TDRI Quarterly Review

Published in *TDRI Quarterly Review*
Vol. 11 No. 4 December 1996, pp. 11-22

Editor: Belinda Fuller

Projection of Morbidity, Health Care Utilization and the Demand for Physicians

Mathana Phananiramai[*]
Somchai Suksiriserekul[**]

Morbidity patterns are determined by factors like age, sex, educational attainment, occupation and income. They are also affected by household environment and by risky behavior, such as drinking and smoking. Morbidity incidence determines health care needs, but actual health care utilization is based on a combination of need, accessibility and ability to pay. This study used information from "The First Survey On Health Status of Thai Population in 1991" to study the determinants of morbidity and health care seeking behavior, then used the results to project changing morbidity patterns and health care utilization into the future. The projected results were then used to project the future demand for physicians.

Present Situation on Morbidity and Health Care Utilization

The survey interviewed 5,882 households which accounted for 22,214 citizens of the kingdom. Approximately 44 percent of the sample population lived in municipal areas. Two questions were used to assess morbidity incidence: (1) "During the past two weeks, have you been afflicted by any illness?" and (2) "Did the illness cause you to stop your regular activities for at least 24 hours?" Forty-one percent and 9.8 percent of respondents, respectively, answered affirmatively. Based on these results, we projected that in 1991, approximately 23 millions persons reported ill within a two-week span and about 5.5 million temporarily stopped all regular activities as a result of their illness. These figures show that the morbidity incidence among the Thai population was indeed very high. A survey of a similar nature conducted by Mahidol University in 1985, which classified a person as being afflicted by illness if unable to perform their regular activities for at least 24 hours, found a morbidity incidence of about 15 percent over a one month period. If it is assumed that morbidity incidence depended only on the length of time span, i.e., rates are independent across time periods, then according to the 1991 Survey, morbidity incidence was approximately 18.6 percent over a one month period. This indicates that morbidity incidence increased over the 1985 to 1991 period.

Morbidity incidence varied significantly by age and sex. Using the second definition of illness, 11.2 percent of children younger than 15 years were afflicted, with rates of 8.6 percent and 10.2 percent for the aged 15-44 and over 45 subgroups respectively. With the exception of children younger than 15 years old, women were more likely to be afflicted by illness than men. The difference in morbidity rates between men and women was most pronounced among adults aged 15-44 years old (see Table 1). Morbidity patterns were also significantly different by age-sex groups. Children were more likely to be afflicted by diseases of the respiratory system, diseases with ill-defined symptoms and diseases of the digestive system. For adults, morbidity was spread more widely among all disease types. In addition to the three types of disease mentioned earlier, adults were also prone to be afflicted by muscular skeletal diseases, diseases related to the eyes, ears, nose and throat (EEN), and dental problems.

If the respondent affirmed that they had been afflicted by an illness in the past two weeks, they were then asked about their choice of health care. Three questions were asked: (1) "What was your choice of health treatment when first afflicted?" (2) "Have you recovered now?" and (3) "What is your present choice of health care treatment if you have not yet recovered?" Treatment choices were classified into three categories: (1) "did nothing," (2) "sought health care from physician," or (3) "sought health care from persons who were not physicians." The last category included self-prescription and health care administered by a traditional doctor. Diagrams 1 and 2 show that health care seeking behavior differed greatly among persons afflicted by illness in urban and rural areas. For persons afflicted in urban areas, their first health care choice was as follows: 47.4 percent sought health care from a non-physician, 34.7 percent sought health care from physician and 17.9 percent did nothing. If the first health care choice did not lead to recovery within some appropriate time span, they would switch to other choices. In sum, 67.3 percent of those afflicted by illness recovered within a two-week span. Among those recovered, 34.5 percent believed that they had recovered because of treatment from a physician, 50 percent believed that they recovered without treatment from a physician and

15.6 percent reported recovery with no special treatment required. Another 32.7 percent who had not yet recovered from illness were equally divided among three different types of treatment at the time of interview. The proportion of rural persons who sought treatment from a physician, either as their first choice or as their current choice, was lower than the urban rate. The proportion of afflicted persons who recovered from their illness within two weeks was also slightly lower. The choice of health care treatment did not only depend on place of residence, but also on the type of illness and its severity. For example, the proportion of those afflicted who sought treatment from physician was higher if the illness resulted in termination of all regular activities for more than 24 hours.

From the pattern of health care seeking discussed above, it can be concluded that Thai people have fairly good judgment on health care since approximately 95 percent of persons afflicted by illness recovered from the first treatment they chose. Only a small proportion had to switch to other treatment later. If switching among different treatments is considered as a waste of resources, better health education should improve the efficiency of resource utilization. Another point worth noting is that more than half of all illnesses could be healed without physician assisted treatment. Thus, primary health care and a good screening and referral system will greatly reduce the cost of health care without sacrificing health status.

Conceptual Framework on the Determinants of Morbidity and Health Care Utilization

The conceptual framework for the model based on the theory of household production assumes that in order to achieve maximum utility, an individual produces "commodities" for own consumption, subject to resource constraints. To produce such commodities, an individual combines their 'own time' with other inputs which can be purchased in the market, thus constraints on production include both time limits and financial limits.

In applying the theory of household production to the determinants of morbidity and health care utilization, 'health' is treated as a commodity that generates utility, and health can only be produced by using own time combined with other inputs, such as living a healthy life style by allocating sufficient time for healthful activities, eating nutritious food, and purchasing health services from experts when health status falls below normal levels, etc. The limit to health production is time, earning ability and medical technology. Note that the ultimate limit of financial resources is not income as usually calculated (i.e., the product of wage rate and time spent in the labor market), rather, income is the true earning ability of an individual if all time is allocated to market activities. This true earning ability is usually named 'full income.' There is a trade-off between allocating time in the labor market in order to earn more income or allocating time directly to the production of health. There is also substitution between using limited resources to produce other commodities in the utility function instead of health; this trade-off is influenced by relative commodity prices. Since all commodities must be produced using own time as an input, any single commodity price consists of two components, namely, the cost per unit of inputs purchased from the market and the cost of own time. The combined cost per unit is called the 'shadow price' of a commodity. Since the opportunity cost of time differs among different persons, each individual faces a different shadow price of health, and chooses a different input mix in producing health.

The Determinants of Morbidity Incidence

Multiple logit models were used to estimate morbidity incidence based on the framework presented above. Two dependent variables were used to measure morbidity incidence. The first one (SICK) is the number of illness episodes within two weeks which has a value of 0, 1, 2 or 3, corresponding to absence of affliction by illness or to one, two or three episodes of affliction during the past two weeks. The second one (DISEASES) referred to type of illness which took on a value of one of eight integers from 0 to 7, corresponding to following eight broad categories: not afflicted; diseases of the respiratory system; diseases of the digestive system; skin and allergy-related diseases; diseases of the eyes, ears, nose and throat, or dental problems; diseases with ill-defined symptoms; muscular skeletal diseases; and heart-related problems.

The independent variables consisted of three sets of variables at individual, household and community levels. Variables at the individual level are age, sex, educational attainment and work status (for adults only). Variables at the household level measured whether the household engaged in agricultural activities. Variables at the community level measured whether the household was located in an urban or rural area. These independent variables were used to reflect the average health endowment of an individual and the shadow price and full income faced by an individual in producing good health. Since average health endowment is largely determined by age, all the models will be estimated separately by three broad age groups, namely person aged 0-14, 15-44 and more than 45. It is expected that morbidity incidence should decrease with age for the first age group and increase with age for the last two age groups. Women of childbearing age should have higher morbidity incidence as the result of pregnancy and childbearing complications.

Moreover, age and sex will affect the shadow price of producing good health because different persons have different opportunity costs for time. Educational attainment, work status and household economic activity will not only affect the opportunity cost of own time, but also the productivity of time used in producing health. Finally, whether an individual resided in a rural or urban area should not only capture differences in environmental settings which may directly affect the incidence of illness, but also the cost of different types of health care treatment due to differential access to physicians in these areas.

The estimated models are shown in Tables 1 and 2. The morbidity incidence of children aged 0-14 declined with age as expected. There was no difference in morbidity incidence between girls and boys, but children in farm households and those living in rural areas were less afflicted by illnesses. The educational attainment of the household head did not have a significant effect on a child's probability of affliction by a first episode of illness, but as education of the household head increased, probability of second or third episode of affliction decreased.

For persons aged 15-44 years, the probability of affliction for women becomes evidently higher. Apart from the possibilities that women are physically different from men and that their subjective definitions of 'illness' may be different, there are social reasons for higher incidence among women. If women tend to underinvest in health or if they tend to work in health endangered environments, they are more likely to become afflicted. However, this study does not have enough information to differentiate among these alternative possibilities. The effects of educational attainment, household economic activities and residential location on morbidity incidence among adults are similar to those among children. The work status variable indicates that government employees are less likely to be afflicted than persons of other work status. Government officials have been covered by the most comprehensive health insurance for a long time and have better access to hospital services, hence as a group they tend to have better health.

For persons aged above 45 years, morbidity incidence increases linearly with age, and elderly women have a higher risk of affliction than elderly men. The effects of the independent variables on occupation, work status and residential location become less important in determining the morbidity incidence. The reason here may be that the health status of an elderly is the accumulated affects of past activities while variables on occupation, work status and residential location measure current situations. However, the variable on educational attainment remains important; greater education is not only linked to reduced incidence of affliction by the second and the third episode of illness (as in the other two age groups), but it is also linked to reduced incidence of affliction for the first episode of illness. In regard to all three age groups, the independent variables included in the model explained about 54-62 percent of total variations in morbidity incidence. The number of variables which are statistically significant and the proportion of explained variations declined for the older age group and with the second and third episodes of illnesses.

The type of disease affliction was also influenced by the age and sex of an individual and his or her socio-economic characteristics. The probability that children will be afflicted by diseases of the respiratory system, the digestive system and skin and allergic diseases declines with age, but the probability that they will be afflicted by diseases of the eyes, ears, nose and throat and dental related problems increases. Boys are less likely to be afflicted by diseases of the digestive system, but are more inceptive to allergy related diseases and muscle and skeletal diseases. Children in urban areas are more likely to be afflicted by diseases of the respiratory system. The education of the household head significantly reduces the probability that their children will be afflicted by diseases with ill-defined symptoms, but does not seem to reduce the probability of affliction by other diseases.

For adults aged 15-44 years, the probability of being afflicted by respiratory diseases, muscle and skeletal diseases, heart diseases and diseases with ill-defined symptoms increases with age. Women have a higher probability of being afflicted by all types of disease, with the exception of skin and allergic diseases and muscle and skeletal diseases. Agriculturists are less likely to be afflicted by respiratory diseases, or those with ill-defined symptoms, but are more likely to be afflicted by muscle and skeletal diseases. Residents of urban areas have a higher probability of being afflicted by respiratory diseases, but a lower probability of being afflicted by digestive diseases. Persons with higher education are more likely to be afflicted by respiratory diseases, but are less likely to be afflicted by digestive diseases, diseases with ill-defined symptoms and diseases of the muscle and skeletal system. The patterns found in the over 45 subpopulation were nearly identical to the patterns found among the aged 15 to 44 subgroup.

The Determinants of Health Care Utilization

A second set of equations measured the determinants of health care utilization. The dependent variable (VISIT) measured the number of times an afflicted person utilized a physician's services per episode of illness and within a two-week span. This variable was assigned one of three values: 0 if the afflicted person had already recovered from illness without utilizing any physician's service, 1 if once used physician's service, but at the time of interview had

stopped using such services regardless of whether or not the person had recovered from illness, and 2 if continuously utilizing a physician's services since first afflicted up to the time of interview. Tabular analysis shows that children aged 0-14 and adults aged above 44 years are more likely to utilize physician's services when afflicted, controlling for type of disease. Moreover, elders are more likely to utilize physician's service more than one time per episode of illness. Women, except for those under 15, tend to utilize more physicians' services than men. Persons who lived in urban areas also have a higher utilization rate.

For the sake of projection, the dependent variable VISIT is estimated using the same set of independent variables used in the morbidity model. However, since the type of disease is also important in determining treatment choice, the estimated equations are not only classified by three broad age categories as in the morbidity equations, but also by illness type. In summary, better access to physician's services in urban areas is the most significant factor determining physician utilization rates. The education of household head and own educational attainment also significantly increased the utilization rate. Those who work in the agricultural sector had lower utilization rates, except when afflicted by muscle and skeletal diseases. Women tend to have higher utilization rate than men if they are afflicted by the same disease type. The only exception is among men aged 15-44 who were afflicted by skin diseases and allergies; this group had a higher utilization rate than their female counterparts.

PROJECTIONS ON MORBIDITY PATTERNS AND THE UTILIZATION OF PHYSICIAN'S SERVICES

Projections of morbidity by disease type and the utilization of physician services were obtained in four steps:

(1) Projection of population by age and sex (Pij).

(2) Estimates of the probability that persons of a particular age and sex (*ij*) will have *k* episodes of illness (*Sijk*) within a two-week span. Thus the total number of times that a person of *ij* age and sex is afflicted is

$$Sij = \sum_{k} Pij * Sijk * k \quad (k = 1, 2, 3)$$

(3) Estimates the number of illnesses by disease type by first estimating the proportion of persons by age and sex *ij* that will be afflicted by the disease types $\ell\,(Dij\ell)$, thus the number of times that persons (age sex *ij*) is afflicted by ℓ disease type is

$$Dij\ell = Sij * Dij\ell$$

(4) Estimates the number of visits to physicians. The probability that persons (age sex *ij*) who are afflicted by illness (ℓ) will visit a physician *m* times per episode $(Mij\ell m)$ can be estimated from the VISIT equations. Thus the total number of visits to physician is

$$M = \sum_{i}\sum_{j}\sum_{l}\sum_{m} Dij\ell * Mij\ell m$$

Two sets of morbidity patterns were projected over the years 1991 to 2010. The first pattern assumes a constant age-sex morbidity rate based on 1991 data, hence any changes in morbidity incidence are solely the result of the changing age-sex structure of the population. The second set used changing age-sex morbidity rates based on changes in socio-economic structure, which also took population dynamics into account. The projected results are summarized in Tables 3.1 and 3.2. The first projection estimated that within a two-week span, the Thai population suffered from 25.3 million episodes of illness in 1991. The number of episodes is estimated to increase to 33.1 million by 2020. In other words, the incidence of illness over a two-week span increased from 0.448 times per person in 1991 to 0.476 in 2010. The result merely reflects a higher average morbidity rate for an aging population. The second projection implies a slightly more rapidly increase in the morbidity rate to 0.477 per person over a two-week span by 2010. Our findings contradict those from a 1990 study which used 1985 data; the earlier study found that better income and education helped to slow an increasing morbidity rate which would result from an aging population. The main reason for such a result is that in 1985, a large proportion of illness was due to infectious diseases and infectious diseases tend to drop off as the standard of living improves. However, in the 1991 morbidity survey, the pattern of morbidity moved toward diseases that increase, not decrease, with economic development. Hence both demographic and economic changes can have a negative impact on health. If this is the case, poverty is probably no longer the largest source of health

problems. At the present stage of economic development, the main sources of health problems are likely to be related to environment conditions and work hazards which increase in intensity with economic development.

Thus economic development alters both morbidity incidence and the types of disease which afflict the population. With higher economic development, the incidence of muscle and skeletal diseases declines, but the incidence of respiratory diseases increases.

Physician utilization depends significantly on accessibility and the system under which health care is provided. One factor which is likely to be important in determining the demand for physician services in the future is the expansion of health insurance in Thailand. Therefore three scenarios based on differential physician services utilization are projected here. The first assumes that health care seeking behavior remains unchanged. The second scenario assumes that the coverage of health insurance under the Social Security Act will expand further, and those with health insurance will utilize physician services at a level similar to the current utilization rate of government employees. The third scenario assumes improved access to health care facilities such that utilization of physician services approaches the current level of urban utilization rates among the entire population.

The projected number of visits to physicians is summarized in Table 4. In 1991, there were 8.6 million visits to physicians within a two-week span. Almost half of the visit (42 percent) were due to diseases of the respiratory system. The number of visits to physicians is projected to increase gradually to 12.2 million in 2010, with an average annual increase of 1.12 percent. The second set of projections, which take into account the potential impacts of increased health insurance, found an annual growth rate in the number of visits to physicians of 1.64 - 1.68 percent, depending on the rate of increase in health insurance coverage. This is equivalent to approximately 13.8 - 14.0 million visits in 2010. (Figures for a less rapidly increase in the coverage are not shown in Table 4.) Finally, if the health care seeking behavior of Thai population approaches that of urban residents, the growth rate in the demand for physician's services will increase even more rapidly at an annual rate of 2.06 percent and the number of visit to physician within a two-week span will be 15.6 million.

PROJECTING THE DEMAND FOR PHYSICIANS

This study uses three methods to project demand for physicians: a physician-population ratio method, a socio-economic-demographic method and a professional-standards method.

1. Physician-Population Ratio Method

This method requires that a ratio of the number of physicians to the number of illness episodes of the total population at present should be the same as that in the future. If the base year's ratio and the projected illness episodes of the future populations are available, the demand for physicians of any period in the future can be estimated.

According to data from the 1991 survey, a physician took care of 1,979 illness episodes during a two-week period. Based on the number of illness episodes projected in this study, 13,551, 14,377, 15,137, 15,815, 16,415 and 16,712 physicians would be demanded in 1995, 2000, 2005, 2010, 2015 and 2020, respectively (see Table 5).

2. Socio-Economic-Demographic Method

This method requires that the ratio of the number of physicians to the physician services demanded by the total population at present should be the same as that in the future. The demand for physicians in the future can be derived using the ratio of the base year and the projected demand for physician services of the future populations.

In 1991, the ratio of the number of physician services demanded per physician was 675 in a two-week period. The estimation indicates that there should be 13,546, 14,503, 15,467, 16,425, 17,379 and 18,157 physicians in 1995, 2000, 2005, 2010, 2015 and 2020, respectively.

As the expansion of the social insurance scheme can boost the demand for physician services, the number of physicians required based on such expansion would be 14,031, 15,453, 16,819, 18,182, 19,619 and 20,794, in the years 1995, 2000, 2005, 2010, 2015 and 2020, respectively. The impact of better accessibility to physician services for rural populations could result in a higher number of physicians demanded: 13,744, 15,141, 16,756, 18,637, 20,839 and 23,167, in 1995, 2000, 2005, 2010, 2015 and 2020, respectively.

3. Professional-Standards Method

This method determines the number of physicians required in any period on the basis of a fixed ratio of the number of physicians to the number of physician services demanded. The ratio, which embodies the current standards of medical practice, is set by experts and technology available. The demand for physicians in the future depends on the ratio and the future demand for physician services.

The Personnel Division of Ministry of Public Health, which is responsible for manpower planning, has established the physician workload as follows:

- A general practitioner should take care 70 patients daily (5 minutes per patient).
- A surgeon should treat 10 patients daily.
- A physician in other specialties should cover 15 patients daily.

It should be noted that the numbers include both outpatients and inpatients. Both types of patients demand physician's time but in differing amounts.

According to data from 1993, the average standard practice of a physician was to provide services to 365 patients during two weeks. Therefore, the demand for physicians would be 25,051, 26,821, 28,602, 30,374, 32,138 and 33,578 in 1995, 2000, 2005, 2010, 2015 and 2020, respectively.

The enlargement of the social insurance scheme in the future would demand more physicians: 25,947, 28,577, 31,103, 33,624, 36,282 and 38,455 physicians (in the same five year intervals as above). Similarly, the better accessibility to physician services for rural people would increase the demand for physicians to 25,417, 28,001, 30,988, 34,465, 38,538 and 42,842 physicians (over the same five year intervals as above).

All the methods offer similar results regarding the projected demand for physicians for treating seven key disease categories among the three major age groups. The demand for physicians can be arranged in accordance with their magnitude in the following descending order: diseases of the respiratory system, diseases of ill-defined symptoms, muscle and skeletal diseases, diseases of the digestive system, heart diseases and other, diseases of eyes, ears, nose, throat and teeth, and skin diseases and allergies. The 0-14 age group will demand fewer physicians than the other age groups. The 15-44 age group will have the highest demand during 1991-2000. After 2000, the demand for physicians among the 45+ age group will become greatest.

There is one difference in the projection results between the physician-population ratio approach and the other two. The former indicates a decline in the demand for physicians among the 0-14 age group whereas the latter two predict an increase in demand.

Since the estimation above does not take into account the demand for physicians due to the AIDS epidemic in Thailand, it is necessary to project the demand for additional physicians by AIDS patients in the future. An AIDS patient, on average, requires 7.27-8.14 out-patient-department (OPD) visits. The number of future AIDS patients was projected by the National Economic and Social Development Board. The multiplication of the average number of AIDS patients' physician services and the total number of AIDS patients is the bases of the demand projection figures reported here. Total demand could reach the maximum of 0.47-0.53 million visits per year in 2000. It is projected to drop to 0.21-0.24 million visits in 2020.

Based on the physician-population ratio method, a further 20-23 physicians will be demanded to treat AIDS patients. The number will go up to 27-30 in 2000. After that, it will decline gradually to 12-14 in 2020. The results of the professional-standards method found that additional physicians needed will be 38-42 in 1995. In 2000, the demand will be 50-56 and it will fall to 23-26 in 2020.

The total demand for physicians, which is the summation of the demand for physicians based on the health status survey in 1991 and the demand for physicians due to the AIDS epidemic, is presented in Table 6. The demand for physicians is expected to rise over time, from 13,568-25,987 in 1995 to 16,725-42,867 in 2020.

PROJECTING THE SUPPLY OF PHYSICIANS

The supply of physicians in any period is the sum of the supply of physicians available in the previous period and the supply of new physicians graduated from domestic and foreign institutions, less the number of decreased physicians and the number of physicians with revoked or expired licenses. To get an accurate figure on practicing physicians, we deducted the number of physicians working outside the sector (e.g., who have other occupations or retire) from the

total number of physicians estimated.

The supply estimation is based on the following assumptions. The growth of the physician production in domestic medical schools is constant at 5 percent and 8 percent annually (i.e., two scenarios are used). The number of new physicians graduating from overseas medical schools is constant at 46 per year (this figure is based on 1995 data which is the latest year available). Each year 0.173 percent of the total number of physicians die. The rate is obtained by averaging the death rates over the last 20 years (based on the most recent data available). The number of physicians with withdrawn medical licenses is so small that it could become nil. Thus, this information was excluded from the analysis. The estimation is reported in Table 7.

Some may argue that medical schools cannot produce more physicians every year linearly as assumed. Instead, after increasing production it will remain constant at the new higher level for a while before the figure increases once again. In other words, the production function is stepwise, which is extremely difficult to estimate. On the other hand, it is reasonable to smooth out the step function to be a linear one especially over a long production period. Since this study is concerned with the supply of next 25 years, the linear production function should not be problematic.

COMPARING THE DEMAND FOR AND SUPPLY OF PHYSICIANS IN THE FUTURE

The comparison between the future demand for and supply of physicians in Thailand, presented in Table 8, shows mixed results. The health sector may be subject to both physician surpluses and physician shortages in the future. The physician-population ratio and the socio-economic-demographic approach indicate a surplus whereas the professional-standards approach predicts a shortage until 2010 and the surplus from 2015 onward.

This means that if the practice of physicians at present is accepted as the standard in the future, the production rate of new physicians would unavoidably result in a physician surplus. On the contrary, if the appropriate physician workload in the future is set differently from the current one in such a way that a physician should take care of fewer patients than they do now (toward increasing the quality of care), the physician shortage would persist.

All in all, regardless of the source of increased demand for physicians, the production of new physicians at a rate of 5-8 percent per year would eventually render a number of physicians redundant in a future period.

REFERENCES

Besley, T. 1989. "The Demand for Health Care and Health Insurance." *Oxford Review of Economic Policy* 5(1): 21-33.

Blaug, M. 1973. "Thailand." Pp. 106-130 in *The Practice of Manpower Forecasting: A Collection of Case Studies,* edited by B. Amamad et al.Jossey-Bass Inc.

GMEMAG. 1980. *Report of the Graduate Medical Education National Advisory Committee to the Secretary of the Department of Health and Human Services.* DHHS Publication No. 81-651. Maryland: DHHS.

Grossman, M. 1972. *The Demand for Health: a Theoretical and Empirical Investigation.* New York: National Bureau of Economic Research.

Jeffers, J. et al. 1971. "On the Demand Versus Need for Medical Services and the Concept of Shortage." *American Journal of Public Health* 61(1): 46-63.

Klarman, H. 1969. "Economic Aspects of Projecting Requirements for Health Manpower." *The Journal of Human Resources* 4(3): 360-376.

Lave, J. et al. 1975. "Medical Manpower Models: Need, Demand and Supply." *Inquiry* XII (2): 97-125.

Lee. et al. 1933. *Fundamentals of Good Medical Care.* Chicago: Chicago University Press.

Mathana Phananiramai et al. 1990. *The Determinants of Morbidity.* Bangkok: Thailand Development Research Institute.

_____. 1992. *Conditional Predictions of Thai Health Care Demands of the Year 2000.* Bangkok: Thailand

Development Research Institute.

Maynard, A. et al. 1977. "Too Many Doctors?" *Lloyds Bank Review* 125 (July): 24-36.

McGuire, A. et al. 1988. *The Economic of Health Care: an Introductory Text.* London: Routledge and Kegan-Paul.

Reinhardt, U. 1987. "Projection Long-term Trends in Health Manpower-Methodological Problems." Pp. 87-107 in *Indicators and Trends in Health and Health Care,* edited by D. Schwefel. Springer: Heidelberg.

Schonfeld. et al. 1972. "Numbers of Physicians Required for Primary Medical Care." *The New England Journal of Medicine* 286: 571-576.

Sorkin, A. 1977. *Health Manpower. An Economic Perspective.* Lexington Books.

ÇÔâÃ¨¹ì µÑé§à¨ÃÔàÊ¶ÕÂÃ. "·Ø¡¢ì, ÊÁØ·ÑÂ ã¹ÃÐººÊÒ¸ÒÃ³ÊØ¢áÅÐËÅÑ¡»ÃÐ¡Ñ¹ÊØ¢ÀÒ¾¤¹ä·Â."
àÍ¡ÊÒÃ»ÃÐ¡Íº¡ÒÃ»ÃÐªØÁÇÔªÒ¡ÒÃ »ÃÐ¨Ó»Õ¢Í§Ê¶ÒºÑ¹ÇÔ¨ÑÂÃÐººÊÒ¸ÒÃ³ÊØ¢ àÃ×èÍ§ »¯ÔÃÙ»à¾×èÍÊØ¢
ÀÒ¾ ÂØ·¸ÈÒÊµÃìãËÁèÊÙè¡ÒÃ¾Ñ²¹ÒÃÐºº ÇÑ¹·Õè 1-2 ¡ØÁÀÒ¾Ñ¹¸ì 2539.

Ê§Ç¹ ¹ÔµÂÒÃÑÁÀì¾§Èì áÅÐ¤³Ð. 2534. ¡ÒÃÈÖ¡ÉÒÊÀÒ¾»ÑËÒáÅÐá¹Ç·Ò§á¡éä¢»ÑËÒ¤ÇÒÁ¢
Ò´á¤Å¹á¾·Âìà©¾ÒÐ·Ò§ã¹ âÃ§¾ÂÒºÒÅÈÙ¹ÂìáÅÐâÃ§¾ÂÒºÒÅ·ÑèÇä». ¡ÃØ§à·¾Ï: ¡ÃÐ·ÃÇ§ÊÒ¸ÒÃ³ÊØ¢.

ÊÁÈÑ¡´Ôì ªØ³ËÃÑÈÁÔì áÅÐ¤³Ð. 2535. ¡ÒÃ¨èÒÂ¤èÒµÍºá·¹á¾·Âì·ÕèàËÁÒÐÊÁÊÓËÃÑºÃÐºöºÃÔ¡ÒÃÊÒ¸ÒÃ³ÊØ¢
¢Í§»ÃÐà·Èä·Â. ¡ÃØ§à·¾Ï.

ÊÓ¹Ñ¡§Ò¹¤³Ð¡ÃÃÁ¡ÒÃ¾Ñ²Ò¡ÒÃàÈÃÉ°¡Ô¨áÅÐÊÑ§¤ÁáËè§ªÒµÔ. 2525. ¡ÒÃ»ÃÐÁÒ³¡ÓÅÑ§áÃ§§Ò¹
¡ÒÃÁÕ§Ò¹·Ó ¡ÒÃÇèÒ§§Ò¹ áÅÐ¤ÇÒÁµéÍ§¡ÒÃ¡ÓÅÑ§¤¹ ã¹ÃÐÂÐá¼¹¾Ñ²¹ÒÏ ©ºÑº·Õè 5 (2525-2529). ¡ÃØ§à·¾Ï.