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Factors Affecting Life Expectancy: Evidence From 1980-2009 Data in Singapore, Malaysia, and Thailand

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Abstract

The authors aim to examine the impact of demographic changes, socioeconomic inequality, and the availability of health care resources on life expectancy in Singapore, Malaysia, and Thailand. This is a cross-country study collecting annual data from 3 Southeast Asian countries from 1980 to 2008. Life expectancy is the dependent variable with demographics, socioeconomic status, and health care resources as the 3 main determinants. A structural equation model is used, and results show that the availability of more health care resources and higher levels of socioeconomic advantages are more likely to increase life expectancy. In contrast, demographic changes are more likely to increase life expectancy by way of health care resources. The authors suggest that more effort should be taken to expand and improve the coverage of health care programs to alleviate regional differences in health care use and improve the overall health status of people in these 3 Southeast Asian countries.

Keywords

life expectancy, health care resources, Southeast Asia, Singapore, Malaysia, Thailand

Introduction

In 1980, the life expectancies (LEs) at birth in Singapore, Malaysia, and Thailand were 72.1, 66.7, and 65.0 years, but by 2008, it had increased to 81.4, 68.9, and 74.4 years, respectively. Population expansion and demographic transition since the 1980s were accompanied by major socioeconomic development in all 3 countries.[1] After more than 25 years of socioeconomic expansion, Singapore, Malaysia, and Thailand had transformed themselves into developed nations. For example, within 30 years, from 1980 to 2009, the gross domestic product (GDP) per capita has risen 7-fold, from US$ 4859 to US$ 35 515, in Singapore; 4-fold, from US$ 1812 to US$ 6975, in Malaysia; and 6-fold, from US$ 685 to US$ 3894, in Thailand.[1] However, the negative impact of the economic crisis is clearly evident by the fall of per capita income in 1998

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by 17%, 29%, and 27%, in Singapore, Malaysia, and Thailand, respectively.[1] Crisis is often accompanied by high unemployment rates, income decline, and loss of health insurance and social status. Consequently, during an economic downturn, the provision of sufficient nutrients and access to adequate medical care are more likely to be hindered or altered, and vice versa during economic upturns. The extent of the impact of the socioeconomic instability on LE, therefore, is not only a critical issue in population health research but also a pressing public health concern, with significant implications for health care policies.

The literature illustrates that the demographic and socioeconomic determinants of LE may consist of gender, age, education, and GDP per capita income.[2-5] A study in South Korea, based on census data for 4 million, showed that there was a positive impact on LE from changes of income both in gender and across age groups.[5] Another study on 14 000 Thai older adults found that older people with higher income and advanced education experienced better health outcomes and health satisfaction.[6] Inequalities in income and education have recently been identified to account for regional inequalities in LE as well as in other health indicators.[7] Unemployment was found to negatively affect health outcomes.[8] Moreover, longer LE was associated with low infant mortality rates and high literacy rates.[9] The health care resources determinants of LE may consist of health care expenditures, health care resources, mortality rates, and health outcomes.[10] Previous studies have shown that improved health care services such as increased number of physicians, hospital deliveries, and prenatal examination could reduce mortality and result in an increase in LE, but this varied across gender and age groups.[11,12]

Although evidence of the effects of demographics, socioeconomic instability, and health care resources on LE has been proved in previous studies, there has been relatively little research undertaken within Southeast Asian countries. Hence, the present study endeavors to fill this gap in the literature.

Materials and Methods

Aims

The aim of this study was to develop an explanatory model to account for the factors that contribute to the LE for each target country. We specifically investigated the direct and indirect effects of socioeconomic status, the availability of health care resources, and demographic factors on LE. For each country, 2 research questions were asked:

1. Do demographic, socioeconomic, and health care resource factors have direct effects on LE?
2. Do demographic and socioeconomic factors have indirect effects on LE?

Settings

This was a cross-country study to collect annual data for Singapore, Malaysia, and Thailand covering a period of 29 years, from 1980 to 2008, from world organization and/or government statistics. We used LE at birth instead of LE at 1 or 5 years because not all the data for 29 years was available from these 3 countries. Exemption for ethical approval was obtained by the Institute Review Board, National University of Singapore (IRB Code: 09-406E).

Data and Sources

We used the findings of previous studies to select the most common variables that have shown an impact on LE.[5,13-15] Because this is a macro-level approach, all variables included in the study

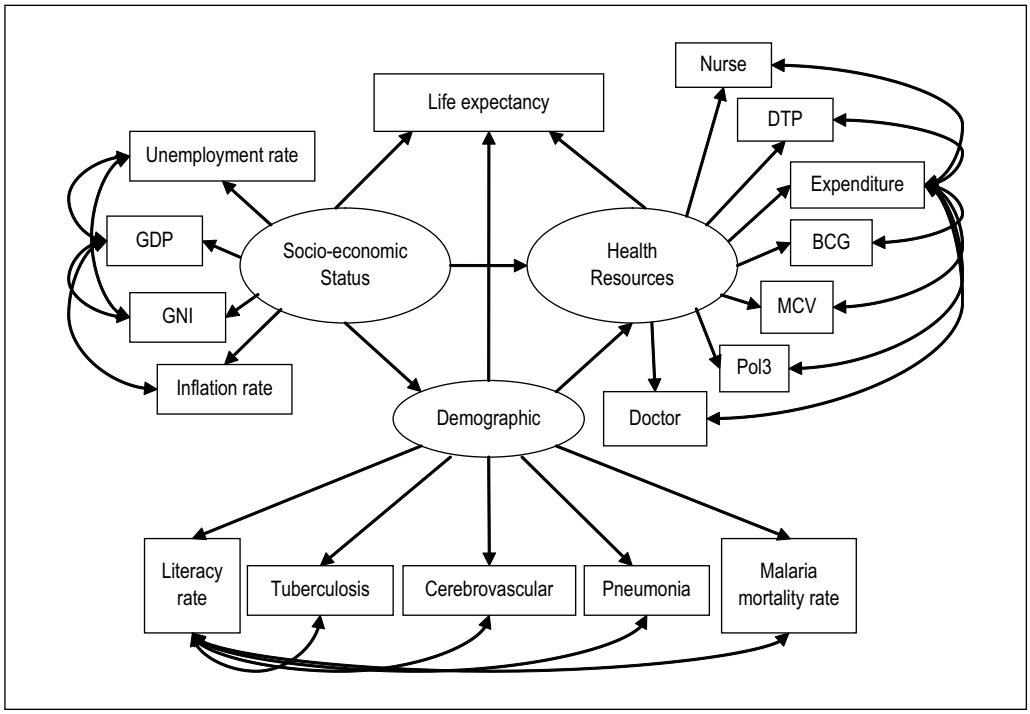

Figure 1. Conceptual model of direct and indirect influence of demographics, socioeconomic status, and health resources on life expectancy.
Abbreviations: GNI, gross national income; DTP, diphtheria, tetanus, and pertussis; BCG, Bacillus Calmette-Guerin; MCV, measles immunization coverage; vaccination Pol3, coverage of third dose of polio immunization among 1-year-olds (percentage).

had to have data available for at least 25 years in each country. The sources of these data were either annual reports or Web site statistics from World Development Indicators,[1] Committee of Health Statistics,[16] Singapore Department of Statistics,[17] The ASEAN Statistical Yearbook,[18] United Nations Development Programme,[19] World Economic Outlook database,[20] National Statistics Office database,[13] Health Nutrition and Population Statistics,[21] Global Health Observatory database,[22] Child Mortality Estimation database,[23] and Bureau of Policy and Strategy.[24] To ensure the relevance of these data, criteria for evaluation were deemed necessary. These criteria included methods used to collect the data, accuracy assessed by comparing data from different sources, time between collection to ensure that it was still valid to the present research problem, and definitions of dependent and explanatory variables, units of measurement, and categories used. A conceptual model developed for this study including endogenous and exogenous variables that embody the causal structure is depicted in Figure 1. An arrow indicates the direction of a hypothesized causal relationship, and the 2 arrowheads indicate the observed covariance between 2 variables, which is developed based on findings from the previous literature and explained in what follows.

In this study, LE is the dependent variable and refers to LE at birth, which is the average number of years a newborn infant would be expected to live if health and living conditions at the time of its birth remained the same throughout its life. It reflects the health of a country's people and the quality of care they receive when they are ill.[2,3] There are 3 main determinants: demographic variables, socioeconomic status, and health care resources. Demographic variables include the literacy rate[2-4] and death rates by major causes, including tuberculosis, cerebrovascular

Table 1. Correlation Matrix of LE, Health Resources, Socioeconomic Status, and Demographic Variables for Singapore (1980-2008).[a]

	LE	Doctor	Expenditure	V-MCV	LR	Pneumonia	GDP	UR
LE	1.00							
Doctor	0.84[b]	1.00						
Expenditure	0.79[b]	0.71[b]	1.00					
V-MCV	0.75[b]	0.63[b]	0.51[b]	1.00				
LR	0.63[b]	0.79[b]	0.73[b]	0.65[b]	1.00			
Pneumonia	−0.75[b]	−0.85[b]	−0.71[b]	0.73[b]	−0.66[b]	1.00		
GDP	0.65[b]	0.74[b]	0.75[b]	0.67[b]	0.71[b]	−0.72[b]	1.00	
UR	−0.71[b]	−0.75[b]	−0.68[b]	−0.78[b]	−0.73[b]	−0.70[b]	−0.63[b]	1.00

Abbreviations: LE, life expectancy (average number of years a newborn infant would be expected to live); GDP, gross domestic income divided by midyear population; UR, unemployment rate (the share of the labor force that is without work but available for and seeking employment); LR, percentage of people aged 15 years and older who can, with understanding, read and write a short, simple statement on their everyday life; V-MCV, Vaccination—measles immunization coverage among 1-year-olds (percentage).

[a]Pneumonia, number of deaths caused by pneumonia per 100 000 population; doctor, number of physicians per 10 000 population in a given year; expenditure, per capita government expenditure on health at average exchange rate (US$).

[b]Significance at $P < .05$.

accidents, malaria, and pneumonia.[24-26] Socioeconomic variables include the GDP per capita, gross national income per capita, inflation rate, and unemployment rate.[7,9,10,27] Health care resources variables include the number of physicians and nurses per 10 000 population in a given year, per capita government expenditure on health, the percentage of vaccination coverage of measles, Bacillus Calmette-Guerin (BCG), poliomyelitis (Poli), and diphtheria, tetanus, and pertussis (DTP) in a given year.[14,15,28]

Statistical Analysis

To analyze this conceptual model, a structural equation model (SEM) is used. The SEM is a powerful technique for the analysis of multiple simultaneous causal relationships among endogenous variables and between endogenous and exogenous variables. Each model represents a plausible alternative formulation of the way in which the 3 main determinants affect each other and the LE. For each country, correlation was used to produce an asymptotic matrix (see Tables 1-3), which was used to estimate the model parameters. All SEM models were tested using AMOS 18. Once a model is specified and found admissible, it was tested by comparing the goodness of fit of the sample correlation matrix with the correlation matrix implied by the model.[29,30] The null hypothesis specifies no difference between the 2 matrices and is tested using a χ^2/df statistics. If that ratio is less than 6, the fit between the model and the data is assumed adequate.[29] Another measure used in comparing models of varying complexity is the root mean square error of approximation (RMSEA).[30] It is a measure of discrepancy per degree of freedom, and a RMSEA value of 0.05 or less indicates a good fit; values up to 0.10 represent reasonable errors of approximation in the population.[30] Finally, the standardized root mean residual (SRMR) is another useful index that varies between 0 and 1, does not depend on sample sizes, and for which a value less than 0.08 is considered a good fit of the model.[29] We set the significance level at $P < .05$ in any test hypotheses.

Table 2. Correlation Matrix of LE, Health Resources, Socioeconomic Status, and Demographic Variables for Malaysia (1980-2008).[a]

	LE	Doctor	Expenditure	LR	Tuberculosis	IR	GDP
LE	1.00						
Doctor	0.75[b]	1.00					
Expenditure	0.81[b]	0.58[b]	1.00				
LR	0.69[b]	0.71[b]	0.64[b]	1.00			
Tuberculosis	−0.71[b]	−0.73[b]	−0.86[b]	−0.67[b]	1.00		
IR	0.84[b]	0.56[b]	0.71[b]	0.63[b]	−0.65[b]	1.00	
GDP	0.68[b]	0.72[b]	0.81[b]	0.74[b]	−0.68[b]	0.76[b]	1.00

Abbreviations: LE, life expectancy (average number of years a newborn infant would be expected to live); GDP, gross domestic income divided by midyear population; IR, inflation rate (as measured by the consumer price index; reflects the annual percentage change in the cost to the average consumer to acquire a basket of goods and services); LR, literacy rate (percentage of people aged 15 years and older who can, with understanding, read and write a short, simple statement on their everyday life).
[a]Tuberculosis: number of deaths caused by tuberculosis per 100 000 population; doctor, number of physicians per 10 000 population in a given year; expenditure, per capita government expenditure on health at average exchange rate (US$)
[b]Significance at $P < .05$.

Table 3. Correlation Matrix of LE, Health Resources, Socioeconomic Status, and Demographic Variables for Thailand (1980-2008).[a]

	LE	Doctor	Expenditure	V-Pol3	Malaria	Pneumonia	LR	IR	GDP
LE	1.00								
Doctor	0.70[b]	1.00							
Expend	0.84[b]	0.64[b]	1.00						
V-Pol3	0.69[b]	0.78[b]	0.62[b]	1.00					
Malaria	−0.78[b]	−0.82[b]	−0.76[b]	0.68[b]	1.00				
Pneumonia	−0.73[b]	−0.78[b]	−0.80[b]	−0.70[b]	0.63[b]	1.00			
LR	0.74[b]	0.77[b]	0.68[b]	0.63[b]	−0.71[b]	−0.72[b]	1.00		
IR	0.79[b]	0.66[b]	0.74[b]	0.65[b]	−0.75[b]	−0.69[b]	0.67[b]	1.00	
GDP	0.64[b]	0.81[b]	0.75[b]	0.72[b]	−0.81[b]	−0.76[b]	0.73[b]	0.78[b]	1.00

Abbreviations: LE, life expectancy (average number of years a newborn infant would be expected to live); GDP, gross domestic income divided by midyear population; IR, inflation rate (as measured by the consumer price index; reflects the annual percentage change in the cost to the average consumer to acquire a basket of goods and services); V-Pol3, coverage of third dose of polio immunization among 1-year-olds (percentage); LR, literacy rate (percentage of people aged 15 years and older who can, with understanding, read and write a short, simple statement on their everyday life).
[a]Pneumonia, number of deaths caused by pneumonia per 100 000 population; malaria, number of deaths caused by malaria per 100 000 population; doctor, number of physicians per 10 000 population in a given year; expenditure, per capita government expenditure on health at average exchange rate (US$).
[b]Significance at $P < .05$.

Results

Figures 2 to 4 are the final SEM model incorporating the LE into 3 main determinants, with the rectangles representing the observed variables. The final model for Singapore (Figure 2) shows that the path from socioeconomic status and health care resources had direct positive effects on increasing LE, and no direct effect was found from demographics ($\chi^2/df = 5.83$; RMSEA = 0.056; SRMR = 0.074). Although demographics did not influence LE directly, it has a positive indirect

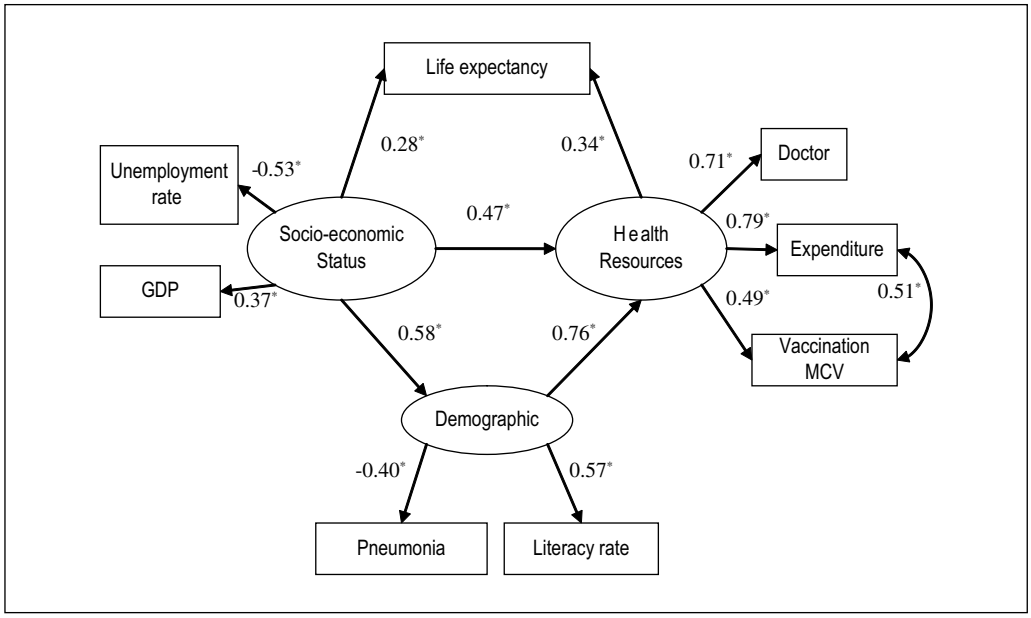

Figure 2. Final model: structural equation model of demographic variables, socioeconomic status, and health resources affecting LE in Singapore from 1980 to 2008.[a]

Abbreviations: LE, life expectancy (average number of years a newborn infant would be expected to live); GDP, gross domestic income divided by mid-year population; vaccination MCV, measles immunization coverage among 1-year-olds (percentage).

[a]Unemployment rate, the share of the labor force that is without work but available for and seeking employment; pneumonia, number of deaths caused by pneumonia per 100 000 population; literacy rate, percentage of people aged 15 years and older who can, with understanding, read and write a short, simple statement on their everyday life; doctor, number of physicians per 10 000 population in a given year; expenditure, per capita government expenditure on health at average exchange rate (US$).

*, Significance at $P < .05$;

**, Significance at $P < .01$.

impact on LE by way of health resources. In addition, socioeconomic status also has a positive but indirect impact on LE by way of demographic and health care resources.

The final model for Malaysia (Figure 3) showed that health care resources had a direct effect on LE (χ^2/df =5.48; RMSEA = 0.061; SRMR = 0.069). Socioeconomic status and demographics, on the other hand, have no direct effect on LE. Although demographics do not influence LE directly, it has a positive indirect impact on LE by way of health resources. In addition, socioeconomic status also has a positive indirect impact on LE by way of both demographic and health care resources.

The final model for Thailand (Figure 4) showed that LE (χ^2/df = 6.19; RMSEA = 0.049; SRMR = 0.071) has a direct impact by socioeconomic status and health care resources. Although no direct impact was found from demographic factors on LE, it has a positive indirect impact by way of health care resources. In addition, socioeconomic status also has a positive indirect impact on LE by way of both demographic and health care resources.

Discussion

Our finding shows that higher education levels among the population have a positive impact on LE. This finding has important implications—that is, higher levels of education are typically associated with more timely receipt of health care, and people are more likely to be aware of their health. Another important issue is the positive association between literacy rate and LE.

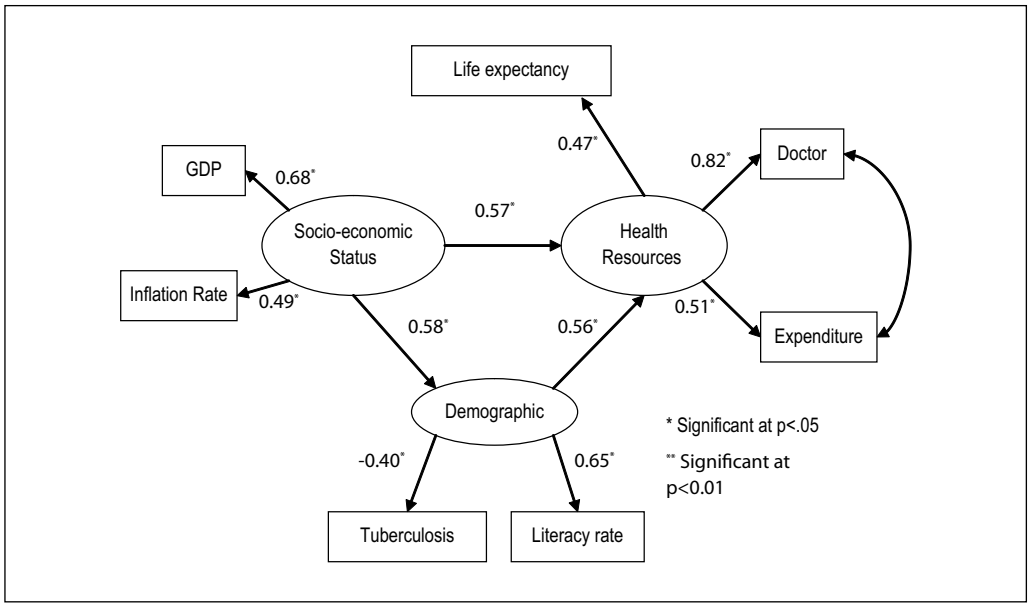

Figure 3. Final model: structural equation model of demographic variables, socioeconomic status, and health resources affecting LE in Malaysia from 1980 to 2008.[a]

Abbreviations: LE, life expectancy (average number of years a newborn infant would be expected to live); GDP, gross domestic income divided by midyear population.

[a]Inflation rate, inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer to acquire a basket of goods and services; tuberculosis, number of deaths caused by tuberculosis per 100 000 population; literacy rate, percentage of people aged 15 years and older who can, with understanding, read and write a short, simple statement on their everyday life; doctor, number of physicians per 10 000 population in a given year; expenditure, per capita government expenditure on health at average exchange rate (US$).

This might suggest that with higher educational levels, people are more aware of the importance of obtaining adequate prenatal care[4] and can be encouraged to optimize the use of maternal health services and avoid situations such as delivering a low-birth-weight baby or encountering other childbirth-related complications.

Results of this study support claims that inflation rate and increase in GDP increase LE.[8,14] These findings have significant implications. Besides implementing economic reconstruction processes such as increasing job opportunities, policy makers would have increased awareness that economic hardship can affect vulnerable populations such as elderly people, whose health status will deteriorate. A previous study found that death rates of elderly people were substantially higher in the lower-income groups.[6] The economic crisis that hit Asia in 1997 created a shortage of health care services that affected the vulnerable populations most and compromised health demands.[8] This leads to the policy implications of our study results—namely, that economic upturns are associated with greater LE rates and vice versa for economic downturns. We need to focus on whether the negative impact of economic downturns on these rates can be reduced, if not avoided. Maybe what we need is a similar focus on the positive health implications, in terms of increasing these rates in times of economic upturns.

Access to health care services is an important resource to protect oneself from disease onset and to hasten recovery from illness and disabilities. In the health care resource factors, public expenditure on health care was positively associated with LE. This is generally consistent with previous work done in Western societies that show the important role that health care access

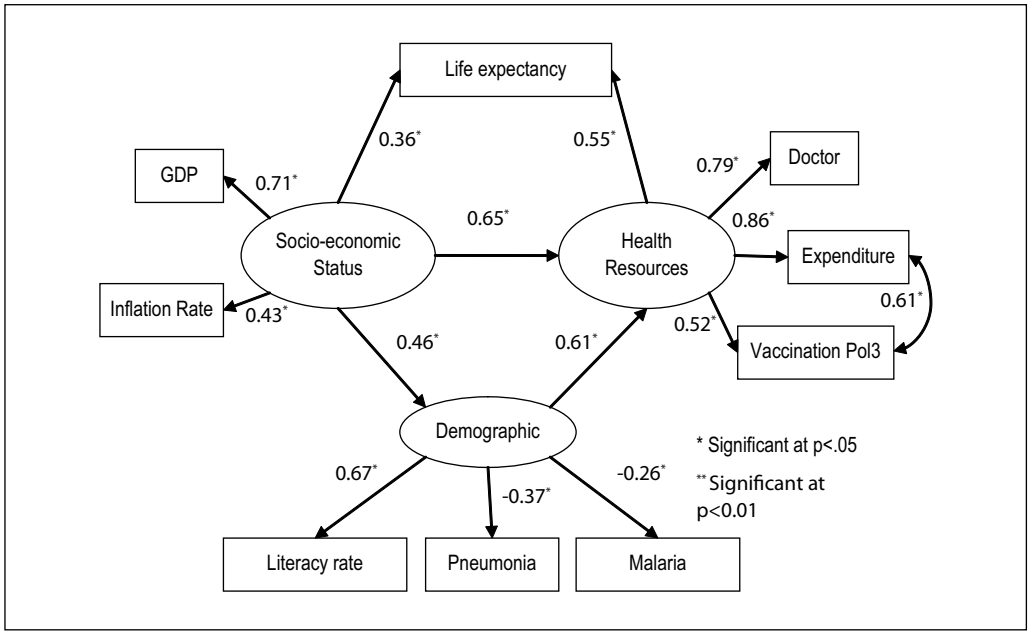

Figure 4. Final model: structural equation model of demographic variables, socioeconomic status, and health resources affecting LE in Thailand from 1980 to 2008.[a]

Abbreviations: LE, life expectancy (average number of years a newborn infant would be expected to live); GDP, gross domestic income divided by midyear population; vaccination Pol3, coverage of third dose of polio immunization among 1-year-olds (percentage).

[a]Inflation rate, inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer to acquire a basket of goods and services; pneumonia, number of deaths caused by pneumonia per 100 000 population; malaria mortality rate, number of deaths caused by malaria per 100 000 population; doctor, number of physicians per 10 000 population in a given year; literacy rate, percentage of people aged 15 years and older who can, with understanding, read and write a short, simple statement on their everyday life; expenditure, per capita government expenditure on health at average exchange rate (US$).

plays in the survival of children and older people.[7,12] A study showed that more health care services available in rural areas can improve the odds of survival and healthy survival of older people.[10] In addition, maternal and fetal-neonatal survival depend on a continuum of basic services through pregnancy, delivery, and the postpartum/newborn period.[2] However, inability to get access to health care services for severe childhood illness could affect psychological development and accelerate the degradation of the functional level of specific organs in adulthood. All these adversities may reduce an individual's reserve capacity to resist disease, thus increasing mortality and health problems at later ages and lead to reduced LE. Therefore, this might explain our finding regarding the significance of increasing health care expenditure and its impact on LE. The effects are obvious, and it is especially true when the socioeconomic environment is in turmoil, when people may require more free health care services from the government. In addition, improvements in medical technology can prolong the length of time to deaths and prevent many deaths.[5]

In examining the health care system of the 3 countries, the most obvious finding was that all 3 countries had a unified system for the entire country and a system that depended heavily on the public sector. Across these 3 health care systems, the outcomes of health care and health behaviors are clearly reflected in the vital statistics. The system is focused predominantly on the public sector, access to care for pregnant and postpartum women is relatively easy, and care is directed at promoting the health of the mother and child, thereby reducing infant mortality. The findings

of this study provide support for recommendations related to the need for continuing support for the expenditure from the government.

Limitations

There are a number of limitations that may affect the results of the study. First, a longitudinal design is a particularly weak design for causal inference. Second, LE was used, although other measures such as disability-adjusted LE or health-adjusted LE are regarded as more accurate reflections of population health and more sensitive to living conditions because they factor in disabling nonfatal health outcomes and their impact on quality of life. However, Robine[14] commented that this issue is especially significant in developed countries because increase in LE raises concerns about morbidity and quality of life in older age. Third, as regards the explanatory variables, this study relies on data collected for different purposes, which might potentially be subject to bias. Last but not the least, other important explanatory variables such as urbanization, tobacco consumption, and sanitation should be considered. Unfortunately, no 29-year data were available from these 3 countries, so we could not examine their effects on LE in this study. We therefore recommend that more research be conducted into how lifestyle affects LE.

Conclusions

This work presents an analysis of how demographics, socioeconomic status, and health care resources affect LE in 3 Southeast Asian countries. Although the present study does not support the findings of direct effects of demographic factors on LE, it strongly supports their impact on LE via health care resource factors. Results indicate that providing more health care resources significantly improves LE, and socioeconomic advantages directly influence LE. Taken together, the results of this study provide a reference for researchers in Singapore, Malaysia, and Thailand and may thereby shed additional light on this issue. As a result, understanding direct and indirect impacts on LE is not only an important issue in research on the health status of a population but also a major public health concern with crucial policy implications. These results, therefore, imply that more effort, particularly during economic downturns, should be spent by removing the barriers that impede access to health care services and increasing preventive care for the population that currently has less access to health care in communities where there is scarcity of medical resources. In addition, efforts should be made to expand and improve the coverage of health care programs to alleviate regional differences in the use of health care services and improve the overall health status of people in these 3 Southeast Asian countries.

Authors' Note

Author contributions were as follows: study design, MFC; data collection and analysis, MFC; preparation, MFC and MKD.

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Declaration of Conflicting Interests

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References

1. The World Bank. *World Development Indicators*. Washington, DC: World Bank; 2010.
2. Meara ER, Richards S, Cutiew DM. The gap gets bigger: changes on mortality and life expectancy, by education, 1981-2000. *Health Aff (Millwood)*. 2008;27:350-360.
3. Shkolnikov VM, Andreev EM, Jasilionis D, Leinsalu M, Antonova OI, McKee M. The changing relation between education and life expectancy in central and eastern Europe in the 1990s. *J Epidemiol Community Health*. 2006;60:875-881.
4. Bulled NL, Sosis R. Examining the relationship between life expectancy, reproduction, and educational attainment. *Hum Nat.* 2010;21:269-289.
5. Khang YH, Yang S, Cho HJ, Jung-Choi K, Yun SC. Decomposition of socio-economic differences in life expectancy at birth by age and cause of death among 4 million South Korean public servants and their dependents. *Int J Epidemiol.* 2010;39:1656-1666.
6. Zimmer Z, Amornsirisomboon P. Socioeconomic status and health among older adults in Thailand: an examination using multiple indicators. *Soc Sci Med.* 2001;52:1297-1311.
7. Hoi LV, Phuc HD, Dung TV, Chuc NTK, Lindholm L. Remaining life expectancy among older people in a rural area of Vietnam: trends and socioeconomic inequalities during a period of multiple transitions. *BMC Public Health*. 2009;9:234-238.
8. Karlsson M, Nilsson T, Lyttkens CH, Leeson G. Income inequality and health: importance of a cross-country perspective. *Soc Sci Med.* 2010;70:875-885.
9. Lin CC, Rogot E, Johnson NJ, Sorlie PD, Arias E. A further study of life expectancy by socioeconomic factors in the National Longitudinal Mortality Study. *Ethn Dis.* 2003;13:240-247.
10. Shaw JW, Horrace WC, Vogel RJ. The determinants of life expectancy: an analysis of the OECD health data. *South Econ J*. 2005;71:768-783.
11. Rattanamongkolgul S, Sithisarankul P, Wattanasirichaigoon S. Life expectancy of Thai physicians during 1998-2002. *J Med Assoc Thai.* 2004;87(suppl 4):S19-S22.
12. Seubsman S-A, Kelly MJ, Yiengprugsawan V, Sleigh AC; Thai Cohort Study Team. Gender, socioeconomic status, and self-rated health in a transitional middle-income setting: evidence from Thailand. *Asia Pac J Public Health*. 2011;23:754-765.
13. The Apache Jakarta Project. National Statistics Office Database. Thailand; 2010.
14. Robine JM. The relevance of population health indicators. *J Epidemiol Community Health*. 2003; 57:318-323.
15. Tang J-L, Griffiths S. Review paper: epidemiology, evidence-based medicine, and public health. *Asia Pac J Public Health*. 2009;21:244-251.
16. Committee of Health Statistics. *SEAMIC Health Statistics 1980-2002. SEAMIC Health Statistics*. Tokyo, Japan: Southeast Asian Medical Information Center; 1980-2002.
17. Singapore Department of Statistics. *Yearbook of Statistics 1979-2010*. Singapore: Singapore Department of Statistics; 1980-2010.
18. The ASEAN Secretariat. *ASEAN Statistical Yearbook 2001-2008*. Jakarta, Indonesia: ASEAN Secretariat; 2001-2008.
19. United Nations Development Programme (UNDP). *Human Development Report 1990-2010*. New York, NY: UNDP; 1990-2010.

20. International Monetary Fund (IMF). *Data and Statistics: World Economic Outlook*. Washington, DC: IMF; 2010.
21. The World Bank. *Health Nutrition and Population Statistics*. Washington, DC: World Bank; 2011.
22. World Health Organization (WHO). *Global Health Observatory Database*. Geneva, Switzerland: WHO; 2011.
23. The United Nations Childern's Fund (UNICEF). *Child Mortality Estimation Database*. Geneva, Switzerland: UNICEF; 2010.
24. Bureau of Policy and Strategy. Thailand Health Profile 1999-2007. In: Wibulpolprasert S, ed. *Thailand Health Profile*. Bangkok, Thailand: Bureau of Policy and Strategy, Ministry of Public Health; 2000-2007.
25. Tan KC, Low CK. Contributions of various major causes of death to life expectancy in Singapore, 1980-1990. *Singapore Med J.* 1996;37:348-351.
26. Jiawiwatkul U, Aekplakorn W, Vapattanawong P. Changes in active life expectancy among older Thais: results from the 1997 and 2004 national health examination surveys. *Asia Pac J Public Health*. 2011;23:112-119.
27. Barlow R, Vissandjee B. Determinants of national life expectancy. *Rev Can Etudes Dev.* 1999;20:9-29.
28. Asiskovitch S. Gender and health outcomes: the impact of healthcare systems and their financing on life expectancies of women and men. *Soc Sci Med.* 2010;70:886-895.
29. Kline RB. *Principles and Practice of Structural Equation Modeling.* 2nd ed. New York, NY: Guilford; 2005.
30. Browne MW, Cudeck R. Alternative ways of assessing model fit. In: Bollen KA, Long JS, eds. *Testing Structural Models*. Newbury Park, CA: Sage; 1993:111-136.