
STUDY

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MORTALITY AS AN INDEX OF SOCIAL DEVELOPMENT*

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The concept of social development, despite its lack of precision, is used in an increasingly generalized way. Probably this reflects an interest in studying development beyond its specifically economic dimensions, but a serious difficulty arises with such an approach: the problem of measurement. The various indicators currently in use, which include mortality rates and other health indices, have not been systematically validated for these purposes and, at least in medical literature, the problem has not even been recognized. Validation of a measure demands a much stricter definition of the concept than has been the case up to now, as well as a consistent programme of interrelated research applying different validation methods.

A qualitative analysis of the value of traditional health indicators as measures of development suggests that, historically, they have reflected general social welfare conditions. Despite the widespread belief that it is possible to achieve a selective impact on mortality through medical intervention, it has been impossible to prove that the supposed effect of medicine is significant in this field.

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The national and Latin American data analyzed tend to confirm that mortality rates form part of a complex network of social phenomena from which they cannot be separated except in an arbitrary way. Practical and economic considerations would favor employing the traditional health indicators as measures of social development, but a systematic effort is required to estimate their validity.

I. Introduction

The use of the term “social development” seems to have become quite generalized in our country over the last few years. Its intuitive meaning, however, is vague, and the aim of using it, highly ambiguous. Nevertheless, it crops up increasingly often, thereby revealing an interest in studying the living conditions of a broad sector of Chile’s population. The need to analyze such conditions is clear, but vagueness in the terminology may point to a certain lack of logical precision which can only be overcome with a great intellectual effort.

The term “development” connotes dynamics or change, and when one talks of social development one is necessarily referring to progress or regression in living standards. The use of the term “social” probably responds to the need to provide the issue with a broader dimension, thereby avoiding reducing it solely to its economic aspects—which have been given wide consideration in development studies. In Chile, the term “social” may also indicate a desire to refer to the poorer sectors, behind the overall averages which are not a good reflection of the situation among such groups.

The economic development indicator *par excellence* has been per-capita Gross Domestic Product (or per-capita income), but this comes nowhere near meeting the needs of all analysts and is gradually beginning to be abandoned. The shortcomings of per-capita GDP are well known. In the first place, it does not include all productive activities. Work done at home, which may include work of considerable economic significance, such as food production in the family vegetable garden, for example, is not taken into account by the statistics forming that index. Self-built housing, which in our country may have had considerable relevance in different periods, is another example of a productive activity not included in the statistics. There are also many state-financed services, such as medical attention, which are not included in the data used to calculate the index.

Furthermore, there also are conceptual differences between countries in way the calculation is made, so the figures may not always be comparable.¹

In the context of national debate, however, the use of an average such as GDP per capita does not respond to the need to evaluate the living conditions of the poorer sectors of society, around which political and academic interest is centered.

In practice, using per-capita GDP as the only development index results in curious observations that reveal its insufficiency. In Costa Rica, for example, at the beginning of the 1970's, life expectancy was very similar to that recorded in the city of Washington D.C., although per-capita incomes amounted to US\$ 700 and US\$ 5000, respectively. In Hong Kong and Jamaica, with incomes of US\$ 1480 and US\$ 930, life expectancy was higher (72 and 71 years of age) and infant mortality (19 and 26 per 1000 live births) was lower than that of Washington D.C. (66 years of age and 29 per 1000 live births).² These comparisons are surprising, to say the least, and show the disadvantages of using GDP figures in an isolated way.

In my opinion, each stage of development requires specific indicators which are sensitive to the variables involved in that stage. In the United States, for example, an awareness has developed of the fact that problems that were overcome through increased material wealth are now a thing of the past, so that now it is necessary to measure and encourage progress in other areas of society's life. This requires data of a non-economic nature reflecting other phenomena, such as internal social tensions, quality of education or the stability of family relationships. For some North American politicians and scholars, it is very important to construct appropriate social indicators as, directly or indirectly, they influence the design of public policies. Sometimes, the only explicit and verifiable goal of a program is to modify certain indicators, on the assumption that they fairly faithful reflect a much more complex and intangible reality.

There is no consensus, however, and, partly due to opposition, a political movement has emerged promoting the use of social indicators.³ As a result, today there are a series of books and other publications devoted to this issue which, as was to be expected, has become quite complex.

The number of indices and figures of different types, on every country, allow a wide range of studies that were not possible a few years ago,

¹ Piñera, S. (1982); "¿Se benefician los pobres del crecimiento económico?" In "Pobreza, necesidades básicas y desarrollo", *Cepal, Ilpex, Unicef*, p. 179.

² Grant, J.P. (1981); "Nuevo procedimiento para medir los progresos del nivel de vida". *Foro Mundial Salud* 2: 433.

³ Toffler, A. (1970); "Future Shock", *Random House*, New York.

but often it is not possible to say exactly what they mean. The number of television sets and newspapers printed per person, divorce and suicide rates, calorie- or protein-based diets, school drop-out rates or defense expenditure, are all elements that can be recorded and appear in certain publications, but their exact meaning is not always clearly stated. Furthermore, in the presence of such vast quantities of data, it appears to be possible to prove very different social trends through the selective choice of indicators.

The interest regarding these issues is obviously shared by international organizations dedicated to the problems afflicting the less developed world. Some interesting measures have been developed by them, one of the most widely used being the material quality of life index. This index is constructed on the basis of three indicators —infant mortality, life expectancy at one year of age, and literacy— which are combined in such a way as to obtain a maximum value of 100 and a minimum of 0. The maximum is given by the value estimated to be achieved by the most developed countries by the year 2000, that is to say, an infant mortality of 7 per 1000 live births, a life expectancy at one year old of 77 years, and 100% literacy. The minimum corresponds to the most unfavourable values recorded in 1950. These were: infant mortality equal to 229 per 1000 live births (recorded in Gabon), life expectancy at one year old equal to 38 years (Guinea-Bissau), and for literacy a simple 0-100 scale has been used.⁴

It is interesting to note that the Tinbergen Group in their study “Reformulating the International Order” proposed national goals in these areas for the year 2000. All of them have been met by our country already. Subsequently, however, a specific goal for each nation was established, of achieving by that date a 50% reduction in the disparities found in 1978 between the actual figures for the country and the maximum figures on the scale.

To achieve this target there must be an annual reduction in disparities of 3.5%. Between 1970 and 1980, our country managed to reduce the disparity shown by the material quality of life index at an annual rate of 5.2%, a much higher figure than that corresponding to the period 1950–1970, which was only 2.6%.

If these indices, which to a large extent are based on the traditional health indicators, are appropriate, our country would be in the fast lane towards achieving the development goals proposed.

The new indicators which are currently being used may be relevant for some countries but not for others. As already mentioned, each develop-

⁴ Unicef (1982); “Dimensiones de la pobreza en América Latina y el Caribe”, Santiago.

TABLE 1

| | 1950 | 1970 | 1980 |
|---|------|------|------|
| Infant mortality (per 1000 live births) | 136 | 79 | 32 |
| Life expectancy at one year of age | 59.2 | 66 | 67 |
| Literacy (%) | 80 | 88.4 | 94.5 |
| M.Q.L.I | 58.8 | 75.9 | 85.9 |
| Annual Reduction | 2.6% | 5.2% | |

ment stage requires its own indices. In the United States, the high per-capita income in the northeastern part of the country does not seem to have a great impact on its inhabitants who continue to emigrate to the southeastern regions, with less relative production but better environmental conditions. The global changes in the output registered in that country probably do not have a major effect on overall living conditions. On the other hand, minor differences between African countries may be revealing of very different standards of living.

Moreover, each country must develop its own measures in response to the political concerns and desires of its people. Evidently, such measures would be of little use for comparisons at an international level, but they could be important for assessing the progress or changes that the country considers really worthwhile. Chile, being in a state of intermediate development and concerned with the situation of groups living in extreme poverty, needs more refined social indicators than GDP. The development of satisfactory indices, rather than being a collection of curious and interesting figures, should constitute a wide-ranging program of interrelated research studies. It seems quite clear, however, that what many research projects require is an objective measure of the living conditions experienced by the middle- and lower-income sectors.

Health indicators have been subjected to fairly detailed examination, both in our country and abroad, and have acquired undoubted political resonance in certain quarters. Those currently in use are, essentially, indicators of mortality—general mortality, infant mortality and life expectancy—which is the result of the combined mortality of all the various age groups. Its meaning, as well as its determining factors, have caused a long and complicated world-wide debate. The possibility of using these values as social development indices will be examined in the final section of this paper, after presenting a general overview of the issue of indicators and their validity.

II. A Theory of Measurement in Social Sciences

One of the problems in the field of social indicators is the lack of a conceptual model to enable the measures to be validated. In the articles on social development and health published in the medical literature, the validity issue has not been properly considered, which arises from the existence of certain implicit assumptions. The reader has no way of knowing, therefore, if such assumptions were taken into account or ignored by the author. It is frequently found, for instance, that GDP per capita is implicitly considered as a faithful reflection of the socioeconomic conditions of groups at higher health risk. The lack of correlation between changes in GDP per capita and health indicators cannot be interpreted without analyzing that assumption, as it may well be the case that there is no correlation between the GDP per person and the socioeconomic conditions of at-risk groups. Although this is a fundamental problem, the GDP per capita is often used as the sole economic indicator.

Analyzing the measurement process in the social sciences is beyond the scope and possibilities of this paper. I shall merely present a model, taken from psychometrics, which may be applied in other fields and has been used with promising results in certain areas of public health.^{5, 6}

The fundamental aspect of this theory is the methaphysical notion of two worlds, one of concepts or ideas and the other of things or material objects. Concepts have various degrees of abstraction (e.g., social development, health condition, cultural level, musical talent, etc.). The realm of things, on the other hand, is populated by physically real objects (e.g., people, hospitals, books, sounds)

To link these two worlds in a significant way we need a procedure that we call measurement. Measurement is a process applied to all real objects to determine symbolic values which, presumably represent a specific concept. Whether such values constitute a good or poor reflection of the concept is a matter to be established through a validity study. That it is in fact possible to link the two worlds constitutes an assumption, known as an epistemic assumption, which can be analyzed with some logical precision, but which in essence is a hypothesis that cannot be proved. Validity is the degree to which that assumption may be applied.

⁵ McAuliffe, W.E. (1978); "Studies of Process-Outcome Correlations in Medical Care Evaluation: A Critique". *Med. Care* 16:907.

⁶ McAuliffe, W.E. (1979); "Measuring the quality of medical care: process versus outcome". *Milbank Mem. Fund. Quart* 57:118.

The measurement of qualities or abstract concepts generally causes skepticism or unease. Social development, quality of life, or intelligence are considered unmeasurable by some people, and there will probably always be those who reject any attempt to measure abstract qualities.

The concept of social development poses numerous problems, some of which will be dealt with later in this paper. For the time being, however, we can state that very possibly it means different things to different people, which may reveal insufficient intellectual development of what we are trying to express through such a concept. Maybe it is an idea that has been formulated deficiently, and is impossible to measure. Nevertheless, although it may be very difficult to define, it must be acknowledged that the same is true of many other ideas which, thanks to the efforts of many great thinkers, have been accepted and are currently used with a certain degree of consensus and with relatively acceptable ways of measuring them. Consider the case of differential calculus, for example, to see how a concept that initially was even the object of ridicule could end up being fully respected.⁷

Health has also resisted theoretical definitions and although they do exist (the World Health Organization defines it as “the state of complete physical, mental and social welfare and not merely the absence of illness”), such definitions have serious deficiencies and are not taken very seriously by most scholars. Notwithstanding the above, in this field there are huge amounts of literature on measurements of state of health and which, despite the conceptual disagreement over the idea itself, show very similar practical methods. It is agreed that to measure the state of health of a population or of a social group, mortality and morbidity rates are acceptable indicators, although their virtues and defects are acknowledged. Functional indices, which attempt to measure a person’s state of health much more precisely, and which can be combined to reveal the condition of a whole group, have received considerable attention, and some of them are beginning to be widely used.⁸ On the way, these more practical studies have helped to unify ideas and to specify the meaning of the concept itself. In its time the same happened in the case of calculus, mentioned above.

What is beyond doubt is the fact that the construction of indices reflecting abstract ideas is a task that goes beyond than any isolated research but which, on the contrary, requires a consistent study program for its design and validation.

⁷ Boyer, C.D. (1959); “The history of the Calculus and its Conceptual Development”. *Dover Publications*, New York.

⁸ Bergner, M. et al (1981); “The sickness impact profile: development and final revision of a health status measure”, *Med Care* 19: 787.

Some of the obstacles in the measurement process may best be illustrated through an example. Suppose that we want to measure the talent of a pianist and compare his performance year by year in order to assess his progress. The quality of his performance is evident through innumerable aspects which are relatively concrete, such as the dynamic elements of sound intensity and those of duration, such as tempo and rubato. Each of these represents still more concrete capacities, such as the pressure applied on the keys, the use of pedals, and other things. But in addition to this we have the opinion of critics, concerts scheduled and popularity, which in turn is expressed through ticket sales and recordings. All of these factors, ranging from neuromuscular abilities to the audience attendance at his concerts, may be used as indicators. Each will reflect a different aspect but none of them, not even a combination of all the quantifiable indices, will reveal the overall artistic talent of the performer.

In general, any variable covered by the concept is capable of being used as one of its indicators, but, strictly, no component or set of components will capture everything, and there will always be some intangibles that resist being recorded. As a result, it seems impossible to measure the more abstract concepts.

It should be quite clear, however, that the two-world model means that all concepts, whether relatively tangible or concrete, are always abstractions that can only be inferred through the process of measuring the objects. This is true even in the case of natural sciences such as physics. Energy, electric power, or temperature, are abstract notions. Some may seem easier to our intuition, but the relationships between concepts and their measurement differ only in degree. Formally, there is no difference in the way they are measured.

Thus, there is no such thing as a direct measurement of a concept; instead, they all require inferences. In some cases, these are derived from a broad set of phenomena, and in others from just one, but from a qualitative perspective the process is the same.

1. Operational Definition of Validity

From an operational point of view, according to this model validity can be defined in statistical terms. As already mentioned, a concept may have different indicators. The material welfare of a social group, for example, is related to the factors that produce it (e.g., income or output per capita); and to factors resulting from it, such as effects or consequences

(e.g., nutritional state). Furthermore, other factors may exist, harder to classify, which simply correlate with the concept itself. Both the causes and the consequences, as well as other factors related to material welfare can be used as indicators. A causal relationship is not needed to establish the validity of a measure; a stable correlation is sufficient to enable it to be used as an index.

The validity of a measure is given by its purity, its exhaustiveness and its representativeness. A measure is pure if it only reflects a particular concept; it is exhaustive if it encompasses or contains all of the relevant aspects, and it is representative if it combines the various components in a balanced way. No measure is perfect, and validity is not a discrete quality that is either completely absent or completely present, but instead it varies along a continuum.

These points may be formalized by using statistical concepts (see Appendix 1). A set of measurements carried out in different social groups will show differences between them. These differences, which are mathematically expressed by the variance of the set, are due not only to real differences in the concept under study, but also to two errors: the systematic error, caused by the inclusion of other concepts in the same measure, and the random error, which is found in all measurements. The proportion of the variance that is due to variations in the concept, is defined as “validity” and corresponds to the statistical correlation between the concept and the measure used to quantify it. Although the correlation between a measure and a concept can never be measured directly, an approximation can be determined through empirical studies of validity, replacing the concept by another measure, the validity of which has already been accepted, or through other kinds of studies to be described later.

The systematic error reflects the impurity of a measure that captures more than one concept in its values. If the measure were to be used as an index of those other abstractions, the portion of the variance that could be considered valid would naturally change.

The reliability of a measure is defined as the proportion of the variance that is free from random error. Thus, validity is a component of reliability.

2. Methods for the Studying Validity

Several strategies have been developed to estimate the validity of a measure. In the area of social development there are two main problems that have to be solved in order to perform a validation study. The first

consists of deciding whether it is really possible to measure such a vague phenomenon, and the second consists of determining whether the degree of validity of the measure as such is sufficient for the purposes being pursued.

As regards the first of these, it is obvious that the notion of social development itself, which until now we have related to the changes in living conditions, needs to be refined. If the latter can be measured, we could then proceed to examine its evolution. However, living conditions — which would be better expressed by the term “social welfare” — pose potentially serious problems, as will be clear to many by the mere mention of the word “welfare”. It is well known that even the most rigorous attempts to define a social welfare function have failed, and that Keneth Arrow proved with his impossibility theorem, that the conditions or assumptions required to define it are mutually incompatible.⁹

The problem arises because each individual may have different preferences regarding the various components of welfare. That is to say, each person values the ingredients in a different way from the rest. For some, their children’s education may be much more important than care for the elderly, but others may think the opposite. These valuations can hardly be quantified, but it may be possible to classify them by a preference ranking. The next problem is to aggregate them in an acceptable way so as to form a system of social preferences.

Clearly, the difficulties may be solved by giving one person the right to decide dictatorially for everyone. A minimum of consistency on the part of that person would suffice to establish a social welfare function, even though the meaning of the term “social” in such conditions, to say the least, problematic.

However, it might be possible to weaken some of Arrow’s assumptions and obtain a reasonable ordering of the various options. The assumptions are the following:

- 1 Social preferences must be transitive (if A is preferable to B and B to C, then A must be preferable to C).
- 2 If everybody prefers A over B, then society’s preference as a whole must be A.
- 3 The social decision between A and B only depends on people’s preference between A and for B.
- 4 Nobody can determine the preferences of the social group by himself.

⁹ Arrow, K.J. (1973); “Formal Theories of Social Welfare”. In “Dictionary of the History of Ideas”, Vol. IV p. 276. *Charles Scribner’s Sons*, New York.

All these assumptions seem reasonable, but they are mutually inconsistent, and it is impossible to sustain all four of them at the same time. The third assumption, in particular, is much more restrictive than it seems at first glance, and if it is changed gradually, it might be possible to find a satisfactory solution to the problems of defining a minimum welfare function, at least.

Faced with this possibility, external decision—which does not take into account the opinion of the people involved— might be acceptable. But it is easy to find politically unacceptable paradoxes in arbitrary social welfare functions.

The option of minimizing a social suffering, as Karl Popper¹⁰ has suggested, does not solve the theoretical problem,¹¹ although the idea is not to be discarded. The complexity of the issue is frightening for those who aiming analyse it thoroughly.

Practical solutions are all arbitrary to some extent. In other words, it is not possible to avoid a group of experts defining the conditions they consider to be preferable without giving full consideration to the internal divergences of the social group. How much arbitrariness is tolerable, according to the political values of the country, is something that has to be examined in rather more detail than has been the case until now. In general, the experts have tended to favor different practical measures, without going into an exhaustive analysis of the notion underlying the measurement process.

The issue is not yet exhausted, and research continues into the question of finding a definition of social welfare. For many purposes, the only viable way seems to be to start the analysis without losing sight of the main issue, by means of a content validity study.

a) Content Validity: This is the first validity study method, and it is extremely useful when beginning the task of developing indicators or measures. Content validity is based on qualitative analyses of the basic components of welfare, which only seem to be definable in their more material aspects. Once these components have been defined, i.e substantive domain of the measure, it is then necessary to construct measures for each aspect of the domain and combine them in a balanced way.

This task, which does not produce a quantitative estimate of validity is, undoubtedly, very costly. The long list of components, the need to

¹⁰ Popper, K. (1966); "The Open Society and its Enemies". 5th edition. *Routledge and Kegan Paul*, London.

¹¹ Smart, J. C. C. and Williams, B. (1973); "Utilitarianism: for and against" *Cambridge University Press*, London.

perform adjust statistically for undesired factors, the weights of the various partial measures, data collection and processing methods and other difficulties, represent serious obstacles. But this procedure allows a global estimation of validity and makes it possible to offer suggestions for improving it.

Once a consensus has been reached with respect to its value, it is possible to proceed with construct validation.

b) Construct Validation: In this method, validity is judged on the basis of variation in the results actually obtained, in situations where the concept under study is theoretically modified. Thus, in different circumstances in which material welfare experiences alterations, according to theoretical predictions, the measures must change accordingly, as expected. Indeed, this process depends essentially on the quality of the theory on which the predictions are based, and, in the field of social welfare, due to its complex nature, it is difficult to obtain a general consensus.

None of the methods described leads to quantitative estimates of the validity of a measure, but they are required during the initial stages of studies. Subsequently, once a more precise definition of the notion of social development has been reached, it is possible to proceed to other methods.

c) Concurrent Validity: If a measure accepted as valid already exists, but which might be inconvenient in practical terms due to its cost (usually known as the criterion), a new simpler or cheaper measure may be validated by examining its correlation with the other one. The validity of some criteria, however, might not be very high, and a low correlation could be accounted for, in some cases, if the measure ends up being better than the criterion. At the beginning, however, it is judged in relation to the latter which, certainly, may be subject to constant revision.

d) Convergence Validity: The existence of a criterion assumes that many of the problems relating to the possibility of measuring such an abstract and general matter as social welfare, have already been solved. Convergence validity does not single out any of the measures which could eventually serve as a criterion. In these studies, several measures —assumed to have some degree of validity— are used and their mutual correlations are studied. If some of them have a strongly positive correlations, this would verify the assumptions about the validity of each one. It is possible that the correlation between two measures may be due to a factor other than the one we are interested in, such as, for instance, a common variance in the systematic error. A low correlation is even harder to interpret, as this

could be due to statistical factors, to errors in one of the measures, to the fact that they measure different aspects of the same concept (not well balanced measures), etc.

The basic underlying principle is the analytical study of the consistency of a set of assumptions, inferences and statistical data. It should not be forgotten that, in the end, validation efforts are always based on assumptions and inferences.

e) Predictive Validity: This method is also based on the existence of a criterion and may be useful in the field of social policies. Its application is reserved for situations in which one desires an early measure that will anticipate the subsequent evolution of the criterion. The classic example is that of admission tests to predict performance at school or work. It is a compromise of sorts, in which some validity is sacrificed in exchange for obtaining a more timely measure. Those responsible for implementing public decisions would undoubtedly be interested in finding a measure—perhaps a component of social welfare—that would anticipate its future evolution and allow a rapid assessment of many programs.

III. Health Indicators and Social Development

Probably, the best way to measure social development is to proceed in a manner similar to the methods described in the previous section. However, because of an insufficient number of studies in our country, it might be useful to try to examine some fairly simple and well established indicators, to determine their validity as measures of social development.

In the first part of this paper we saw that the GDP per person suffers from certain deficiencies and should not be used as the only measure of social welfare. At this stage of the evolution of the concepts under study, an analysis of convergence between various measures associated with development would seem to be a promising method as, in this way, work would proceed to refine the ideas while measuring actually prevailing conditions at the same time. In particular, we are interested in examining the traditional health indicators in order to obtain an approximate estimate of their validity as social development indices. These indicators are well known; they do not present major ambiguities, they are practically the same for all countries, and records have been kept for a long time. In all these aspects they are better than any of the other proposed indicators¹² but,

¹² Piñera, S. (1978); “¿Cómo medir el progreso de los países?”, *Cepal*, working paper.

like all the others, they have not been systematically validated for this purpose.

There are numerous studies that support the idea that some of the health indicators are very good indices of general welfare. Infant mortality, in particular, (mortality among children under one year old) and late infant mortality (children between 28 days and one year old) have been considered as the most sensitive indices of a society's development.^{13 14} Some of these studies base their conclusions on thorough quantitative analysis. Others attach greater importance to the qualitative analysis of the factors determining mortality. Menchaca, for example, states: "This small human being, not yet well adapted to the nature and culture surrounding it: if the home is unhygienic it cannot escape; there is little it can do if the food provided does not meet its quality and quantity requirements; it is helpless against a lack of organization within the family and the community, against parental ignorance and the absence of social assistance and social security".

This base, although acceptable in principle, has been the subject of much controversy. In our country, these ideas have been questioned. However, there is data, obtained through a well designed and controlled study¹⁵ which provides direct evidence of the influence exerted by poverty and isolation of the home, by the availability of drinking water and sewage systems, as well as by overcrowding and the mother's educational level, on the risk of death in small children. The lack of correlation between mortality and the general state of the economy, measured essentially through GDP and unemployment indices, have caused many to doubt the usefulness of the correlation between mortality and living conditions in Chile.^{16 17 18}

For a large proportion of the population, the main determinant of health indicators is the quality of medical care. Those who believe this support a conceptual model that attributes a high degree of effectiveness to medicine, although they usually express this implicitly. The inevitable co-

¹³ Brenner, M. H. (1973); "Fetal, Infant and Maternal mortality during periods of economic instability", *Int J. Health Services*, 3: 145.

¹⁴ Menchaca, F. J. (1981); "La mortalidad infantil post-perinatal como indicador del desarrollo económico-social". *Cuad. Med. Soc.* 22: 42.

¹⁵ Burke, M. (1979); "Inter-american investigation of mortality in childhood-report on a household sample". *P.A.H.O. Scientific Publication* N° 386.

¹⁶ Raczyński, D. and Oyarzo, C. (1982); "Evolución reciente de la tasa de mortalidad infantil", *Rev. Med. Chile*, 110: 784.

¹⁷ Medina, E. and Kaempfer, A.M. (1982); "La salud en Chile durante la década del setenta. I: Descripción de la situación. II: Un intento de interpretación", *Rev. Med. Chile*, 110: 903 and 1004.

¹⁸ Haignere, C. S. (1983); "The application of the free market economic model in Chile and the effects on the population's health status", *Int J. Health Services* 13: 389.

rollary is that mortality indices are valid as a measure of social reality only to the extent that medical care is a reflection of such reality, and this may very high or very low.

The issue has not been clearly resolved and, so some questions are valid and pertinent. Cannot medicine alter the final results in the health area, separating this variable from the rest of the set of social and economic phenomena? Is it possible that medical technology constitutes such a selective intervention that, without substantially modifying the conditions of material welfare, they can have a significant impact on mortality rates? Or, on the contrary, do these depend on the set of material, social and cultural conditions—which we have vaguely identified with social development—without being affected by medicine?

In this section we shall present some of the countless studies that may be useful in attempting to answer to those questions. The last part will present some preliminary results of an analysis of national and Latin American data.

a. Historical Background

Since ancient times it has been accepted that medical intervention has a decisive impact on the outcome of illnesses. Hypococrates and Galeno, lacking any effective medical capacity, achieved renown for the effectiveness unjustifiably attributed to their methods. Only in the 19th century did the first controlled therapeutical research emerge and, to everyone's surprise, it was observed that many illnesses, when left to follow their natural course, ended in spontaneous healing. The importance of this finding did not go unnoticed. In 1876, Harvard professor Edward Clarke stated that, in his opinion, this finding was the medical science's greatest achievement of the century.¹⁹

Since then, a vast amount of literature has accumulated, tending to confirm the limited influence of medical intervention on people's mortality. Thomas McKeown, in England, and René Dubó in the United States, have been the main figures behind these ideas.

McKeown began his research by studying population growth in England and Wales during the 18th century. His conclusions state that this was caused by a fall in mortality rates which can only be accounted for by an improvement in environmental conditions.²⁰ This statement not only

¹⁹ Thomas, L. (1979); "Medical lessons from history". "The Medusa and the Snail". Bantam Books, New York.

²⁰ McKeown, T. and Brown, R. G. (1955); "Medical evidence related to english population changes in the eighteenth century". *Pop Studies* 9: 119.

surprised those who attributed the change to increasingly efficient medical actions, but it also contradicted the widespread belief that the industrial revolution had caused a deterioration in environmental conditions. Today, however, a large number of economic historians share McKeown's opinion about that period's environment, including Von Hayek and Ashton. As Hayek has suggested, the poor of those times were the dead of earlier times.²¹ McKeown, who is a medical doctor, based his conclusions on the systematic elimination of other hypotheses and finally supports it further by quoting Sherlock Holmes: "Having eliminated the impossible, what remains, no matter how improbable, must be the truth".

He then went on to study mortality in the 19th century, from 1838, when official records were established, to make his now classic finding that mortality caused by tuberculosis, one of the main causes of death at that time, began to decline at the same time as the earlier records.²² When the tuberculosis bacillus was discovered, mortality from that cause had already declined by 50%. Subsequently, it was proved that this particular mortality rate was already minimal in Europe when the first effective medicine against the illness was discovered.

In his work, McKeown attributes little influence to scientific progress and professional care in the change in the general mortality rate which occurred in the twentieth century:²³ probably less than 10%.

Clearly, these studies have given rise to criticism. Eversley²⁴ stresses the existence of many factors, not only environmental conditions, in explaining the decline in mortality. But, he says, if one factor has to be singled out, it must be the fact that "the great epidemics did not recur for reasons that may not be related to any human action". Later on in the paper we shall see other criticisms, and although they may cause us to alter certain figures and ideas, the basic conclusions arrived at by McKeown have resisted subsequent analysis quite well.

In the United States, Dubó came to similar conclusions.²⁵ In the second half of the 18th century, both leprosy and the plague had virtually disappeared in Europe, and smallpox, malaria and cholera were largely

²¹ Hayek, F. et al (1960); "Capitalism and the Historians", *University of Chicago Press*, Chicago.

²² McKeown and Record, R. G. (1962); "Reasons for the decline of mortality in England and Wales during the nineteenth century". *Pop Studies* 16: 94.

²³ McKeown T. et al (1975); "An interpretation of the decline of mortality in England and Wales during the twentieth century". *Pop Studies* 29:391.

²⁴ Eversley, D. E. C. (1965); "Population, economy and society", quoted in Bereby (30).

²⁵ Dubó, R. (1959); "The mirage of health", *Anchor Books*, New York.

under control. Many of these illnesses, including typhoid, were practically eradicated in Europe way before the theory of germs was formulated.

Analysis carried out with North American data reveal the same results.²⁶ The great decline in mortality in North America is mainly due to the disappearance of certain infectious diseases for which, at least, there are efficient treatments. However, the conclusions of the researchers indicate that medical-type measures, chemotherapeutic and prophylactic between them, account for a minimal part of the reduction in the mortality rate—probably less than 3.5%.

In Latin America, the reduction in mortality has taken place at a faster pace than in the developed countries, and although it is equally true that the general process of development has been faster—economic growth rates in Europe during the 19th century reached an annual average of 1.5%²⁷—it is possible that medical intervention has been and still is more effective here than it was in Europe in the past. Taucher,²⁸ however, whilst studying the decline in mortality in Chile between 1955 and 1975, found that the phenomenon was mainly the result of a decrease in deaths caused by preventable illnesses. There was also a reduction in illnesses that react to sanitation and to mixed measures. The only ones that did not experiment any decline were those that depend on medical diagnosis and treatment.

Blanco *et al*²⁹ did a factor analysis of the structure of causes of death by Chilean province, in two recent periods. Although the study was not designed to examine the determinants of mortality, the authors were able to conclude—through very indirect inferences—that medical attention might partially affect the structure of causes of death. The third factor in their analysis, which accounts for 10% of the total variance, might partly reflect the influence of medical services.

b. Socioeconomic Determinants of Mortality

Studies in this field, perhaps more abundant than those related to medical effectiveness, reveal the significant effect of socioeconomic fac-

²⁶ McKinlay, J. B. and McKinlay, S. M. (1977); “The questionable contribution of medical measures to the decline of mortality in the U.S. in the twentieth century” *Milbank Mem. Fund Quart.* 55: 405.

²⁷ Hartwell, R. (1972); “The long debate on poverty”. *Institute of Economic Affairs*, London.

²⁸ Yaucher, E. (1978); “La mortalidad en Chile desde 1955 a 1975: Tendencias y causas”. *Notas de Población* 6: 113.

²⁹ Blanco, R. et al (1977); “Análisis del factor para la estructura de las causas de muerte en Chile. I parte: Quinquenio 1961 – 1965. II parte: Quinquenio 1968 – 1972”, *Rev. Med. Chile*, 105: 822 and 934.

tors on the traditional health indicators. Grosse,³⁰ in studying developing countries, concluded that social factors such as nutritional and hygiene habits, explain variations between countries better than medical and sanitation factors.

In the developed countries it has been possible to carry out studies for each cause of death and, in general, socioeconomic factors have been found to prevail as determinants of mortality.³¹

The methodologies needed to reach reliable conclusions are inevitably complex due to the number of variables at play. Various forms of multiple regression, factor analysis, principal components, time series in several of its variations, and other more specific methodologies may be required to answer some of the questions.³² However, nothing eliminates the problem of data quality, which is particularly significant in less developed countries. Nevertheless, on analyzing various countries selected for the quality of their statistics, it is possible to use some of the more powerful analytical methods.

In Israel, Berebi and Silver (30) did a study of mortality in 34 countries with different levels of development and found, by means of an analysis of principal components, that the first component, which undoubtedly reflects the general level of development, explains more than 50% of the variance. In a proximity analysis, which enables the study of various pathologies, they could only find moderate medical effects in two of the eleven causes of death under study: respiratory and degenerative diseases.

Studies on Latin America are few, probably due to the researchers' mistrust of statistical data.³³ Carvajal and Burgess³⁴ analyzed five economic variables as determinants of fetal and child mortality, using a multiple regression model. The study was carried out with samples of women from three cities and revealed that the variables—income, education, labor force participation, migration and legal marriage—explain much of the variance. In some age groups it reaches 43%, and the minimum, observed among young women in Rio de Janeiro, was close to 15%.

³⁰ Grosse, R. B. (1979); "Background paper on health", mimeo, quoted in Berebi (30).

³¹ Berebi, Z. M. and Silber, J. (1981); "Health and development: socioeconomic determinants of mortality structure". *Soc. Sci. Med.* 15C: 31.

³² Pocock, S. J. et al (1982); "Analysing geographic variation in cardiovascular mortality: Methods and Results". *J. R. Stat. Soc. A* 145: 313

³³ Palloni, A. and Wyrick, R. (1981); "Mortality decline in Latin America: Changes in the structure of causes of death, 1950-1975". *Social Biol.* 28: 187.

³⁴ Carvajal, M. and Burgess, P. (1978); "Socioeconomic determinants of fetal and child deaths in Latin America". *Soc. Sci. Med.* 12C: 89.

Palloni and Wyrick³² studied mortality decline in eleven Latin American countries, with the aim of estimating the influence of the dissemination of medical technology as opposed to environmental conditions. With a multiple regression model using only three variables —Gross Domestic Product, illiteracy and availability of drinking water— the authors were able to explain 90% of the variance in standardized mortality rates for the 1950's, and 67% for the year 1973. The GDP variable, however, has no significant influence in 1973, so only one educational variable and another housing variable assume the whole power of the model.

This result is particularly interesting, as it comes from a study done in countries that were experimenting a rapid reduction in their mortality rates, in a period when efficient medical technology existed to fight high prevalence diseases. The contrary hypothesis would therefore have seemed more likely.

Although the reliability of Latin American data may give rise to some doubts, the authors' conclusion that "the non-economic factors proved much less significant than was earlier thought" seems unquestionable. Among malaria-free countries, such as Chile, the data are even clearer, indicating a strong influence of living standards on mortality rates.

In social sciences it is almost impossible to isolate variables and study them mathematically. Because of this, the analysis of relatively complex statistical models is necessary. The case of England, however, provides some simple data which are relevant to the study of the socioeconomic determinants of mortality. For over 30 years, England has had a unique health service which provides equal care to all social sectors. In a way, it could be said that the medical care variable became a constant parameter in that country. Yet changes in mortality from 1951 to 1971 varied according to social strata.³⁵ , ³⁶ In the case of the highest class mortality declined by 29%, the middle class declined by 8%, while the two lowest classes experienced an increase of 9% and 3%. That is to say, with equal medical care, the differences between the social classes increased as far as mortality is concerned, reflecting the effect of other factors of vital importance. There are, however, a series of variables that are neither medical nor economic, such as, for example, the smoking habit, which might explain part of these differences (in 1976, 53% of the English blue-collar workers smoked, whereas only 25% of professional people did so; however, there is no data available for 1951 to allow a quantitative examination of this hypothesis).

³⁵ Bosanquet, N. (1981); "Mortality rates and social class". *Lancet* 1: 162.

³⁶ Townsend, P. (1981); "Toward equality in health through social policy". *Int. J. Health Services* 11: 63.

But, undoubtedly, the finding tends to confirm the influence of the set of non-medical determinants, of a social or cultural nature, on the mortality rate.

An experience related to what happened in England occurred in the United States, between 1956 and 1962. On the indian reservation of Many Farms–Rough Rock, of the Navajo indians, Cornell University set up a medical team that made all modern medical technology available to the impoverished inhabitants. In 1968 a count was made and it was found that the mortality rate had not undergone significant change. The modern medical equipment, which included an entire range from vaccines to surgical instruments, only reduced the incidence of certain illnesses that can have side effects, but which usually do not cause death, such as middle-ear otitis in children.³⁷

c. Behavioural Factors

The influence of culture and social habits on people's health is a fact that has been proven repeatedly. The large amount of literature on this issue will only be illustrated by mentioning certain studies dealing with the main causes of death in Chile.

Cardiovascular and circulatory diseases have been linked to eating habits, smoking, sedentary lifestyles, emotional stress and certain personality traits. Some of these factors have been very well established. During the Second World War, the nutritional diets of many nations experienced significant modifications that enabled quasi-experimental studies to be made, all of which showed in a notably precise way that cardiovascular diseases, to a large extent, are conditioned by the consumption of certain types of lipids.³⁸, ³⁹ The decline in this cause of death in the United States as from 1964, may also be explained by a change in nutritional and smoking habits.⁴⁰

Apparently, modern medical technology has not had a major influence in changing mortality rates caused by these illnesses. Mather *et*

³⁷ McDermott, W. et al (1972); "Health care experiment at Many Farms". *Science* 175: 23

³⁸ Strom, A. and Adelsten Jensen, R. (1951); "Mortality from circulatory diseases in Norway 1940-1945" *Lancet* 1: 126.

³⁹ Malmros, H. (1950); "The relation of nutrition to health: a statistical study of the effect of the war-time on arteriosclerosis, cardiosclerosis, tuberculosis and diabetes". *Acta Med. Scan* 246 Suppl. (137)

⁴⁰ Walker, W. J. (1977); "Changing United States life-style and declining vascular mortality: cause or coincidence?". *N Engl. J. Med.* 297: 163.

al.,⁴¹ in a random clinical testing, found that mortality due to heart attack was the same whether the patient was looked after at home or in the most complex specialized hospital units. This study has given rise to controversy and should not be taken as the last word. What is quite clear is that, despite the tremendous technological progress that has taken place, its actual effects are not as obvious as they are supposed to be. It is significant that the study on coronary care units was carried out after these had been in operation for several years. Today, there is still a lack of precise measures of the effects of these treatments which, although potentially effective, have probably not been used in the most appropriate way.

The influence of medical practices in this area has not been clearly determined. Economic development, by itself, does not seem to have an effect on these illnesses either, which probably depend essentially on social and cultural factors. Indirectly, yes, it is possible that economic development, through its effect on social phenomena, may alter mortality from these causes, but it is not possible to predict whether it increases or decreases it.

As regards cancer, the second cause of death in Chile, its determinants are not well known, although everything seems to indicate that it is an environmentally originated disease.⁴² Prevention of smoking, by itself, would reduce the mortality caused by all types of cancer by one third.⁴³ Some forms of this disease seem to involve predisposing factors as diverse as the loss of a significant person during the patient's childhood, divorce, and the inability to express emotions.⁴⁴

Medical programs aimed at controlling this illness are not providing convincing results. Economic factors alone do not appear to have a decisive influence either. Our ignorance in this matter only allows us to say that medicine has a moderate influence, at most, and that the other determinants can only be described through epidemiological studies.

The third cause of death in Chile relates to accidents which, contrary to common belief, have a complex relation to development, and a general tendency towards reduction has been observed.

The effect of medical care over on main causes of death is not very pronounced. The same could be assumed regarding the elements of econo-

⁴¹ Mather, M. G. et al (1971); "Acute myocardial infarction: home and hospital treatment". *Brit Med J* 3: 334.

⁴² Doll, R. and Peto, R. (1981); "The causes of cancer: quantitative estimates of avoidable risks of cancer in the U.S today". *J. N. C. I.* 66: 1200.

⁴³ Doll, R. (1983); "Perspectivas de la prevención"; *Foro Mundial Salud* 4: 253.

⁴⁴ Wood, C. (1982); "Cultura, estilo de vida y enfermedades crónicas". *Foro Mundial Salud* 3: 509.

mic development, but in order to determine the relevant factors the only alternative is to undertake an analysis of the empirical data. The information available to date attaches great importance to social and cultural factors.

d. Rigorous Measures of Medical Efficiency

Another interesting source of data for our analysis comes from a detailed study of medical practices. In England, Cochrane⁴⁵ has carried out a detailed analysis on this issue. The therapies which have been closely studied have resulted, with alarming frequency, to be ineffective. The list would be long to detail, but it includes the treatments for heart attack diabetes, cancer, some forms of anemia, and many psychiatric treatments. Equally long would be the list of effective therapies, such as those for most infectious diseases, hypertension and others. In actual fact, there are treatments that are so effective that for ethical reasons it is not possible to carry out controlled studies.

The conclusion, however, is far from being the expected one, in view of the frequent celebrations of the progress of modern medicine. "One should be delighted and surprised whenever any treatment turns out to be effective, and should always assume a treatment is ineffective until the opposite is proved", concludes professor Cochrane.

The same phenomenon seems to occur in practically all fields of medicine. In obstetrics, the issue check-ups during pregnancy still cannot be considered solved. Women who attend their check-ups are those with a certain cultural level and who, moreover, are interested in the outcome of their pregnancy. Their good final results cannot be attributed exclusively to medical supervision. Apparently, medical intervention in this field is supposed to lower the risk of having a child of low birth weight, and this would apply only to mothers coming from a low socioeconomic level.⁴⁶ The various studies have come up against different methodological problems and present different conclusions. The same does not seem to be the case with professional care during delivery, which, despite the controversies, probably does reduce perinatal mortality.⁴⁷

⁴⁵ Cochrane, A. L. (1972); "Effectiveness and efficiency: Random reflections on health services". *The Nuffield Provincial Hospitals Trust*.

⁴⁶ Gortmaker, S. L. (1979); "The effects of prenatal care upon the health of the newborn". *Am J Public Health* 69: 653.

⁴⁷ Adamson, G. D. and Gare, G. D. (1980); "Home or hospital birth". *J.A.M.A.* 243: 1732.

We shall not dwell much more on this issue, which is of an eminently technical nature. I would only add that studies on surgery are not very optimistic,^{48 49} and that in pediatrics there are data to suggest that only a small proportion of deaths could be avoided with medical action.⁵⁰ Too-late medical attention and even death in the home, are fairly frequent among these patients.

Cochrane makes a distinction between opinions, observations and experimental testing, as bases for justifying the different medical behavior. The experimental approach in clinical medicine can be said to have started only in the 1950s, when several of the current professional conducts were already quite developed. Many of the forms of medical care were accepted in accordance with the methods that were available at the time —opinions and observations— and they have not been subjected to the rigorous proofs that are possible today.

The Role of Medicine

The evidence that the influence of medicine on mortality rates is somewhat limited, albeit not negligible, has encouraged in many circles a reflexion on the social role of medical activities. The results presented undoubtedly conflict with the general belief among the public and the vast majority of clinicians, so I shall allow myself a digression to deal briefly with this issue.

In the first place, it is necessary to recognize the emergence of certain groups which attribute a decidedly negative social value to the medical profession. The most outstanding representative of these trends is Iván Illich, who takes the ineffectiveness of medicine for granted, but also extends the concept of iatrogenics to include a cultural dimension.⁵¹ His ideas, while interesting and worth knowing about, are clearly exaggerated and I shall not present them in this article.

⁴⁸ Bunker, J. P. et al (1977); "Costs, risks and benefits of surgery". *Oxford University Press*, New York.

⁴⁹ Wennberg, J. and Gittelsohn, A. (1982); "Variations in medical care among small areas". *Scientific American*, April: 120.

⁵⁰ Pharoah, P. O. D. (1976); "International comparisons of perinatal and infant mortality rates". *Proc. R Soc. Med.* 69: 335.

⁵¹ Illich, I. (1976); "Medical nemesis: the expropriation of health". *Random House*, New York.

A more significant line of argument call into question the validity of mortality rates as health indicators.^{52, 53} If we use physical disability instead, the general health evolution picture in some countries is very different to that obtained using mortality figures.⁵⁴ A very interesting investigation, because of its methodology,⁵⁵ concludes that traditional indicators should be abandoned as a means of evaluating the effectiveness of medical attention, as they are highly sensitive to sociodemographic variables. The authors propose searching for other indices, such as lethality by diagnosis, to achieve these objectives.

Preventing disease; educating of patients about the predisposing factors of the various infections; avoiding the aftermaths of certain illnesses; rehabilitating the disabled; assuring healthy people of about their good state of health; diagnosing and formulating prognoses and, most particularly, healing, treating, providing comfort and alleviating the sick, are top priority medical tasks, as anyone who has suffered the uncertainty and pain of illness may bear witness to. It must also be remembered that, if only 1% of deaths are avoided in a given year, we are talking about approximately 500,000 individual cases. It is not possible in the present paper to examine the social role of medicine, which I consider to be of great value, but we can make clear that its influence on mortality should in no way be understood as the sole task of a doctor.

Furthermore, an important distinction needs to be made between medical care and health services. In our country, the latter constitute an important community center providing health education, offering non-medical social services, distributing foodstuffs and performing other tasks that do not correspond to medical care as such. Some of these tasks make a direct contribution to social welfare and were not considered in the previous discussion, for there we were trying to clarify the possibility of selective medical intervention that would alter mortality without having a specific effect on general welfare conditions. For the purposes of the present study, we have not tried to isolate health service actions, but only those corresponding to classical medical care.

⁵² Green, R. M. (1977); "Beyond the role of medicine: McKeown as medical philosopher", *Milbank Mem Fund Quart* 55: 389.

⁵³ McDermott, W. (1980); "Medicine: the public good and one's own" *World Health Forum* 1: 123.

⁵⁴ Wilson, R. W. (1981); "Do health indicators indicate health?" *Am J Public Health* 71: 451.

⁵⁵ Martini, C. J. M. et al (1977); "Health indexes sensitive to medical care variation" *Int. J. Health Services* 7: 293.

Nevertheless, measurement of health service performance should be attempted. The information on some of the experience abroad is not favorable, but it could hardly be applied to our country. In Venezuela, life expectancy in various municipalities rose at the same rate in municipalities with organized health services as in those without such services.⁵⁶

Our ideas and concepts are based both on assumptions and on actual data. For most people, the studies I have briefly reviewed come as a surprise. Over the centuries, the concept of health was linked to a notion of balance between different elements. For the Greeks, four humours determined the state of health; for the Chinese, the balance between Ying and Yang. With the advent of Cartesian reductionism, the stage was set for the emergence of the theory of specific etiology, which explains the origin of illnesses mechanically and linearly, from cause to effect. When Koch discovered that inoculation with certain bacilli caused tuberculosis in previously healthy animals, it was thought that the final answer had been found for all questions concerning the nature of the diseases that had afflicted man since his origins. However, if it had been able to examine the lungs of Koch himself, or those of the most people attending his lectures, it could have been proved that the bacillus was present in them without producing any alterations (see note 19). The germ's presence is a necessary condition, but is far from being sufficient.

The cause of illnesses is so complex, that even the use of the word "cause" is inadequate in this context.⁵⁷ In almost every case "the joint action of various determining factors is needed to produce a pathological status", according to Dubó⁵⁸, and in normal conditions, outside the laboratory, the complexity of the phenomena even in such simple cases as an accident caused by a bald tire bursting on a rainy night on a road being repaired, prevents answering the question: "What is the cause?". The rain? The night? The signals in the road? The nail that resulted in a burst tire? The wear and tear on the tires? The age of the driver? The driver's state of health? The festivities at a party earlier? It is useless to restrict oneself to a simple line of cause and effect in order to clarify all the factors that determine this kind of phenomenon.

Medicine, like all contemporary sciences, seeks explanations through the analytical separation of different elements. In reality, complex

⁵⁶ Gabaldón, A. (1980); "First need, to track the killer". *World Health Forum* 1: 159.

⁵⁷ Bunge, M. (1979); "Causality and modern science". Third revised edition: *Dover Publications*, New York.

⁵⁸ Dubó, R. (1975); "Hombre, medicina y ambiente". *Fondo de Cultura Económica*, Mexico, p. 121.

systems do not fit this model, and we will probably come upon many more surprises before we can identify a new paradigm to address these kinds of phenomena. Meanwhile, it can be said that medicine's traditional methods do not seem to be as effective as they were once thought to be. The huge contemporary effort made on this basis —over the past 20 years medical expenditure has matched that of all previous history—⁵⁹ has not yielded the expected results. Probably because changes in mortality were attributed to medical intervention, it was thought they could continue steadily, but figures show that without improvements in social and economic conditions, not much can be achieved.

IV. National and Regional Observations

The data analyzed enables us to state quite confidently that the proposal to use mortality rates as indicators of general living conditions is worthy of consideration. An exhaustive study of the matter should include various validation strategies and, even then, numerous investigations would be needed to support this kind of proposal and obtain quantitative estimates of the validity of such indices.

A brief preliminary analysis of some Chilean and Latin American data, presented in Appendix 2, tends to confirm the validity of health indicators as measures of social development. Examining the traditional mortality indicators together with economic, educational, housing and health care variables, reveals multiple correlations between the majority of the factors considered.

The available data, however, are not sufficient to reach final conclusions. The level of aggregation, on the one hand, and the variables used, which were selected largely due to their availability, rather than the result of a good prior analysis of the components of the welfare concept, are difficulties that must be overcome at a later stage.

Nevertheless, up to now, it may be noticed that traditional health indicators seem to be immersed in a network of social phenomena from which it would be arbitrary to isolate them. In Chile, socioeconomic conditions apparently continue to affect mortality rates. Despite the danger of reaching conclusions on the basis of correlation coefficients, it is still interesting to note that a significant association was found, for example, between general mortality and housing conditions, and between infant mortality and propor-

⁵⁹ Horrobin, D. F. (1980); "Whither medicine? Nemesis or not? A reply to Ivan Illich". *World Health Forum* 1: 139.

tion of the population employed by the PEM (*Translator's note*: Emergency Minimum Employment Program) (See Appendix 2). Many other pertinent relations could be discussed, but the only purpose of examining the data was to observe the behaviour of mortality rates compared with other variables. Neither mortality rates nor the variables corresponding to medical services present special characteristics that would justify excluding them from a set of social indicators.

The present paper, very modestly, tends to confirm the decision made by international organizations to use mortality indicators as social development indices. Their systematic validation, however, is a pending task that requires the participation of numerous researchers.

Appendix 1

If (X_i) represents a set of real measurements obtained by using the measure X , the total variance σx_i^2 may be broken down into three elements:

$$\sigma x_i^2 = \sigma v^2 + \sigma es^2 + \sigma e^2$$

where σv^2 corresponds to the variance associated with the concept under study, known as the valid variance; σes^2 is the variance due to systematic error and σe^2 is the variance originating in the random error.

The validity of a measure is given by:

$$\text{Validity} = \frac{sv^2}{sx_i^2}$$

which corresponds to the algebraic expression of $\sqrt{xc^2}$, the square of the theoretical correlation coefficient between measure X and the concept C .

The reliability of a measure is given by:

$$\text{Reliability} = \frac{sv^2 + ses^2}{sx_i^2}$$

Appendix 2

This Appendix presents a brief analysis of national and Latin American data, obtained from *Geografía Económica de Chile*,⁶⁰ as well as from the National Institute of Statistics⁶¹ and Unicef⁴

As regards Latin America, 24 countries were considered and for each a record was made of life expectancy, an expression that summarizes the mortality rates for each age group. Furthermore, per capita GDP was included as an economic indicator; two variables from the medical services: number of inhabitants per hospital bed and number of inhabitants per doctor; two housing variables: number of people per room and the proportion of inhabitants without drinking water in their home; and three educational variables: illiteracy amongst those aged 15 years or more, illiteracy among the 11–15 year-old population and the net rate of schooling amongst 6–11 year-olds.

The correlation matrix is shown in Table 2. The first column shows Pearson correlation coefficients between the variable under study, life expectancy, and the others. The number shown in parenthesis corresponds to the significance level; i.e. the probability that an equal or higher coefficient would be obtained simply at random. It may be noted that all the variables show a significant correlation with the variable under study, but at the same time it can be seen that multicollinearity between all the variables is high.

The multiple regression analysis was deliberately kept simple, without including interaction terms or performing transformations, as we only wanted to explore the capability of the life expectancy variable to reflect the values of the other variables. The analysis was done using the corresponding program from the Statistical Package for Social Sciences, using the step-up procedure whereby in each step a new variable is added only as a function of the residual variance. In this way, to some extent one can avoid repeating variables that are highly intercorrelated.

The first step included adult illiteracy, which explains 67% of the variance of the dependent variable. Subsequently, the following variables were introduced successively: number of inhabitants per hospital bed, illiteracy in the 15–19 age group, the percentage of the population not connected to the drinking water system, and the number of people per room, thereby obtaining an explained proportion of the variance equal to 85%. Not all of the regression coefficients, however, are significant, and two of them show the opposite sign to that expected. Multicollinearity does not allow further

⁶⁰ Gemines (1982); “*Geografía económica de Chile*”, Editorial Andrés Bello, Santiago.

⁶¹ Instituto Nacional de Estadísticas (1983); *Compendio Estadístico 1983*, Santiago.

study of the data which, nonetheless, reflect a close relationship between all variables, including life expectancy.

In the Chilean case, the data were taken by regions and included general mortality and late infant mortality. As well as this, 19 other variables were recorded as they were considered to be independent variables. The list of the variables is included in Table 3. Table 4 presents the correlation coefficients between the different mortality rates and the variables that were statistically related to them. In this table it can be seen that a series of factors appear to be related to mortality rates. However, correlation coefficients do not constitute conclusive evidence, and further studies are needed to clarify the nature of such relations.

It is important to stress that data on the age distribution of the population were not available, which would have made it possible to adjust the variables for that factor. This could well explain certain correlations that are apparently paradoxical, such as the positive correlation between child mortality rates, on the one hand, and the number of school students per inhabitant, the amount of milk distributed per inhabitant and the number of appointments non-medical professionals. If the primary school coverage is high and uniform throughout the country, as it seems to be, the variable "primary school students per inhabitant" would reflect the proportion of young children in the population, and the multicollinearity between the five variables mentioned could be explained by this demographic factor. According to well established studies, there is an association between high birth rates and high infant mortality rates.

Multiple regression analysis is the most appropriate tool for studying the relations between the variables considered. Table 5 summarizes these analyses, undertaken using the step-up method for each type of mortality. The table indicates the variable included in each step and the proportion by which the variance is reduced by its inclusion. The total variance explained is quite high, but not all the regression coefficients are significant.

Table 6 presents standardized regression coefficients for the independent variables incorporated in the first three steps of the step-up analysis. One can appreciate the relative influence of each independent variable on the mortality under study, avoiding the apparently exaggerated weight given to the first variable to be incorporated in the step-up process.

Finally, factor analysis was performed to reduce the explanatory variables. This analysis transforms the set of variables into a new set of orthogonal factors (not mutually correlated). In one sense this method is the inverse of the one described in Section II. This analysis is used to select

the measures for the data set, but the concepts underlying each of them is unknown.

The first factor, which accounts for 52% of the variance of the data set, probably reflects demographic composition, as it is highly correlated with the number of students in primary school per inhabitant and the milk distribution program, and shows an inverse relation to the number of telephone lines per inhabitant. Moreover, it has a negative correlation with the number of medical doctors per inhabitant and with the number of square meters of housing constructed per inhabitant during the decade.

The second factor, which accounts for 18% of the variance, is highly correlated with power consumption and with medical appointments per inhabitant, and to a lesser extent with the number of inhabitants per square meter of housing and with GDP per capita. There are no significant negative correlations. It is not easy to interpret the meaning of this factor, although to some extent it may reflect economic welfare.

TABLE II: CORRELATION MATRIX FOR LATIN A MERICAN DATA

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|--------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|-----|
| | L.E. | GDP | I./H B | I/MD | PPR | PWW | I. 15+ | I.15-19 | NSR |
| 1. Life Expectancy | 1.0 | | | | | | | | |
| 2. GDP per capita | 0.618 | 1.0 | | | | | | | |
| | (0.001) | | | | | | | | |
| 3. Inhabitants /Hosp. bed | -0.719 | -0.558 | 1.0 | | | | | | |
| | (0.001) | (0.004) | | | | | | | |
| 4. Inhabitants per doctor | -0.514 | -0.517 | 0.757 | 1.0 | | | | | |
| | (0.009) | (0.008) | (0.001) | | | | | | |
| 5. People per room | -0.387 | -0.423 | 0.726 | 0.620 | 1.0 | | | | |
| | (0.051) | (0.045) | (0.001) | (0.004) | | | | | |
| 6. % Pop. w/o drinking water | -0.747 | -0.429 | 0.738 | 0.630 | 0.549 | 1.0 | | | |
| | (0.001) | (0.026) | (0.001) | (0.001) | (0.007) | | | | |
| 7. Illiteracy 15yrs+ | -0.842 | -0.585 | 0.776 | 0.731 | 0.523 | 0.681 | 1.0 | | |
| | (0.001) | (0.002) | (0.001) | (0.001) | (0.011) | (0.001) | | | |
| 8. Illiteracy 15-19yrs | -0.702 | -0.428 | 0.755 | 0.735 | 0.269 | 0.667 | 0.937 | 1.0 | |
| | (0.001) | (0.027) | (0.001) | (0.002) | (0.157) | (0.001) | (0.001) | | |
| 9. Net Schooling Rate 6-11 yrs | 0.814 | 0.497 | -0.684 | -0.549 | -0.477 | -0.657 | -0.930 | -0.839 | 1.0 |
| | (0.001) | (0.009) | (0.001) | (0.005) | (0.019) | (0.001) | (0.001) | (0.001) | |

Pearson Correlation coefficients between the indicated variables, using data from 24 Latin American countries.

TABLE III: LIST OF VARIABLES USED
(Chilean Regions)

| |
|--|
| 1. General mortality rate |
| 2. Infant mortality rate (per thousand live births) |
| 3. Late infant mortality, 28 days to 1 year old per thousand live births) |
| 4. Gross Domestic Product per capita. |
| 5. Kilowatt Hour power consumption per inhabitant. |
| 6. Primary school children per inhabitant. |
| 7. Secondary school children per inhabitant. |
| 8. Medical appointments per inhabitant. |
| 9. Non-medical professional appointments per inhabitant. |
| 10. Number of newspapers published per inhabitant |
| 11. Students per teacher in primary school. |
| 12. Workers in the Minimum Employment Plan per inhabitant. |
| 13. Number of telephone lines per inhabitant. |
| 14. Kilograms of milk and protein mixtures distributed per inhabitant. National Program of Supplementary Nutrition. |
| 15. Square meters of housing constructed during the past decade per inhabitant. |
| 16. Meters of drinking water pipe system constructed during the past decade per inhabitant. |
| 17. Meters of sewage piping system constructed during the past decade per inhabitant. |
| 18. Number of medical doctors per inhabitant. |
| 19. Number of inhabitants per dwelling. |
| 20. Number of inhabitants per hospital bed. |
| 21. Number of inhabitants per square meter of housing. |

TABLE IV: CORRELATION AND COEFFICIENTS SIGNIFICANCE OF
THE VARIABLES INDICATED.
DATA FOR THE CHILEAN REGIONS.

| | |
|-----------------------------|--|
| General Mortality | Telephone lines per inhabitant (-0.668; s = 0.017) |
| | Square meters of dwelling in last decade (-0.515; s = 0.036) |
| | Inhabitants per dwelling (0.4824; s = 0.048) |
| | Secondary school students (-0.478; s = 0.049) |
| Infant Mortality | Telephone lines per inhabitant (-0.863; s = 0.001) |
| | Medical doctors per inhabitant (-0.33; s = 0.001) |
| | Students in primary school (0.826; s = 0.001) |
| | Students in secondary school (-0.7588; s = 0.001) |
| | Non-medical professional appointments (0.627; s = 0.011) |
| | Kilograms of milk N.P.S.N. (0.716; s = 0.003) |
| | GDP per capita (-0.572; s = 0.021) |
| Late Infant Mortality | Workers in PEM (0.516; s = 0.035) |
| | Telephone lines per inhabitant (-0.8849; s = 0.001) |
| | Students in primary school (0.806; s = 0.001) |
| | Medical doctors per inhabitant (-0.791; s = 0.001) |
| | Students in secondary school -0.783; s = 0.001) |
| | Non-medical professional appointments (0.627; s = 0.011) |
| | Kilograms of milk N.P.S.N. (0.625; s = 0.011) |
| | GDP per capita (-0.5918; s = 0.017) |

TABLE V: SUMMARY OF MULTIPLE REGRESSION STEPS

| | |
|-----------------------|--|
| General Mortality | Students in secondary school (47%; 0.686) Inhabitants per hospital bed (19%; 0.815) Meters of sewage piping last decade (26%; 0.962) GDP per capita (5%; 0.986) |
| Infant Mortality | Students in primary school (75%; 0.864) Medical doctors per inhabitant (8%; 0.909) Dwelling square meters past decade (7%; 0.945) Telephones per inhabitant (2%; 0.956) |
| Late Infant Mortality | Medical doctors per inhabitant (73%; 0.857) Students in secondary school (11%; 0.918) Sewage piping meters past decade (6%; 0.952) Dwelling square meters past decade (4%; 0.974) |

The table indicates the variable introduced in each of the first four steps of the step-up multiple regression. The figures in parentheses represent the percentage reduction in the variance of the independent variable and the multiple correlation coefficient.

TABLE VI: STANDARDIZED REGRESSION COEFFICIENTS

| | | |
|-----------------------|--|----------------------------|
| General Mortality | Independent variables: Secondary school students Sewage piping meters last decade Inhabitants per hospital bed (R ² = .56) | -0.613 -0.572 -0.397 |
| Infant Mortality | Independent variables: Primary school students Medical doctors per inhabitants Dwelling square meters past decade (R ² = .79) | 0.629 -0.369 0.238 |
| Late Infant Mortality | Independent variables: Medical doctors per inhabitants Secondary school students Sewage piping meters past decade (R ² = .85) | -0.410 -0.617 -0.265 |

Standardized regression coefficients for each of the three variables selected using the step-up method. Figures in parentheses show the proportion of the variance accounted for by these variables in the regression equation obtained using ordinary least squares.

FIGURE: SIGNIFICANT FACTORS FOR REDUCING HEALTH RISKS AT DIFFERENT
 MOMENTS OR
 EVOLUTIONARY STAGES

Health Risks
Evolution over Time

A. Overall Development
B. Health Care
C. Habits, Mores, Ecology