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Systematic Correlations between Demographic Transition and Epidemiologic Transition

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Abstract

Objective: Because of the insufficiencies of the current theoretical and empirical endeavors for explaining the systematic relationship between demographic transition and epidemiologic transition, this study is an attempt to theorize and empirically test a demographic transition thesis for explaining favorable conditions for population health and subsequent epidemiologic transition outcomes in less developed countries.

Methods: OLS regression and cross-tabulation methods were used to conduct a cross-national analysis of all available data from less developed countries.

Findings: Demographic transition, as measured by global fertility and cultural transition, exerts robust positive effects on the index of favorable conditions for population health and subsequent epidemiologic transition outcomes regarding the communicable- to non-communicable diseases transition and communicable diseases- to- injuries transition.

Conclusions: Theorizing and testing a demographic transition thesis of epidemiologic transition contributed to theory development and interdisciplinary research for bridging demography and epidemiology. Theory, research, policy implications and suggestions for future research were discussed.

Keywords: favorable conditions for population health, demographic transition, epidemiologic transition

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I. Introduction

During the previous four decades, research on the epidemiologic transition theory has been somewhat discrepant and inconsistent regarding the credibility of a systematic account and a generalized pattern of epidemiologic change (Behrman et al. 2011; Fetter et al. 1997; Gage 2005; Gaylin and Kates 1997; Malina et al. 2008; Popkin 1994; Preston 1976; Salomon and Murray 2002; Stuckler 2008). Theoretically and empirically, systematic relationships and generalized patterns provide vital clues to identify a theoretical relationship. Without such a relationship, no theory can be documented.

During several decades, research on demography, epidemiology, and health has been characterized by a dearth of theory; few explicit theories exist within epidemiology and demography (Wallace 2001). In addition, research on social epidemiology and public health has been depicted as a-theoretical for approaching the social determinants of health (SDH) (see Richter 2010). This study attempted to address this gap in the literature by providing a full theoretical account and empirical testing on the systematic relationship between demographic transition and epidemiologic transition. The latest research has documented, theoretically and empirically, the influence of the demographic transition in shaping modern society (Dyson 2001, 2011; Murphy 2011; Reher 2004, 2011). The crucial role of the demographic transition on improving public health conditions and the resultant health-related outcomes can advance knowledge for both demography and epidemiology. Given that both disciplines are deeply concerned with the health and social well-being of the population, by theorizing and testing a demographic transition thesis to systematically

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explain epidemiologic transition outcomes in less developed countries, this study can enhance the academic linkage between demography and epidemiology.

A review of the literature reveals that prior research has usually applied problem solving (e.g., defining the transmission and secular change of a communicable disease), or at most, stressed a single theoretical explanation of the epidemiologic transition (i.e., an economic development explanation or a globalization explanation; Salomon and Murray 2002; Stuckler 2008). As a result, most studies have failed to specify a complete theoretical framework for empirical testing and have exhibited a model misspecification problem. Thus, according to Caldwell (2001), research on the SDH needs to consider the influence of distal structural forces (including economic development, techno-economic heritage, and economic dependency), intervening mechanisms of the demographic transition (Dyson 2001), and unfavorable effects of income inequality on health (Pop et al. 2012), and has neglected favorable conditions for population health (as approached in this study).

Regarding the development of a theory for bridging demography and epidemiology, one way to promote interdisciplinary research is to develop empirical theories to document the complementary relationship between two disciplines. The collaborative development of a new demographic theory can foster solid bases for further interdisciplinary research.[1] More than a decade since Wallace (2001) proposed that "the demographic transition within developing countries" can be one of the promising candidate

1 For a collaborative interdisciplinary investigation of demography and epidemiology, some of the concepts can be defined as follows: the demographic transition can be re-conceptualized as a global fertility and cultural transition, whereas the epidemiologic transition outcomes refer to the communicable diseases-to-non-communicable diseases transition and communicable diseases-to-injuries transition. Favorable conditions for population health can be conceptualized as the prevalence of health manpower, health innovations, healthy living, and health knowledge. See the text for a detailed interpretation.

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theories and themes for linking demography and epidemiology, no study has examined this thesis either theoretically or empirically, thus, the present study represents a first attempt to fill this gap in the literature.

Recent research on health in developing countries has over-focused on HIV/AIDS, and under-focused on non-communicable diseases. Thus, social scientists have been urged to refocus their efforts on non-communicable diseases rather than on HIV/AIDS (Behrman et al. 2011). A further reflection on the current state of demography and health research concurs with the latest claim by Bhrolchain and Dyson (2007) that aggregate phenomena and demographic change, rather than micro-foundations, should be at the center of demography, and that the theory and specification of mechanisms deserve attention (see also Coleman and Schofield 1986; De Bruijn 2006; Hobcraft 2002). Therefore, explaining epidemiologic transitions based on macro-demographic transitions would contribute to developing a genuine testable theory for both epidemiology and demography, in addition to the other possible theories proposed by Wallace (2001).[2]

II. Demographic Transition and Epidemiologic Transition

(1) Bases for a Systematic Theoretical Account

The notion of an epidemiologic transition was first sketched by Omran (1971) to explore the complex relationships in disease and illness patterns and the correlated demographic, economic, and sociological determinants

2 These other theories mentioned by Wallace for linking demography and epidemiology include the life course approach, Malthusian dilemma, theory of evolution, ecological and environmental theories, and systems theory.

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and consequences. Whether an epidemiologic transition is a general transition pattern and constitutes a universal theory of unidirectional change in disease deserves a rigorous theoretical examination. Theoretically, using a structure-agency approach in addition to the earlier thesis of structural determinants (Omran 1971) provides an alternative demographic account of the epidemiologic transition. Empirically, given the limitation of the standard regression approach for examining each constituent cause group in the Global Burden of Disease study, new models for calculating the log ratios of each cause fraction, relative to other cause groups, represent the most promising research strategy for elaborating the epidemiologic transition theory (Salomon and Murray 2002). The linearity of the log ratios both of injuries to communicable diseases and of non-communicable diseases to communicable diseases can be applied in a standard regression approach, combining the work of Preston (1976) on the systematic relationship between total mortality levels and causes of death. All these prior endeavors have allowed development of a systematic account of a generalized epidemiologic transition pattern. Consequently, the proximate and distal determinants of a systematic shift in epidemiologic patterns can be theoretically elaborated and empirically tested.

(2) Re-Conceptualization of the Demographic Transition as a Global Fertility and Cultural Transition and Epidemiologic Transition

Wallace (2001: 73) stated that to bridge epidemiology and demography and explore complex, population-related phenomena, "theory development may be important from several perspectives: uniting disciplines to jointly approach common and important scientific problems, providing existing frameworks for new scientific questions, and promoting enhanced

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scientific rigor by more tightly linking methods and hypotheses." The current theoretical extension can be linked to the latest research efforts, which provided a heuristic theorizing to re-conceptualize the demographic transition as a global fertility and cultural transition (Chen 2013; Reher 2004, see also Caldwell 1993). This theorizing highlights the essence of the demographic transition to denote a global fertility transition, a global societal-forms transition, and a global communication and diffusion of information and ideas to reach a global cultural transition. A valuable hypothesis that has been supported empirically states that a higher level of demographic transition regarding global fertility and cultural transition results in a higher level of human well-being, with this effect strengthening in the latter stages of the transition. A further theorizing linking the demographic transition, favorable conditions for population health, and epidemiologic transition is analyzed in the following section.

(3) Pre-Transitional Phase of the Demographic Transition and Age of Pestilence and Famine

The stages of the demographic transition (i.e., the pre-transitional phase, transitional phase, and post-transitional modern phase) roughly coincide with the social transition from a traditional society to a transitional society to a modern society (Dyson 2001). This coincidence is systematic in that during the pre-transitional phase, the most crucial problem is how to cope with high mortality rates. In the classic theory of the epidemiologic transition proposed by Omran (1971), all populations experienced a shift in the major patterns of illness and disease, following a change from higher to lower mortality levels. The first era, called the "age of pestilence and famine"(Omran 1971: 516), usually features high, varied, and fluctuating mortality rates, and a low and variable average life expectancy at birth

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(between 20 and 40 years). In this early transition, unfavorable conditions for population health are the results of low levels of health manpower, as well as poor living conditions, reflected in the low number of physicians relative to the population size. Malnutrition, as well as low levels of health innovation and health knowledge, are common in traditional societies and during the early stage of the demographic transition.

Nevertheless, conditions that favor the subsequent epidemiologic transition of population health can derive from the efforts of governments and agents of change from the civil society such as intra- and inter-national non-governmental organizations (Shircliff and Shandra 2011; see also Hall and Lamont 2009). The stages of the demographic transition can also concur with the levels of global diffusion of information and ideas for promoting a global cultural transition (see Caldwell 1993; Chen 2013; Reher 2004, 2011). In the pre-transitional phase, traditional values and health habits, as well as the preference for having numerous children and large families, represent unfavorable conditions for population health. By contrast, human efforts for a global communication and diffusion of information, ideas, and cultural values regarding the importance of the health transition and prevention of communicable diseases are favorable conditions for promoting population health, and subsequently, epidemiologic change.

(4) Transitional Phase of the Demographic Transition and Age of Receding Pandemics

During the transitional phase of the demographic transition, roughly corresponding to the "age of receding pandemics," mortality declines steadily as average life expectancy at birth rises from 30 to approximately 50 years (Omran 1971: 516-517), yet fertility usually remains high because of the support for cultural norms encouraging numerous children. As

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sustained population growth begins, human efforts to challenge traditional norms of high-fertility behavior result in an eventual reduction of fertility levels. During this transition moment, population pressure is usually treated as an unfavorable condition for both economic growth and population health, whereas the abundance of health innovations such as contraceptive prevalence and family planning programs foster favorable conditions for promoting population health and epidemiologic change.

Several explanations for the incipient changes in epidemiologic patterns are based on the intricate transitional phase of the demographic transition per se. First, when the original demographic equilibrium state of high mortality and high fertility changes as a result of the decline in mortality, some demographic and social structural outcomes are followed. These outcomes initially include changes in the natural growth rate and size of the population, accompanying the level of population movement resulting in a differential degree of ecological concentration. The classic work of Durkheim (1893) (Simpson [trans.] 1960) theorizes on how ecological concentration results in competition for resources and subsequent changes in the social division of labor, with possible consequences of both normal and abnormal developments. Therefore, the preceding demographic disequilibrium and destabilization that reflects a decline in the mortality rate is a crucial structural force and developmental momentum, which engenders subsequent differential outcomes of development (see also Kirk 1996).

During the transition process, the increasing population size forces the movement of individuals from traditional and rural to industrial and urban societies. Dyson (2011) extended the de Vries's stylized sector-specific model of urbanization by providing a heuristic, interesting, but seemingly naive explanation for the demographic transition of urbanization, pointing to a stylized sector-specific model of the demographic transition, where the

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urban crude death rate is usually higher than the rural crude death rate, and the urban crude birth rate characterizes the urban sector as a demographic "sink" (i.e., the urban population would not exist without rural-to-urban migration). Because a demographic "sink" usually characterizes the pre-transitional phase of the demographic transition, both urban growth and urbanization are the natural outcomes of the population growth during the demographic transition,[3] and urban populations are also believed to contribute to sustained economic growth.

The beginning of the developmental momentum during the transitional phase marks the crucial difference between this phase and the pre-transitional phase. Overall, population growth, urban growth, and mobile population growth set the tone for the developmental momentum, fueled by global communication and the diffusion of innovations and cultural values, fostering a "development idealism" (Thornton 2005) for the transitional society to pursue improved health and nutrition conditions.

In most cases, the onset of the developmental momentum gradually yields favorable conditions for population health because of the global diffusion of knowledge and innovations to prevent communicable diseases, encourage contraception and family planning, and concurrently, diffuse information and ideas regarding the quality of child and family limitation,

3 Competing perspectives of urbanization have been observed in addition to the explanation of industrialism, a variant of the modernization thesis. These competing perspectives cover economic dependency (from the dependency and world system theories) and techno-economic heritage (from the ecological-evolutionary theory). For Dyson, the conventional economic accounts and other explanations are only secondary influences (Dyson 2011: 51). Dyson illustrated the demographic transition thesis of urbanization by pointing to two historical case studies of Sweden and Sri Lanka to support his account. A preliminary analysis of the effect of the demographic transition (as measured by the global fertility and cultural transition) and favorable conditions for population health on an urban population supported the thesis of Dyson regarding urbanization, in which the demographic transition plays a role in the process of urban growth, even controlling for the labor force of the industrial sector, a measure of industrialism.

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resulting in increases in body size for the younger generations and changes in the family life. Furthermore, the ideology of the conjugal family, values of universality, achievement orientation, functional specificity, and developmental idealism aiming for economic growth create changes in the working style of the mobile population, and later, in the lifestyle of the general public. The changing working style, lifestyle, and human efforts that promote health and nutrition conditions to improve population health (see Young 2013) are considered to launch the incipient change in epidemiologic patterns from communicable to non-communicable diseases to injuries.

This generalized account of the systematic relationship between the demographic transition and the epidemiologic transition can be illustrated by the case study conducted by Malina et al. (2008): "The marked changes in age and causes of death over the three decades (epidemiologic transition from Stage I to Stage II) occurred concurrently with significant secular increases in body size in children, adolescents, and young adults, highlighting improved health and nutritional conditions in the community which is in early Stage II of the demographic transition. The demographic transition to Stage II is a leading indicator (15-25 years lag) for the onset of the secular trend……" (Malina et al. 2008: 69).

(5) Post-Transitional Phase of the Demographic Transition and Age of Degenerative and Man-Made Diseases

In the post-transitional phase, as has been usually observed when progressing into the "age of degenerative and man-made diseases," the average life expectancy at birth rises until it exceeds 50 years, and cancers, cardiovascular diseases, and accidents constitute the major causes of death (Omran 1971: 517-518). In this post-transitional modern society, the global diffusion of innovations for controlling communicable diseases

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reaches a high level. During this later transition, the increase in health innovations constitutes favorable conditions for both population health and the continuing epidemiologic transition. However, an aging population and a persistent and changing working style and lifestyle further facilitate degenerative, man-made and non-communicable diseases to dominate mortality trends.

Moreover, global communication and diffusion of information and ideas regarding the values of "king child with parents," human capital, gender equality, self-expression, and cultural individualism encourages individuals to adopt the new lifestyle, and provide solid bases for pursuing increasingly satisfying physical and psychological needs. Consequently, to deal with degenerative and man-made diseases, human efforts can make a difference to change working styles, lifestyles, and the physical and psychological needs of individuals, thus promoting favorable conditions for population health to cope with the persistent epidemiologic shift that results in degenerative and man-made diseases dominating mortality trends.

(6) A Structure-Agency Approach

In contrast with the structural determinants of the transition (eco-biological, socioeconomic, political and cultural factors, or medical and public health factors) (see Omran 1971), a global diffusion of information and ideas regarding innovations and cultural values enriches the existing material and schematic structures, creating favorable conditions for population health and general human well-being (see also London and Schneider 2012; Young 2013). The latest development of a variant of the structure-agency theory (i.e., the theory of conjunctural action; Johnson-Hanks et al. 2006) delineates how human activity reflects on both material and schematic structures, which also organize social action by inculcating

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social actors with intuitions, habits, inclinations, and influencing the conjunctures or configurations of exigencies that social actors might face at specific times. Resolving conjunctures remakes a structure either by reinforcing or transforming the original structures. During the demographic transition process, the different phases of the transition are supposed to face different conjunctures, both favorable and unfavorable, which have to be construed and evaluated thoughtfully to adopt actions for change (see also the Commission on the Social Determinants of Health, [CSDH]; CSDH 2008; Moore 2010).

In this regard, a demographic transition thesis on favorable conditions for population health implies using a combined structure-agency approach to understand the enhancing effects of the transition on general population health and epidemiologic change. As Caldwell et al. (2001: 160) stated: "With its three basic models of the epidemiological transition, fails to grasp the global nature and the historical sequence of the mortality transition as it spread…… it underestimates the flow around the world of ideas, behavioural models, education systems, public health approaches and medical technologies."

By combining a unique structure-agency approach for theorizing the association among the demographic transition, favorable conditions for population health, and epidemiologic transition, the intermediate mechanisms can be clearly delineated. Net of other effects, the demographic transition regarding the global fertility and cultural transition is expected to positively affect the favorable conditions for population health, and both the demographic transition and favorable conditions for population health contribute to the epidemiologic transition, as exemplified by the shift in patterns of disease and illness. In other words, higher levels of global fertility and cultural transition result in more favorable conditions for

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population health. Both the levels of global fertility and cultural transition, as well as on the level of favorable conditions for population health can be further analyzed to demonstrate a systematic shift in epidemiologic patterns.

III. Distal Structural Forces Underlying the Transitions in a Full-Model Test

To develop a full-model test of the demographic transition thesis of population health and epidemiologic transition, a comprehensive theorizing needs to trace back their long-term structural roots, which constitute distal macro forces that influence the subsequent socio-demographic change. Determining how these structural roots are linked to the demographic transition would allow identification favorable conditions for population health and epidemiologic change. The modernization perspective focuses on developing an industrial society. Proponents of the modernization perspective stress that economic development is the driving force for the decline in infant mortality and the subsequent reduction in fertility. By re-conceptualizing the demographic transition as a global fertility and cultural transition, economic development is expected to exert positive influences on the level of global fertility and cultural transition, level of favorable conditions for population health, and epidemiologic transition outcomes.

By contrast, the ecological-evolutionary perspective stresses the importance of the techno-economic heritage and social carrying capacity from a pre-industrial society for the subsequent trajectories of development (Lenski and Lenski 1982; Lenski and Nolan 1984), which are expected to exert positive effects on the level of global fertility and cultural transition, creating favorable conditions for population health and epidemiologic transitions. Following the Neo-Marxist thesis of a long-term harmful effect

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of economic dependency, economic dependency regarding investment dependence and trade dependence is expected to negatively influence the level of global fertility and cultural transition, create unfavorable conditions for population health, and result in negative epidemiologic transition outcomes, because of the underdevelopment and distortion development effects (Shandra et al. 2005; Shannon 1989; Shen and Williamson 1999). Therefore, a comprehensive understanding of the structural determinants of socio-demographic changes needs to consider all these three distal macro-forces in a full-model test, or at least treat these distal forces as possible control variables. Clearly, this study expands on prior research efforts considering only the measure of gross domestic product (GDP) per capita (see Salomon and Murray 2002) or measures of globalization (Stuckler 2008) as explanatory variables, which failed to conduct a complete model testing.

IV. Limitations of Previous Research: A Methodological Note

By taking a global view of vital events and population health, prior research on epidemiologic transition has used the traditional method of cross-national study for studying less-developed countries (Salomon and Murray 2002; Shandra et al. 2005; Shen and Williamson 1999; Shircliff and Shandra 2011; Stuckler 2008; Wimberley 1990). By contrast, demographic anthropologists seem to prefer the method of field case study (e.g., Malina et al. 2008). The strengths of cross-national studies include using numerous countries as a unit of analysis, tracing the long-term structural roots and proximate determinants, and searching for a generalized pattern with a solid theoretical basis. Furthermore, developing macro-theories has strengthened the theory-deduced research tradition of the cross-national study.

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In general, case studies of population health and epidemiologic transition have long focused on one or a few cases for deeply examining human activities, vital events, and health. The case-study method can be fruitful in its purpose of conceptualizing or generating hypotheses, and thus contributing to the theoretical development of a generalized pattern. For instance, a case study of the Valley of Oaxaca in southern Mexico reported in Malina et al. (2008: 78) concluded that up to the second stage of the demographic transition (15-25 years after the start of the transition), no sign of epidemiologic change was apparent. It took 28-32 years for the incipient Stage II of the epidemiologic transition to begin, and 36-39 years for complete degenerative disease to dominate mortality trends. This generalized pattern and systematic relationship indicates that cross-national testing is necessary.

A general review of the literature reveals that some patterns always deviate from the typical stages of the epidemiologic transition. These exceptional patterns can be easily exemplified either by case studies of an individual country under particular settings, or by pointing to the diversity of historical paths (e.g., Gage 2005, but see comments in Caldwell 1993). In contrast with the generalized pattern, these exceptional cases are an individualist fallacy in research logic. These particular and exceptional cases can be of some academic interest, and contribute to a further understanding of a generalized pattern, but can not falsify the findings from a cross-national study regarding a generalized pattern and a systematic relationship approach.

According to Bhrolchain and Dyson (2007), theory and research agenda could be reoriented by first determining the dynamics of the demographic change at the global level to enhance the understanding of the macro-dynamics of demography, and later efforts could also be followed by subsuming the meso (interactive) and the micro (idiosyncratic) levels

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under this broad macro-context to form a comprehensive macro-micro link of demographic theories. This strategy is a response to the critique by Coleman and Schofield (1986), who argued that demography has no central paradigm to combine processes at the micro-level with those operating at the societal level. Moreover, the need for a common theoretical framework and a macro strategy is also in accord with the in-depth insight of Hobcraft (2002) that any specific explanations of demography should be drawn from an overarching framework providing a solid ground for theorizing the systematic relationship between the demographic transition and the epidemiologic transition, owing to the collective property of the transitions, and thus demanding an "explanation at the macro-analytic level in terms of other properties of the collectivity" (Ryder, 1980: 201).

This discussion stresses the crucial role of the theoretical and research strategies for addressing the theoretical and research insufficiencies in previous studies. The current study expands on prior research by proposing an integrated conceptual framework based on a newly formulated demographic transition theory and on re-conceptualizing the demographic transition as a global fertility and cultural transition to explain favorable conditions for population health and subsequent epidemiologic transition outcomes. Hence, the current cross-national study of less-developed countries can contribute to advance knowledge, both theoretically and empirically to link demography and epidemiology.

V. Methods of Analysis, Measures and Data

(1) Methods of Analysis

This study presents a full model using robust independent variables that are long-standing structural conditions with strong theoretical bases.

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Because of the limited data on measures of epidemiologic transition, this study used the OLS regression method to test the thesis that demographic transition generates favorable conditions for population health and the epidemiologic transition. The focus of the analyses was restricted to the less developed countries where the theoretical and research implications of this study are most relevant, as explained and predicted by the theoretical perspectives.

In the following analyses, the indices of global fertility and cultural transition during 1995-1998 were expected to directly and positively affect the indicators or index of favorable conditions for population health during 2000-2004, and subsequently affect the measures of epidemiologic transition. Given that the impact of the distal structural forces can be traced back up to 50 years (see Kentor 1998)[4] most of the prior cross-national analyses seemed to incorporate an inappropriate time specification (e.g., limited to a 10- or 20- year lag). To extend the probable long-term effects of economic dependency as well as those of the techno-economic heritage, all distal macro forces present in 1967 (the year the investment dependence measure became available) were included in the full model testing, and are expected to reveal insignificant influences as a result of the mediated effects of the demographic transition. Finally, a cross-tabulation method was used to demonstrate how a combination of measures of global fertility and cultural transition and an index of favorable conditions for population health generated systematic epidemiologic-transition outcomes in less developed countries.

4 The underlying theoretical perspectives concerning distal structural forces (i.e., investment dependence, trade dependence, and techno-economic heritage) provide explicit and solid theorizing bases for extending the possible long-term effects. However, this long-term effect does not apply to proximate determinants such as the demographic transition and favorable conditions for population health, which in relation to the causality prior time lag (e.g., five years or even less) will always produce exactly the same findings and do not require up to 10 or 20 years of specification.

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(2) Measures and Data

A. Independent Variables (First and Second Endogenous Variables)

(a) Global Fertility and Cultural Transition

Following the latest re-conceptualization of the demographic transition as a global fertility and cultural transition (Chen 2013; Reher 2004, see also Caldwell 1993), four indices of global fertility and cultural transition were constructed using indicators of fertility, infant mortality, and availability of telephone mainlines and internet hosts. Fertility was measured using total fertility rates, which take into account the age structure factor, and are generally considered a refined measure. The data for total fertility rates from 1995 to1998 were collected from the World Development Report published by the World Bank. Infant mortality was measured by the number of deaths during the first year of life per 1,000 live births; data for the period from 1995 to 1998 was obtained from the Demographic Yearbook published by the United Nations and the World Development Report. The data regarding telephone mainlines per 1,000 people and internet hosts per 1,000 people during 1995-1998 were obtained from the World Development Indicators published by the World Bank. These two measures of information flow were logged to correct for a skewed distribution.

A theorizing of global fertility and cultural transition, used to characterize the complicated process of the demographic transition, can be empirically represented by the decline of fertility and the rise of a global cultural transition. For index construction, for instance, standardized *Z* telephone mainlines plus standardized *Z* internet hosts, and minus the standardized *Z* total fertility rate (the negative indicator) can form an index of global fertility and cultural transition (gFACT3). Other index

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constructions are the gFACT2-TEL (standardized *Z* telephone mainlines minus the standardized *Z* total fertility rate), gFACT2-NET (standardized *Z* internet hosts minus the standardized *Z* total fertility rate), and gFACT4 (standardized *Z* telephone mainlines plus standardized *Z* internet hosts, minus the standardized *Z* total fertility rate and the standardized *Z* infant mortality rate).

(b) Favorable Conditions for Population Health

Previous studies on the prevalence of health care resources and medical care infrastructure have focused on a single indicator (e.g., the number of physicians per 1,000 people; Sanderson 2010; Shen and Williamson 1997; Wimberley 1990), and failed to note that a comprehensive understanding of multiple favorable conditions for population health constitutes the infrastructure and prerequisite for health outcomes. So far, no composite index exists to evaluate the global population health infrastructure. To link demography and epidemiology, multiple indicators for characterizing population health infrastructure can offer a detailed theoretical account. As delineated in earlier theories, and based on a structure-agency approach, this multiple-indicators approach can foster solid bases for developing a concept of health infrastructure and subsequently applying it in population health efforts and effectiveness evaluation (PHEEE) for less developed countries.

This study represents a first attempt to conceptualize the favorable conditions for population health, such as the prevalence of health manpower, prevalence of health innovations, prevalence of healthy living, and prevalence of health knowledge,[5] which can be measured using indicators such as physicians per 1,000 people, contraceptive prevalence, malnutrition

5 This preliminary conceptualization and operationalization does not exclude the possibility of other dimensions concerning the favorable conditions for population health, nor other possible indicators that could not be included in the index construction.

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prevalence, and female-to-male enrollment ratio. The number of physicians per 1,000 people and level of malnutrition prevalence from 2000 to 2004 were obtained from the World Development Indicators published by the World Bank. The female-to-male ratio of secondary-school enrollment refers to the number of females per 100 males in secondary school, whereas contraceptive prevalence can be measured as the percentage of married women of childbearing age currently using contraception. For the period between 2000 and 2004, these two measures were collected from the World Development Indicators and Demographic Yearbook. A preliminary analysis of these four indicators revealed that all of them were highly correlated and loaded on one factor, and exhibited high factor loadings (0.86, 0.903, 0.820, and -0.799 for physicians per 1,000 people, contraceptive prevalence, female-to-male enrollment ratio, and malnutrition prevalence, respectively). These four measures were then converted into *Z* scores to form an index by adding the standardized *Z* physicians, standardized *Z* contraceptive prevalence and standardized *Z* female-to-male enrollment ratio, and then subtracting the standardized *Z* malnutrition prevalence (the negative indicator).

B. Dependent Variables

(a) Measures of Epidemiologic Transition

The measures of epidemiologic transition represent compositional data of different cause groups, including communicable diseases (Group 1 in the Global Burden of Disease), non-communicable diseases (Group 2), and injuries (Group 3). Group 1 covers infectious and parasitic diseases, maternal and perinatal conditions, nutritional deficiencies, and acute respiratory infections. Group 2 includes non-communicable diseases such as malignant neoplasms, diabetes mellitus, endocrine disorders, blood

diseases, cardiovascular diseases, and chronic respiratory diseases. Group 3 covers deaths caused by injuries, both intentional (suicide and homicide) and unintentional (road traffic deaths).

Most prior research on the Global Burden of Disease has failed to recognize that the cause-of-death patterns represent the proportions of all deaths attributable to each of these cause groups. For all types of compositional data, two basic constraints must be met (see Katz and King 1999): the proportion of deaths for each cause group must be between 0 and 1, and the three proportions corresponding to the three cause groups must sum to 1. According to Salomon and Murray (2002), the measures of epidemiologic transition can be calculated as the log ratios of each cause group relative to the other cause groups. Meaningful measures include the log ratios of the proportion of injuries to the proportion of communicable diseases (Ln[P3/P1]), and the log ratios of the proportion of non-communicable diseases to the proportion of communicable diseases (Ln[P2/P1]). Data for the three cause groups were obtained from statistics published by the World Health Organization in 2008.

$$Y_{13} = \mathrm{Ln}(P_3/P_1);\ Y_{12} = \mathrm{Ln}(P_2/P_1); \quad (1)$$

where $\mathrm{Ln}(P_3/P_1)$ represents the communicable diseases-to-injuries transition, whereas $\mathrm{Ln}(P_2/P_1)$ denotes the communicable diseases-to-non-communicable diseases transition.

(b) Regression Equations

Based on the proposed thesis, the multivariate normal model for the log ratios can be expressed as the following two regression equations (Equations [2] and [3]), as a linear function of the explanatory variables in the proposed model:

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$$Y_{13} = \beta_0 + \beta_1 (T_i) + \beta_2 (D_i) + \beta_3 (F_i) + \varepsilon_{13} \quad \text{.....(2)}$$

$$Y_{12} = \gamma_0 + \gamma_1 (T_i) + \gamma_2 (D_i) + \gamma_3 (F_i) + \varepsilon_{12} \quad \text{.....(3)}$$

where Y_{13} and Y_{12} are the log ratios as defined in Equation (1), T_i is the all-cause mortality rate in the model of Preston (1976), D_i is an index of demographic transition, F_i is an index of favorable conditions for population health, and ε_{13} and ε_{12} are two residual terms.

C. Control Variables and Exogenous Variables

According to Preston (1976), in a comprehensive statistical model connecting the systematic relationship between total mortality levels and causes of death, a measure of total mortality levels should be treated as a crucial control variable for testing the model. The total mortality rate in 2008 was obtained from statistics provided by the World Health Organization. Other critical control variables included the overall globalization index for 2000 (Dreher 2006), and a measure of economic development (see Salomon and Murray 2002; Stuckler 2008).

All the measures of the distal structural forces should be combined into a full model specification, and at least be treated as control variables to evaluate the proposed demographic transition thesis, regarding the intervening and proximate determinants of the epidemiologic transition. To measure economic development or economic modernization, the real gross domestic product (RGDP) per capita published by Summers and Heston (1984) was used to measure the increased productivity associated with industrialization in the 1970s and 1980s. Two measures of economic dependency, representing the continuing process of dependence, were used together. An earlier measure of investment dependence, transnational

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corporate penetration (PEN, proposed in 1967), was used by Bornschier and Chase-Dunn (1985) to identify the most critical component of the complex process of dependency and core-peripheral relations. According to Firebaugh (1992) the PEN measure should be inversely interpreted because of the denominator effect. The substantially positive effect of the PEN should be re-interpreted as a negative effect, in accordance with the prediction of the dependency/world system thesis. The other measure of the classical dependency, trade as a percentage of GNP in 1965, is available in the World Handbook of Political and Social Indicators by Taylor and Jodice (1983). This variable has been logged to correct for its skewed distribution.

Social carrying capacity as a result of the long-term techno-economic heritage was measured using the agricultural density in 1960 (Crenshaw 1992). In agreement with the two economic dependency measures using data from 1965 and 1967, the agricultural density in 1960 was appropriate for the present study, because the social carrying capacity and economic dependency were supposed to be long-term and extensive functions (Crenshaw 1992; Kentor 1998). This variable has been logged to correct for skewness; the data were obtained from the World Handbook of Political and Social Indicators, edited by Taylor and Hudson (1979) and Taylor and Jodice (1983).

D. Research Questions to be Answered for Testing the Model

Several crucial research questions for the full model testing can be stated as follows:

(a) Do all the distal structural forces, including economic development, investment dependence, trade dependence, and techno-economic heritage substantially affect the demographic transition, as measured by the indices of global fertility and cultural transition?

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(b) Do all the distal structural forces also substantially affect all the indicators representing favorable conditions for population health, even when the net effect of overall globalization is considered?

(c) Does the demographic transition, as measured by indices of global fertility and cultural transition, substantially affect all the indicators representing favorable conditions for population health, even holding constant all the effects of the distal structural forces?

(d) Does the demographic transition, as measured by indices of global fertility and cultural transition, substantially affect the index representing favorable conditions for population health, even controlling for all the effects of the distal structural forces and overall globalization index?

(e) Does the demographic transition, as measured by indices of global fertility and cultural transition, and an index of favorable conditions for population health, substantially affect the epidemiologic transition outcomes, operationalized as the transition from communicable diseases to non-communicable diseases, and communicable diseases to injuries, net of the effects of the distal structural forces, all-cause mortality rate, and globalization?

VI. The Findings

(1) Analysis of the Effects of Distal Structural Forces

The theoretical perspectives underlying the distal structural forces predict that economic development and techno-economic heritage should positively affect the demographic transition and favorable conditions for population health, whereas investment dependence and trade dependence should negatively influence the demographic transition and favorable

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conditions for population health. Prior studies have documented the substantial effects of distal structural forces on the fertility and demographic transition (Chen 2013; London 1988; Nolan 1988; Tolnay and Christenson 1984). An examination of the effects of the distal structural forces on the fertility and demographic transition, as measured by indices of global fertility and cultural transition, reveals that all the distal structural forces exhibited substantial and expected effects on either fertility levels or indices of global fertility and cultural transition. Table 1 presents the influences of distal macro structural forces and the overall globalization index for 2000 used as a control variable, on indicators representing favorable conditions for population health. All measures of distal macro-forces including economic development, investment dependence, trade dependence, and techno-economic heritage seemed to exert the theoretically expected effect (see Equation [1]). A comparison of all the distal structural forces across the equations revealed that economic development exerted the most consistent and significant effects on all other indicators representing favorable conditions for population health, including the physicians per 1,000 people, contraceptive prevalence, malnutrition prevalence, and female-to-male enrollment ratio, whereas measures of economic dependency and techno-economic heritage exerted somewhat discrepant, but expected, effects on all these indicators.

(2) Analysis of the Influences of Demographic Transition

By holding the effects of distal macro-forces constant, the theoretically expected positive effects of various measures of demographic transition on the indicators representing favorable conditions for population health can be examined. As displayed in Table 2, all the indices of global fertility and cultural transition exhibited robust and statistically significant effects

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Table 1. Regression-model estimates of distal structural determinants of indicators representing favorable conditions for population health[a] (2000-2004)

	Ln(Physicians per 1,000 people) (1)	Contraceptive prevalence (2)	Malnutrition prevalence (3)	Female to male enrollment ratio (4)
Economic Development	0.703***/ 0.516***	0.478***/ 0.414**	-0.582***/ -0.534**	0.403**/ 0.446**
Investment Dependence	0.201*/ 0.237*	0.290**/ -0.051	-0.225/ -0.266	0.314*/ 0.182
Ln(Trade Dependence)	-0.472***/ -0.432***	-0.329**/ -0.286#	0.074/ 0.089	-0.195/ -0.082
Ln(Techno-Economic Heritage)	0.174*/ 0.018	0.325**/ 0.064	-0.075/ 0.002	0.225#/ 0.312*
Overall Globalization Index	----/ 0.267*	----/ 0.327*	----/ -0.027	----/ 0.153
Constant	1.38/ -1.34	33.67/ 26.93	30.25/ 24.23	73.79/ 38.74
R^2	0.686/ 0.732	0.461/ 0.477	0.499/ 0.487	0.369/ 0.482
Adj. R^2	0.665/ 0.691	0.431/ 0.413	0.460/ 0.416	0.319/ 0.414
N	64/49	78/47	56/42	55/44

Note. Beta-weights are reported.

[a] Controlling for overall globalization index yields similar results.

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, #$p < 0.10$.

on the different indicators representing favorable conditions for population health. Additional analyses revealed that these results remained unchanged, even using health and women-related non-governmental organizations (see Shircliff and Shandra 2011) as control variables.

The same findings can also be observed in Table 3; all indices of global fertility and cultural transition considerably affected the index of favorable conditions for population health, with high variance explained.

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Table 2. Summary of regression-model estimates[a]: Structural determinants of indicators representing favorable conditions for population health (2000-2004)

	Physicians per 1000 people (1)	Contraceptive prevalence (2)	Malnutrition prevalence (3)	Female to male enrollment ratio (4)
gFACT2-TEL[b]	0.638***	0.890***	-0.736***	0.829***
gFACT2-NET[b]	0.627***	0.772***	-0.696***	0.681***
gFACT3[b]	0.697***	0.817***	-0.677***	0.685***
gFACT4[b]	0.757***	0.854***	-0.694***	0.709***
R^2	0.785-0.838	0.703-0.766	0.640-0.656	0.543-0.626
Adj. R^2	0.766-0.823	0.681-0.750	0.60-0.619	0.494-0.583
N	59-64	59-64	51-55	50-54

Note. Beta-weights are reported.

[a] Controlling for all the measures of distal structural forces for a full model test.

[b] See text for definitions and index construction.

***$p < 0.001$.

Nevertheless, all the distal structural forces were negligible, demonstrating the intervening roles and proximate effects of the demographic transition on the favorable conditions for population health. This study expands on earlier research efforts based on approaches of primary health care (Walsh and Warrant 1979; Wimberley 1990), which seemed to neglect the roles of the distal macro-forces and demographic transition as possible determinants of population health.

(3) Full Model Testing

A comprehensive model examining the proximate determinants of diverse epidemiologic transition outcomes can be achieved by comparing the relative effects of an index of global fertility and cultural transition and those of an index of favorable conditions for population health (see Table 4).

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Table 3. Regression-model estimates of structural determinants of an index of favorable conditions for population health[b] (2000-2004)

	Index of Favorable Conditions for Population Health				
	(1)	(2)	(3)	(4)	(5)
Economic Development[a]	0.591***/ 0.543***	0.052/ 0.024	0.215$^{\#}$/ 0.148	0.169/ 0.025	0.141/ 0.040
Investment Dependence[a]	0.244$^{\#}$/ -0.089	0.017/ 0.075	-0.081/ 0.003	-0.012/ 0.021	0.019/ 0.040
Ln(Trade Dependence)[a]	-0.190/ -0.145	0.043/ 0.003	0.047/ 0.018	0.028/ 0.022	-0.002/ -0.010
Ln(Techno-Economic Heritage)[a]	0.326**/ 0.219$^{\#}$	0.043/ 0.034	0.016/ -0.005	0.029/ -0.004	0.025/ -0.013
Overall Globalization Index	----/ 0.274$^{\#}$	----/ 0.014	----/ -0.008	----/ -0.069	----/ -0.080
gFACT2-TEL[b]		0.865***/ 0.848***			
gFACT2-NET[b]			0.757*** 0.777***		
gFACT3[b]				0.863***/ 0.926***	
gFACT4[b]					0.873***/ 0.925***
Constant	-8.22/ -11.26	-2.03/ -1.31	-1.98/ -0.68	-2.94/ 1.36	-2.22/ 2.18
R^2	0.611/ 0.645	0.861/ 0.846	0.790/ 0.781	0.832/ 0.821	0.855/ 0.838
Adj. R^2	0.571/ 0.581	0.842/ 0.812	0.760/ 0.732	0.807/ 0.781	0.833/ 0.803
N	43/34	42/34	40/34	40/34	40/34

Note. Beta-weights are reported.

[a] As expected, all the measures of the distal structural forces and overall globalization index were negligible, demonstrating the mediated role and expected proximate effects of the demographic transition.

[b] See text for definitions and index construction. Controlling for the overall globalization index yields similar results.

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\#}p < 0.10$.

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Table 4. Regression-model estimates of the structural determinants used in the different epidemiologic transition outcomes study (2008)

	Ln (P3/P1)[a-1]/ Ln(P2/P1)[a-2]	Ln (P3/P1) / Ln(P2/P1)	Ln (P3/ P1)	Ln (P3/ P1)	Ln (P2/ P1)	Ln (P2/ P1)
Economic Development	0.203/ 0.281*	-0.140/ -0.077	0.106	0.153	0.154	0.238$^{\#}$
Investment Dependence			-0.35*	-0.45**	-0.251**	-0.347**
Ln(Trade Dependence)			0.175	0.281$^{\#}$	0.064	0.116
Ln(Techno-Economic Heritage)			-0.115	0.056	-0.070	0.001
Overall Globalization Index	0.378**/ 0.390**	-0.062/ -0.076				
All Causes		-0.367**/ -0.502***	-0.277$^{\#}$	-0.297$^{\#}$	-0.436***	-0.459***
gFACT4[b,c]		0.609***/ 0.562***	0.520***		0.447**	
PHEEE[b,c]				0.502**		0.402**
Constant	-2.95/ -0.96	-0.157/ 2.14	-0.665	-2.002	1.787	1.239
R^2	0.275/ 0.361	0.606/ 0.777	0.556	0.626	0.789	0.788
Adj. R^2	0.252/ 0.341	0.579/ 0.762	0.501	0.560	0.763	0.751
N	67/67	63/63	56	41	56	41

Note. Beta-weights are reported.

[a-1] Ln(P3/P1): Communicable diseases-to-injuries transition

[a-2] Ln(P2/P1): Communicable diseases-to-non-communicable diseases transition

[b] See text for definitions and index construction. Controlling for measures of distal structural forces, overall globalization, and all causes yielded similar results.

[b,c] Correlation coefficient for the two indices ($r = 0.914^{***}$, $p < 0.001$), see text for a discussion of multicollinearity.

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\#}p < 0.10$.

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Prior research on the epidemiologic transition has included economic development and globalization as crucial explanatory variables (Salomon and Murray 2002; Stuckler 2008). If inserting a measure of economic development and the overall globalization index for 2000 (Dreher 2006) into Equation (1), at first glance, both variables reveal the expected effects on the epidemiologic transition outcomes. However, by using total mortality rate as a control, as well as an index of global fertility and cultural transition (gFACT4), the effects of economic development and globalization in Equation (2), (3) disappear, whereas the index of global fertility and cultural transition exhibits the most robust effect on the epidemiologic transition outcomes. All the other indices of global fertility and cultural transition yield exactly the same results.

A preliminary analysis demonstrated that the correlation coefficient of the two indices was high ($r = 0.914^{***}$, $p < 0.001$). The VIF test results also demonstrated the existence of a possible multicollinearity problem when these two indices were combined in the same equation. As displayed in Table 4, both indices separately revealed favorable and significant effects on two epidemiologic transition measures, (Ln[P3/P1] and Ln[P2/P1]), even controlling for total mortality level. The index of the demographic transition seemed to exert the strongest effect, followed by the index of favorable conditions for population health, being consistent with the findings of Malina et al. (2008).

In contrast with Salomon and Murray (2002), investment dependence rather than economic development provided the most consistent positive influence on epidemiologic change. The latest research highlights the substantial effects of globalization on the long-term changes in mortality rates of heart disease and chronic non-communicable disease (Stuckler 2008). However, by using the overall globalization index for 2000 (Dreher

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2006) as a control, the predominant determinant was the index of global fertility and cultural transition, gFACT4 (beta-weight = 0.632, $p < 0.001$ for Ln(P2/P1), and 0.894 for Ln(P3/P1), $p < 0.001$), whereas globalization failed to exhibit any considerable effect.

(4) Cross-Tabulation Analysis

By cross-tabulating the two major determinants of the epidemiologic transition (i.e., the measure of the demographic transition, gFACT4, and the index of favorable conditions for population health applied in the population health efforts and effectiveness evaluation, PHEEE), various average percentages of epidemiologic transition outcomes were calculated for 52 less developed countries.[6] The communicable diseases-to-injuries transition, calculated as the average of the percentages of injuries to communicable diseases for the countries involved, ranged from 16.1% in low gFACT4 and PHEEE levels, to 59.3% in medium gFACT4 and PHEEE levels, and 86.8% in high gFACT4 and PHEEE levels, agreeing with the estimation that injuries will rival communicable diseases as a source of ill-health by 2020 (see World Health Organization 2012).

Furthermore, the transition from communicable diseases- to- non-communicable diseases, calculated as the average of the percentages of non-communicable to communicable diseases, exhibited substantial change, increasing from 119.6% in low gFACT4 and PHEEE levels, to 408% in medium gFACT4 and PHEEE levels, and 732% in high gFACT4 and PHEEE levels, agreeing with the latest estimation that by the year 2020, non-communicable diseases will account for 7 out of every 10 deaths in

6 To conserve space, for those Tables or Figures not shown in the text are available from the author upon request.

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the developing world (World Health Organization 2012). As displayed in Figure 1, the compositional proportions of three cause groups were also represented in the six cross-tabulation positions to demonstrate the utility of the gFACT4 and PHEEE.

According to the proposed thesis, which states that favorable conditions for population health are created by the demographic transition, no high PHEEE level (i.e., high level of favorable conditions for population health) is to be expected for countries in the low level of the demographic transition, nor can the low PHEEE level be observed in the medium and high levels of the demographic transition. This cross-tabulation of all countries into various world positions of the epidemiologic transition advances the knowledge on the current situation of the health of the general population in less developed countries. An additional focus on some exceptional cases in the cross-tabulation framework (e.g., Malaysia) maintains other possible particular factors such as religion (see also Gage

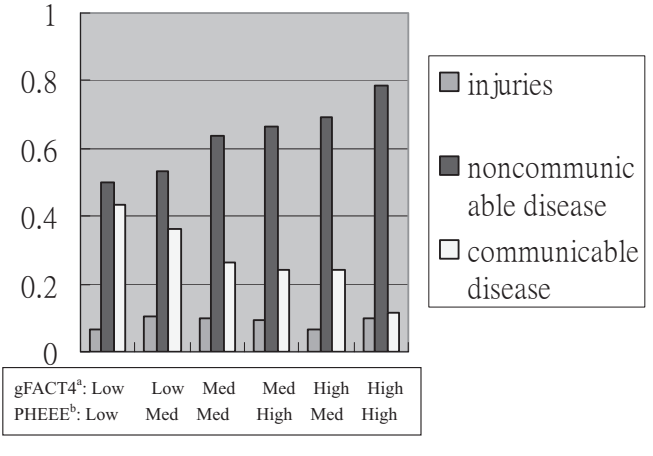

Figure 1. Compositional proportions of three cause groups in six cross-tabulation positions

[a] Global Fertility and Cultural Transition.

[b] Population Health Efforts and Effectiveness Evaluation.

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2005; Nagi 1984), but does not obviate the systematic approach for building a generalized pattern of epidemiologic change and identifying a systematic relationship between the demographic transition and the epidemiologic transition, highlighting the importance of this systematic relationship for the underlying policy considerations in the developing world.

VII. Conclusion and Discussion

As a response to Wallace (2001) regarding the theoretical development bridging epidemiology and demography, this study represents a research endeavor in theorizing and testing a demographic transition account to identify the systematic relationship between the demographic transition and the epidemiologic transition. We used a continuous measure of demographic transition as a global fertility and cultural transition, applied the latest notion of compositional models to determine causes of death, and further conceptualized the epidemiologic transition as a transition from communicable to non-communicable diseases to injuries Thus, this study offers by far the most comprehensive model linking distal structural forces, proximate mechanisms of the demographic transition, and favorable conditions for population health to explain a systematic shift in epidemiologic patterns.

(1) Summary of Findings

Some of the major findings can be summarized as follows:

A. In accordance with the proposed thesis, the demographic transition in relation to the global fertility and cultural transition exerted theoretically expected positive and robust effects on all measures representing favorable conditions for population health, even controlling

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for the effects of the distal structural forces and the overall effect of globalization.

B. Both indices of global fertility and cultural transition, as well as the favorable conditions for population health, yielded substantial positive influences on the measures of epidemiologic transition outcomes, including the communicable to non-communicable diseases transition and communicable diseases to injuries transition, holding constant the effects of the distal structural forces, all-cause mortality rate, and overall globalization impact.

C. Additional cross-tabulation analyses proved the importance of the global fertility and cultural transition, and favorable conditions for population health as two theoretical constructs for ranking countries in the epidemiologic-transition world to evaluate population-health situations in less-developed countries.

D. The structure-agency approach, used to determine the measures representing favorable conditions for population health, can be also applied to population health efforts and effectiveness evaluation (PHEEE), which combined with the levels of the demographic transition (gFACT4), offers a novel heuristic device for understanding and predicting the systematic distribution and progression of epidemiologic transition patterns.

(2) Theory, Research, and Policy Implications

Theoretically, given that the decline in the mortality rate is an integral part of the demographic transition process, the epidemiologic transition can be used to explain changing disease patterns within the general demographic transition model (Selya 2004). As Omran (1971: 536) stated: “Despite the inherent difficulties in attempting to structure a matrix that includes all the

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complex vital factors of population dynamics, the need to do so is urgent," this study enriches the theoretical and research tradition on epidemiologic transition by re-conceptualizing the demographic transition and using a structure-agency approach to theorize an alternative demographic- transition thesis. Moreover, this theorizing confirms one of the candidate theories and themes (i.e., "the demographic transition within developing countries" as proposed by Wallace [2001]) for linking demography and epidemiology.

Empirically, these findings reveal the robust effects of both the demographic transition and favorable conditions for population health in affecting epidemiologic change. This confers strong support for the proposed thesis that the demographic transition creates conditions that boost population health, with expectable outcomes for examining other research issues never explored before, including maternal mortality (Shen and Williamson 1999), child mortality (Shandra et al. 2005), killer diseases (Shircliff and Shandra 2011), urbanization (Dyson 2011), women liberation, and democracy development (Dyson 2001, 2012). Future research endeavors for bridging epidemiology and demography may also approach other theories proposed by Wallace (2001) for a collaborative development of epidemiology and demography.

Eventually, provided the solid theoretical and empirical bases of a systematic relationship among the demographic transition, favorable conditions for population health, and epidemiologic transition, the policy implications point to the efforts of governments and agents of change from the domestic and international civil societies (see Fetter et al. 1997: 236) to implement the progression of the demographic transition as a crucial policy consideration for creating general favorable conditions for population health in less developed countries, thus producing the expected epidemiologic transition outcomes.

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(3) Limitations of This Study and Suggestions for Future Research

Although this study provides a powerful account of the communicable-to-non-communicable disease transition and communicable diseases-to-injuries transition, we describe some of the limitations and provide suggestions for future research. First, given the latest evolution of the Triple Burden of Diseases (TBD) plaguing the less-developed countries not originally mentioned in Omran (1971), the current endeavor can be further extended to explore the influence of the demographic transition and favorable conditions for population health on the TBD. A plausible operationalization of the TBD can apply an index of qualitative variation (IQV) method to simultaneously measure the level of heterogeneity resulting from different proportions of communicable diseases, non-communicable diseases, and injuries being combined. Second, additional research efforts can be devoted to a demographic transition explanation of age-specific and sex-specific epidemiologic transition outcomes to broaden and deepen the understanding for dealing with specific epidemiologic transitions problems in less-developed countries. Finally, a crucial experiment test can be conducted to examine the rival explanation of income inequality, an unfavorable condition for population health that also affect the epidemiologic transition. Further approaches of this testable demographic transition theory can demonstrate the theoretical and empirical efficacy of this theory for bridging demography and epidemiology, and hopefully, for advancing interdisciplinary research in the future.

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Research Notes

人口轉型與疾病轉型系統性的相關聯

陳正和*

摘要

目的：有鑒於目前理論與經驗研究在探討人口轉型與疾病轉型系統性相關聯的不足，本研究以人口轉型理論提出人口轉型所帶來的人口健康有利條件如何在理論上與研究上解釋疾病轉型。

方法：運用OLS迴歸分析與交叉表列方法，針對開發中國家可得資料進行跨國資料分析。

發現：以全球生育與文化轉型所量度的人口轉型不僅影響人口健康有利條件的發生，二者並同時帶動疾病轉型有系統性的循序進展，從傳染性疾病轉型為非傳染性疾病，以及從傳染性疾病轉型為傷害為主的死亡成因。

結論：本研究有助於理論發展與跨學科研究連結人口學與流行病學，結論並討論理論、研究，與政策上的涵義及對未來研究的具體建議。

關鍵詞：人口健康有利條件、人口轉型、疾病轉型

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