-point increases the average annual growth of SDP per capita by 0.145% and the SDP per capita by Indian Rs 2.70. Other results of relevance are:

- higher growth and decreased infant mortality rate tend to reduce poverty;
- higher SDP growth reduces infant mortality;
- higher per capita health spending reduces infant mortality.



The authors summarize their findings by stating that further reduction in poverty is probably not possible without significant improvements in the health condition of the population (p. 203). This reduction in poverty would be possible by economic growth directly and also by growth achieved through health outcomes. The main policy implication is stated to be “that improved health outcomes are necessary for improved rates of growth of income. At the same time, higher growth enables the system to generate better health outcomes. Better health will also lead to lower poverty” (p. 204). The paper concludes that investments to improve health (as opposed to improved health per se) and, specifically, to reduce infant mortality rates are appropriate to increase economic growth and reduce poverty in the areas studied.

A caveat of the paper in terms of our interest in MNH is that only infant mortality is considered and not maternal mortality; health status of the child and the mother is not incorporated in the health measure. Further, in the isolation of MNH on growth it is also important to control for other health influences than MNH. The impact of MNH in countries that have a greater development of overall health will most likely be exaggerated if the growth in overall health is not controlled for. The paper does not take this fact into consideration when modelling the relationship between infant mortality, growth and poverty but when estimating the structural equations it controls for per capita health spending and thus indirectly controls for general health. Another aspect of development in MNH is that the effect from MNH on general health and on economic growth may be split into two components, one immediate and one lagged. Gupta & Mitra construct a model of the relationship between infant mortality rate, poverty and growth and apply it on data from 1970/1971 to 1995 and thus most probably capture the lagged effect on growth. This is the effect of interest, since transitory effects may be important in the short run but the goal is a sustainable, long-term positive economic development. A final comment is that we suspect that the trend of infant mortality at a time of increasing growth may contribute to observed significance of infant mortality.

A weakness is that Gupta & Mitra do not directly discuss the magnitude of the estimated effects of better health on growth. The potential Rs 2.70 increase in SDP per capita is not mentioned other than that the estimate has the correct sign and is significant. Its magnitude relative to other factors or currencies is not discussed. Further, the measure of SDP per capita is not a growth measure but a measure of income level. This means that the effect on the growth rate of the economy is not clear since the estimated effect of that factor is not significant. Further, a discussion of the sensitivity of the results would have been helpful. The authors say the two models that are not discussed further do not add to the results, but they do not comment further on the subject. Assuming that statement to be correct, a sensitivity analysis of the result of the chosen model would have been interesting. For instance, in what range of infant mortality (e.g. within a 95% confidence interval) are the results robust and at what stage of infant mortality would there be significant changes in the coefficient estimates? Another issue is that the quality of data is not discussed to any extent. Conceivably, some of the data problems discussed in this review would most likely have been encountered and a discussion of this subject would have been desirable. A final shortcoming is that the paper presents estimates for India and one may wonder to what extent the results are valid for other countries.

## 5.2 The effect of health on economic growth: a production function approach (Bloom et al., 2004)

Bloom et al. (24) estimate the effect of health in a well-specified aggregate production function model of output growth on physical capital, labour and human capital in three dimensions: education, work experience and health. To complement and develop the knowledge in the area where human development has traditionally been defined as education, they include work experience and health as the two factors constituting human development and use the model to check specifically for the effects of health on economic growth. The aim of the study is to investigate the effect on growth of health-induced labour productivity enhancement.



By the use of a variety of data sources, the authors construct a panel data set of 104 countries observed every 10 years over 1960–1990. The output measure (real GDP) and capital stock data are obtained from the Penn World Tables (43). The health variable – life expectancy – is obtained from the United Nations' demographic indicators. Other sources include previous research (work experience, governance and tropics land area) and the International Labour Office. By the use of data from two periods, 1970–1980 and 1980–1990, the models are estimated by nonlinear two-stage least square techniques in which all current growth rates of inputs are instrumented with their lagged growth rates. The validity of the lagged variables as instruments is considered (using tests of over-identifying restrictions). Methodological considerations such as the inclusion of experience and educational variables as well as physical capital and labour are taken to isolate the effect of life expectancy on growth. The analysis is performed by investigating cross-country differences in the variables. Special consideration is given to total factor productivity (the efficiency by which the factors under study are used to obtain economic growth).

The results indicate that better health has a positive effect on growth of output and that an extra year of life expectancy enhances the productivity of workers and increases output (real GDP) by 4%. Bloom et al. also find that the estimated effects of education and work experience are close to corresponding effects found in earlier microeconomic studies, and this indicates no existence of externalities of human capital in these dimensions (schooling and experience). The results are shown to depend on whether the total factor productivity is assumed to be equal or to differ across countries. In the case of equal total factor productivity across countries, the effect of the health variable on growth indicates that an increasing life expectancy of one year results in a 1% raise in output. The estimated effect of the health variable is, however, not significant. When assuming that total factor productivity differs across countries the main result is that health's effect is positive and significant on economic growth. The results indicate that a one-year improvement in a population's life expectancy would give a 4% increase in output. Sensitivity analysis (omitting work

experience levels) maintains the result and the conclusion is that the health effect represents a real productivity effect. The two variables that explain the most of the differences in growth between countries are life expectancy and average years of schooling, whereas work experience plays a minor role.

An important problem mentioned by Bloom et al. is that key estimates, such as physical capital, are insignificant which is typical in macroeconomic studies where there is a lack of observations (degrees of freedom) and multicollinearity among explanatory variables such as capital intensity, educational level and health (see Section 4.1). The authors also point out that the estimation focuses on the direct effects of education and health, which means that they do not consider the potential indirect effect of health on output which operates through education. The authors also note that they assume that the effects of health and schooling depend only on their levels and not on their distribution. In more realistic models, it would be possible to allow for nonlinear effects of human capital on output at the individual level, which means that the distribution of human capital matters at the macroeconomic level. Such estimations would have policy implications, because health interventions may have different effects on different sections of society. The paper does not appear to control for country-specific effects. A weakness of the life-expectancy measure of MNH has already been emphasized.

### 5.3 Health's contribution to economic growth in an environment of partially endogenous technical progress (Jamison et al., 2003)

The study by Jamison et al. (13) has two aims: the first is to estimate the effect of better health on real GDP per capita and the second is to explore potential endogenous sources of the variation in the rates of technical progress (from either adoption or the generation of new technologies) across countries, e.g. the effects of health, education and economic openness are estimated.

In the analysis of the first aim, a variant of an aggregate Cobb–Douglas production function is estimated by use of



panel data from 53 countries over 1965–1990 and five-year intervals and multilevel analysis techniques. This procedure allows for country-specific intercepts and effects of technological progress. The latter may be important, since variations in growth rates across countries may be attributable to persistent differences in the characteristics of countries, such as geographical location. The health measure used is the logarithm of the survival rate per 1000 for males aged 15–60 years. The analysis shows that increases in the average adult survival rate in 1965 and 1990 increased income growth by 0.23% per year. This indicates that better health accounts for about 11% of the economic growth overall during the period 1960–1990. They also find that countries with higher initial levels of health (adult survival) realize more modest contribution to growth from better health than countries with lower initial health. Accumulation of physical capital (per capita measured in PPP conversion factors) and education (years of schooling attained per male between ages 15–60 years) accounts for 67% and 14%, respectively.

In the analysis of the second aim, no evidence is found for an effect of health on rates of technical progress. This indicates that health effects do not appear to raise growth through technical progress. The most important effect on rates of technical progress emanates from policies of economic openness with some impact of education. Hence, this result indicates that technical progress is partially endogenous.

Jamison et al. remark that many of the effects of the explanatory variables are estimated with modest precision but conclude that openness of the economy is a powerful predictor. When performing a sensitivity analysis by extending the time period (with a slightly smaller sample) the overall effects are similar with a small reduction in the contribution of health.

#### 5.4 Economic growth and human development (Ranis et al., 2000)

The aim expressed by Ranis et al. (25) is to study the two-way relationship between human development (which

they define as the health and education of the people of a country) and economic growth (development of GDP and GNP). The first effect runs from economic growth to human development as a result of households using their income on, for example, education and health activities; the second effect runs from human development to economic growth as a result of healthier and better-educated people contributing more to economic growth. To test the first possibility of direction of the relationship – whereby growth increases human development – the dependent variable is life expectancy shortfall reduction in 1970–1992 from a maximum of 85 years and the explanatory variables are lagged GDP per capita growth rate in 1960–1972 and a number of other control variables. To test the second possibility of direction of the relationship – whereby human development increases growth – the dependent variable is real GDP per capita average growth in 1970–1992 and the independent variables are the logarithm of GDP per capita in 1960 to test for convergence of income levels as countries approach high income levels, initial levels of human development using three different measures (the logarithm of life expectancy in 1962, adult literacy 1970–1972 and a combined index of life expectancy and literacy for 1970) and changes in human development over time using two measures (change in the log of life expectancy 1962–1982 and life expectancy shortfall reduction in 1970–1992). Lagged variables are generally used as instruments to avoid simultaneity bias.

Overall, both the effect of economic growth on human development and the effect of human development on economic growth are increasing. The effect on GDP growth of an increase in life expectancy is shown by the estimated effect of the change in log life expectancy between 1982 and 1962, i.e. a percentage change. The initial level of life expectancy is controlled for and the estimated effect for the change variable is between 0.12 and 0.17 in all cases but one. Consequently, the effect from a 10% change in life expectancy over the period would lead to an increased annual GDP per capita growth of between 1.2% and 1.7%. The effect of initial life expectancy is also investigated using its logarithm, and the estimated effect varies between 0.03



and 0.06, i.e. an initially higher level of life expectancy of 10% provides a higher yearly GDP per capita growth of between 0.3% and 0.9%.

These findings indicate that an economy may systematically cycle upwards or downwards, i.e. high (or low) levels of human development lead to high (or low) economic growth which in turn promotes (or worsens) human development, and so on. Human development had a stronger influence on growth the higher the investment rate and the more equally distributed income. Further, an inertia effect is found in the sense that a fall in per capita income is not immediately translated to a slowdown or reversal in human development improvements.

Ranis et al. also categorize country performance in four groups: (i) virtuous cycles, where good human development augments economic growth which in turn promotes human development; (ii) vicious cycles, where poor human development reduces economic growth which in turn decreases human development; (iii) lopsided cycles with strong human development and weak economic growth, where good human development may not generate good economic growth, e.g. if there is a weak relationship between human development and investment rates; and 4) lopsided cycles with weak human development and strong economic growth, where good economic growth may not generate good human development, e.g. if there is a weak relationship between economic growth and social expenditure ratio. Ranis et al. argue that such lop-sided developments are unlikely to persist: either the weak relationship in the cycle acts as a brake on the strong link in the relationship and all move to a vicious cycle or, alternatively, the weak relationship is strengthened, e.g. by a policy change, and all move to a virtuous cycle. Ranis et al. (25) also studied country movements over the four categories over three decades 1960–1970, 1970–1980, 1980–1992 and found that over half of the countries in the vicious-cycle category in 1960–1970 remained there over the whole period. The final conclusion is that, while economic reform is important to economic development, focus on human development must be included from the beginning of any reform programme.

## 5.5 Endogenous fertility, mortality and growth (Blackburn & Cipriani, 1998)

Blackburn & Cipriani (23) present a theoretical model with the aim of incorporating mortality in a growth model, where growth is affected by mortality which in turn is affected by growth (mortality is then an endogenous variable). This is a development of the theory in line with the work following the Solow model where efforts have been made to include various factors and make them endogenous in growth models. The authors also draw on work by Barro & Becker (44, 45). The utility of each adult is described by own consumption, number of children and the utility of each child, and the aggregate utility of the next generation enters additively with a multiplicative discount factor that is negatively dependent on the number of offspring, i.e. there is a diminishing marginal utility of children. This utility function may be rewritten into a discounted sum of the adult's utility and that of all future generations, which means that the utility of a dynasty (the number of adult descendants) depends only on the consumption and number of children. The size of a dynasty is determined by the fertility and infant mortality rates and the resulting net is the number of surviving children. A mortality function is specified where mortality is determined by both parental care (food, shelter and expenditure on medication) and societal care (public health expenditure and social infrastructure). In equilibrium, utility is maximized given the individual's budget constraint. Rates of fertility, mortality, per capita income growth and population growth are determined simultaneously and the solutions accord with the basic theory.

When looking for dynamics in the model, fertility and mortality rates are both negatively related to the level of per capita income. Further, fertility and mortality rates are positively correlated with one another and the net rate of population growth (the difference between fertility and mortality) is negatively related to per capita income. There is also a positive relation between per capita income and expenditures on child health care. This is in accordance with theory (see Figure 1). The general conclusion when looking at the steady-state outcomes are the same as in the dynamics case: the same patterns and relations are seen between



mortality, fertility and income. The authors conclude that the model appears to be theoretically sound and that it may be used when investigating the fertility–mortality–development nexus and utilized with infant mortality as the health measure. The article contributes mainly to the MNH area by adding theoretical legitimacy to the work done after it was published.

Table 2. Aims, methods, variables, main findings and quality of reviewed studies

Section	Authors of reviewed article	Aim(s)	Methods	Variables: (i) health variables (ii) other covariates (iii) dependent variables	Main findings	Quality of contribution and relevance to the review
5.1	Gupta & Mitra (21)	To study the links between economic growth, poverty and health.	Panel data fixed-effects models using data from 15 Indian states, 1970/71–1995	(i) Infant mortality rate, life expectancy (ii) Per capita health expenditure, the percentage below the poverty line (iii) Five-yearly average rate of growth of GDP; GDP per capita	Per capita health expenditure increases health status; increases in health status reduce poverty; higher growth raises health status and better health status improves growth	Relevant and clear contribution to MNH Quality impaired by lack of sensitivity analysis and discussion of methodology
5.2	Bloom et al. (24)	To test and quantify the effect on health of labour productivity in a well-specified aggregate production function	Two periods: 1970–1980 and 1980–1990 104 countries Nonlinear two-stage least square estimation All contemporaneous growth rates of inputs are instrumented with their lagged growth rates	(i) Life expectancy (ii) Average years of schooling, average experience, square of average experience, log of capital per worker, % of land in the tropics, governance, time dummies (iii) Real GDP	Health has a positive effect on economic growth A one-year increase in a population's life expectancy raises output (real GDP) by 4%	High quality paper but life expectancy is not directly in MNH area
5.3	Jamison et al. (13)	To study the effect of technical progress on growth and the factors that account for differences in countries' rates of technical progress; in particular, health and other factors as determinants of differences in rates of technical progress	Data from 53 countries for 1965, 1970, 1975, 1980, 1985 and 1990 An annex updates the study with data for 1995 and 2000 Estimate a variant of Cobb–Douglas model and multilevel techniques	(i) Survival rate per 1000 for adult males aged 15–60 years (ii) Log of physical capital per capita, average education of male population aged >15 years, log of adult male survival rate, log of total fertility rate, time (iii) Log of per capita GDP (adjusted for PPP)	Health improvements accounted for 11% of growth (0.23% of growth rate) Accumulation of physical capital and education accounted for 67% and 14%, respectively Health influences growth through higher income levels but not through changing the rate of technical progress	Low relevance and contribution to the MNH area owing to the use of male mortality rate Extensive discussions and sensitivity analysis

continued overleaf



Table 2. (continued)

Section	Authors of reviewed article	Aim(s)	Methods	Variables: (i) health variables (ii) other covariates (iii) dependent variables	Main findings	Quality of contribution and relevance to the review
5.4	Ranis et al. (25)	To study the two-way links between human development and economic growth at both theoretical and empirical levels	Data from 35–76 developing countries over 1960–1992. Instrumental variable techniques are used to reduce simultaneity bias and where lags of the original variables are used as instruments	(i) Initial log life expectancy 1962, change in log of life expectancy 1960–1982 (ii) Log of real average GDP per capita growth 1970–92 (iii) Log GDP per capita in 1960, adult literacy 1970–1972, combined index of life expectancy and literacy 1970, gross domestic investment as % of GDP 1960–1992, three alternative measures of lagged income distribution 1960–1992, regional dummies	A 1% point increase in the average growth of GDP per capita reduces life expectancy shortfall by more than 3% points over the period The change in life expectancy 1960–1982 was positive on GDP per capita growth 1970–1992 A 10% higher initial life expectancy gives 0.3–0.9% higher yearly growth A 10% change in life expectancy over a 20-year period increased annual growth by 1.2–1.7%	Unclear relevance and contribution to the MNH area due to doubt on what influence MNH has on life expectancy measure
5.5	Blackburn & Cipriani (23)	Extend theory on economic demography	Endogenization of growth and infant mortality in a microeconomic model	Income growth, fertility, infant mortality, consumption and savings	The model accords with stylized facts and may be seen as a step to understanding the fertility–mortality–development nexus	Relevant for further research

## 6. Conclusions and discussion

The review of work on the effect of MNH on economic growth was undertaken in order to assess the likely effect on growth of investing in MNH in low- and middle-income countries. A systematic search of relevant databases identified 10 studies. We reviewed only five of the papers owing to non-MNH and causality issues of the others. Methodological issues and results are discussed and suggestions are offered for further research.

### 6.1 Summary of results

Gupta & Mitra (21) use infant mortality in an Indian setting as a proxy for health; two of the other empirical articles – Bloom et al. (24) and Ranis et al. (25) – use life expectancy, whereas Jamison et al. (13) use adult survival rate for males over 15 years of age. Blackburn & Cipriani (23) present a theoretical paper which treats the subject of health and growth; their model uses infant mortality as a proxy for health and may be relevant in an MNH setting.

All studies indicate that health impacts on economic growth. Gupta & Mitra show that reductions in infant mortality increase growth. The estimated effect on GDP per capita is –2.7, meaning that a reduction of infant mortality by one 1/1000-point increases GDP per capita by Indian Rs 2.70; the estimated effect on annual growth is –0.145, implying that if infant mortality is reduced by one 1/1000-point then growth of GDP per capita increases by 0.145%.

The study by Bloom et al. indicates that an extra year in life expectancy increases output in terms of real GDP by 4%. The results from Jamison et al. indicate that a reduction in adult survival rate for males over 15 years of age increases growth by 0.23% per year and contributes by 11% overall over the period 1965–1990. Ranis et al. show an expected effect from human development on economic growth. The estimated effect of an initial life expectancy and change of life expectancy varies between 0.03 and 0.09 and between 0.12 and 0.17, respectively. An initially higher life expectancy, and growth in life expectancy over the period by 10%, would provide a higher yearly GDP per capita growth of 0.3–0.9% and 1.2–1.7%, respectively.

Blackburn & Cipriani make mortality endogenous in a theoretical growth model. When studying both dynamics and steady-state conditions, they find that fertility and mortality rates are negatively related to the level of per capita income. Fertility and mortality rates are positively correlated with one another, and the net rate of population growth (the difference between fertility and mortality) is negatively related to per capita income. There is also a positive relation between per capita income and expenditure on child health care. Thus, fertility, mortality, per capita income growth and population growth are determined simultaneously in accordance with theory, and the model may be used when investigating the fertility–mortality–development nexus and extended to use infant mortality as the health measure. The paper contributes to the MNH area by adding theoretical legitimacy to work done after its publication.

### 6.2 Conclusions of the review

Presentation of the conclusions below corresponds to the aims of the review (see Section 1.2).

#### 6.2.1 The evidence of a causal effect of MNH on economic growth

Gupta & Mitra (21) find that reductions in infant mortality tend to raise GDP per capita and growth of GDP per capita. The paper studies the conditions in 15 Indian states and the results may not be directly generalizable to other countries or regions. The authors do not present any sensitivity analysis, so it is not clear how robust are the results. Bloom et al. (24) show an increasing effect of life expectancy on development of GDP. Life expectancy may be seen as comprising MNH dimensions but, for the MNH effect to be discernible, other health aspects need to be controlled for, which is not done (although the primary aim of the study is to estimate the effect of general health rather than MNH). Jamison et al. (13) note an increasing effect of life expectancy on growth and that the effect operates on the income level and not through, for example, technical progress. However, the results are based on male survival rate, which is clearly not an MNH factor. Ranis et al. (25) show effects of life expectancy, both as an initial variable and as a factor under development, on economic growth. Blackburn & Cipriani (23) contribute mainly to the MNH area by adding



theoretical legitimacy to the work done after their paper was published. As an example, Gupta & Mitra explicitly take into account the fact that health is an endogenous factor in a growth model and measure health as infant mortality. The model could be extended to include MNH to test for validity in the context.

### 6.2.2 The evidence of a causal effect of MNH on growth determinants

Gupta & Mitra (21) estimate the impact of infant mortality on poverty and find that reductions in infant mortality also lead to reductions in poverty. However, the model restricts poverty's impact on economic growth. It would have been interesting to see the results of the first model – which they do not report – where the endogenous variables growth, poverty and health influence each other. Thus, if poverty influences growth and infant mortality affects poverty, then part of the effect of infant mortality on growth may operate through poverty. Bloom et al. (24) study the effect on growth of health-induced labour productivity enhancement – a determinant of economic growth. Their health variable is life expectancy. They analyse cross-country differences in the variables and consider, specifically, total factor productivity. The result indicates that better health increases growth: an extra year of life expectancy increases the productivity of workers and provides an increase of 4% in output when assuming that total factor productivity differs across countries. Health operates through a determinant of growth and not on growth directly. The result indicates that growth may be achieved not only directly from increasing income levels but also from productivity enhancements through better health, in this case life expectancy. Jamison et al. (13) find no evidence for effects of health on rates of technical progress. This indicates that health effects do not operate through technical progress but on income levels directly. The result is achieved when using male survival rate as proxy for health.

### 6.2.3 The likely effect on growth of investing in better MNH

Evidence on the effect of life expectancy on economic growth is shown by Bloom et al. (24): an extra year of life expectancy leads to a 4% increase in output; by Jamison et al. (13): the contribution of better health on growth was

0.23% yearly which amounted to 11% of the total growth rate; and by Ranis et al. (25): a 10% positive change in life expectancy over the 20-year period gave an increase in annual GDP per capita growth of between 1.2% and 1.7%, and a 10% higher initial life expectancy leads to a higher annual GDP per capita growth of between 0.3% and 0.9%. The effect of infant mortality on economic growth was studied by Gupta & Mitra (21), who find that a reduction in infant mortality by one 1/1000-point leads to an increase of the level of SDP per capita by Indian Rs 2.70. The relevance of the effects of health on growth for the MNH area is not clear, however, as shown below.

### 6.2.4 Final conclusions

Our main conclusion is rather disappointing in that the evidence base is not convincing, owing to a surprisingly limited number of MNH-related studies and results that are both geographically and methodologically limited. Also, the robustness and applicability of the results can be questioned. Thus we cannot present any clear-cut evidence of the size of the effect of MNH on economic growth. One reason – among others – for the weak evidence base is that the health measures used can be considered only as crude proxies for MNH. Another reason is that even if the measures used are valid, the estimated effect may be confounded by other health dimensions correlated with the included MNH measure. Hence, it is important to control for health exclusive of health of newborns and young mothers. The studies we review also use different methodologies, dependent variables, control variables, data sets, geographical areas and health measures, etc., so there is a great deal of uncertainty around the reported estimates and the differences may not be meaningfully compared.

The conclusion of the review is that evidence of the MNH–growth relationship is sparse, though some evidence exists indicating that there is an effect on economic growth of health. This effect may or may not, however, come from changes in MNH. Methodological issues lend concern to the validity of the results, partly because the studies focus on health and are not targeted specifically on MNH. To be able to draw firm conclusions about the effect of MNH on economic growth, MNH should be measured as closely as



possible. The studies reviewed use health measures such as infant mortality and life expectancy which can be considered as proxies for MNH, but only crude proxies. Maternal health status and length of life are not reflected in the health measures used. Death of young mothers is by definition not incorporated in infant mortality; in life expectancy, child survival and maternal survival are included but so is survival of other than newborns and young mothers. Thus, infant mortality is too narrow and life expectancy is too broad. In addition, studies should also control for health aspects other than MNH in order to isolate the MNH effect. If this is impossible, then the effect of MNH may be biased. Although not all of the above-mentioned issues can be addressed with available data sources, we believe that some of them could with an MNH targeted approach, e.g. modelling the effect of a combined maternal/infant mortality measure after controlling for mortality exclusive of newborns and young mothers.

### 6.3 Implications of the review

The weak evidence base of research on MNH–growth calls for more and diversified research in order to increase knowledge about the return of investments in the MNH area compared with alternative actions in other areas of public health. If the results of the reviewed studies can be generalizable to MNH by further research and the equity problem can be addressed (i.e. what areas of society should benefit from investments in MNH?) interventions may raise growth with sizable effects.

### 6.4 Future research

The review has not substantially increased knowledge about the size of the effects of MNH on economic growth. We have been able to draw a few conclusions but the evidence base makes conclusions premature. Therefore, the basic point is that research is needed on the effects of MNH. First, to obtain valid results, more comprehensive MNH measures should include aspects such as quality of life, functional limitations, mental health and sickness absenteeism. Estimations of MNH need to control for health exclusive of MNH: this is important, because otherwise MNH may capture the effect of irrelevant aspects of health when considering MNH.

Second, research has to cover geographical areas within countries so as to extend the validity of the results. We also suggest studies based on longer time series to obtain better estimates of the long-term growth paths. Third, a wider variety of determinants of economic growth ought be covered. Fourth, a compilation of micro-economic data, e.g. at the firm level, could be performed to study effects on labour productivity from increased MNH and thereby provide employers with incentives to bear the costs to reduce health-related absenteeism.

Other issues to be answered include how the importance of investments in health, and MNH, relate to other human development and human capital investments; and the most efficient manner in which to invest in health in a developing country. Health economic evaluation studies may help in answering this question. Equity issues may also be discussed: what would have the greater impact for a poor country, investing in MNH across the population or focusing on MNH for those below the poverty line?







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