Public Health Classics

This section looks back to some ground-breaking contributions to public health, reproducing them in their original form and adding a commentary on their significance from a modern-day perspective. In this month's *Bulletin*, Professor Kenneth Hill reviews the 1984 paper by W. Henry Mosley and Lincoln C. Chen on their proposal for a new analytical framework for the study of child survival determinants in developing countries. The original paper is reproduced by permission of The Population Council.

Frameworks for studying the determinants of child survival

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The early 1980s was a period of great optimism about child survival in high mortality developing countries and a time when much research activity was generated. The principle of primary health care, defined as essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible at an affordable cost, had been endorsed by the Declaration of Alma-Ata in September 1978. An increasing body of research showed that some low-income countries had succeeded in achieving low child mortality (*1, 2*). New technologies made it possible to prevent major infectious diseases of childhood through mass immunization campaigns and to treat diarrhoeal dehydration and malaria at low cost. International aid agencies pushed an agenda of a limited number of inexpensive, highly effective interventions to reduce child mortality in low income countries.

Henry Mosley and Lincoln Chen argued in their influential and widely cited 1984 article (*3*) that research efforts to identify the most cost-effective uses for health sector resources were hampered by the lack of clear conceptual models for the study of child health. In particular, they noted a disparity between social science research, which focused largely on the roles of socioeconomic and cultural factors in child deaths, and medical research, which focused on specific disease processes and used morbidity as the most common outcome variable. The objective of their paper was to develop an analytic framework that would integrate the two research methodologies, and to introduce a single outcome variable that combined both mortality and morbidity. The conceptual core of their framework was the idea that all background (socio-economic and cultural) variables have to operate through a limited set of proximate determinants that directly influence the risk of disease and the outcome of disease processes.

The idea of a proximate determinants (or intermediate variables) analytic framework was first introduced by Davis & Blake (*4*) for the study of fertility. They argued that any social factors influencing the level of fertility had to operate through one or more of three groups of a total of 11 "intermediate variables," the three groups being: exposure to sexual intercourse; risk of conception given sexual intercourse; and likelihood of a live birth given conception. The appeal of the analytic framework was that, whereas a particular social factor might influence more than one intermediate variable, and could thus either increase or decrease fertility, a change in an intermediate variable was a necessary and sufficient condition for a fertility change in an unambiguous direction. Research could therefore focus on the associations between background factors and individual intermediate variables, since by definition the intermediate variables were causally related to reproduction.

Mosley & Chen note that the problems raised by mortality analysis are far more complex than those posed by the analysis of fertility, since "... a child's death is the ultimate consequence of a cumulative series of biological insults rather than the outcome of a single biological event." (p. 29) As a result, they developed what is perhaps the least used part of their framework: a single outcome variable combining both child death and child health status, represented by weight-for-age. They argue that both child mortality and child growth are affected by the same set of underlying nutritional and infectious conditions, such that weight-for-age can be regarded as a measure of health status rather than solely of nutritional status. They thus define five health status categories using the Gomez classification (*5*): healthy (90% or higher of standard weight-for-age); Grade I (75–89% of standard); Grade II (60–74% of standard); Grade III (below 60% of standard); and dead. This index of health status has the great advantage of providing many more observations than a dichotomous alive/dead outcome; it lends itself to ordered analytical techniques, and has not received the attention it deserves.

Mosley & Chen's analytical framework is conceptually identical to that of Davis & Blake (*4*). Background social, economic, cultural, and health system variables influence a parsimonious but exhaustive set of proximate determinants which in turn directly influence the single outcome variable just described. The authors define five categories of a total of 14 proximate determinants: maternal factors (age, parity, birth interval); environmental contamination (air, food/water/fingers, skin/soil/inanimate objects, insect vectors); nutrient deficiency (calories, protein, micronutrients); injury (acciden-

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tal, intentional); and personal illness control (personal preventive measures; medical treatment). Determinants in the first four groups affect the rate at which children move from healthy to sick, whereas factors in the last group influence both this rate (through prevention) and the rate of recovery (through treatment). This list of proximate determinants is intended to be exhaustive, such that child health will change if — and only if — one or more of the determinants change.

The framework thus provides a conceptual model for researchers, whether social scientists or epidemiologists, on child survival. A variety of statistical modelling strategies have become common post-Mosley–Chen: analysis of links between background factors and proximate determinants, such as analyses of the factors associated with child immunization; models that incorporate an outcome variable, generally mortality, with both proximate determinants and background factors (often implemented in a step-wise process, first including background factors, and then incorporating proximate determinants); and, finally, reduced-form models of net associations of background variables and child mortality.

Each strategy has strengths and weaknesses. The first approach, modelling a proximate factor on background factors can provide useful insights for health sector professionals about how to improve systems, but provides no direct indication of the potential health gain. Some proximate determinants, particularly environmental contamination, are difficult to measure satisfactorily, and it is also hard to know what exactly constitutes a proximate determinant. For example, where should one place low birth weight, a potential risk factor for subsequent child survival, in the framework? Some variables seem to have different levels of "proximity" than others.

The second approach, a modelling strategy that incorporates both background and proximate determinants of child health, can provide important indication of the proximate pathways through which background variables operate, but may be affected by omitted variables bias, since proximate determinants are rarely measured exhaustively. Indeed, in a model combining background and all proximate determinants, the coefficients on the background variables should not be significantly different from zero, since the proximate determinants have by definition to pick up all variance in the outcome (*6*). In practice, it is rare for all background factors to lose their association with the outcome variable, presumably because proximate determinants are either not measured or are not measured accurately; the remaining effect of a background variable once the proximate determinants have been controlled is hard to interpret.

Thirdly, the reduced-form approach indicates the magnitude of the net influence of background factors on an outcome, but does not provide any information that would allow a health system to identify what to focus on to improve things.

Looking back, the optimism of the early 1980s that child survival could be improved rapidly and at low cost in all low-income settings was at best premature. Although immunization programmes have greatly increased immunization levels and oral rehydration has been effective at reducing deaths from diarrhoea in some settings, child mortality declines in the 1980s were not noticeably faster than those of the 1970s (*7*). The Mosley–Chen model, however, has stood the test of time remarkably well, and still provides, explicitly or implicitly, the conceptual basis for many studies of child survival. The underlying ideas have influenced a wide range of health research. The basic proximate determinants framework is very similar to the household health production function in economics (*8*). The proposal of a single health status outcome measure, combining both morbidity and mortality, is picked up in studies of disease burden in the 1990s (*9, 10*). Mosley & Chen correctly predicted that it would not be possible to develop their framework into a readily-quantifiable model, whereby the effect on child health status of a given change in one of the proximate determinants could be estimated (in the way that Bongaarts (*11*) had developed Davis & Blake's framework for the study of fertility). However, social science research on child mortality has benefitted greatly from the clarity of the conceptual framework proposed by Moseley & Chen. As their paper concludes, the framework permits research that " ... can not only assess the overall health impact of alternative development strategies, but also more sharply define which among a number of specific factors amenable to change by health policymakers are of greatest consequence for child survival." This is just as true today as when the paper was written. ■

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