Influences of Socio-Demographic and Social Context Risk Factors on Labor Force Aged Mortality from Communicable Disease

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Objective: *Study the influences of socio-demographic and social context risk factors on labor force aged mortality from communicable disease.*
Material and Method: *A sample of 28,298 individuals were used to build a piece-wise exponential hazard model. Investigation of the cause of death used "verbal autopsy".*
Result: *It was found that more males are likely to die than females (Exp. = 1.54, S.E. = 0.19). Mortality risk for those who work is lower than for the jobless while mortality risk for laborers is greater than for the jobless (Exp. = 2.80, S.E. = 0.54). Migrants are more likely to die than those who have not migrated (Exp. = 12.68, S.E. = 0.22). People who live in households with debt are more likely to die than those who live in debt-free households (Exp. = 1.21, S.E. = 0.17). Environmental problems and drinking water quality have significant positive relationship with death due to communicable disease.*
Conclusion: *A health prevention plan for individual, household, and community level for this labor force aged population needs to be provided.*

Keywords: *Labor force aged mortality, Communicable disease, Social context, Hazard rate*

J Med Assoc Thai 2006; 89 (6): 854-63
Full text. e-Journal: *http://www.medassocthai.org/journal*

There have been several studies that tried to explain the mechanisms that cause death in a population. In the study of mortality, accuracy of the cause of death and the mortality risk factors are the issues of interest. The understanding of these issues have changed with the passage of time and the development of knowledge and technologies. For example, in the 19th century it was believed that germs were the causes of disease. Therefore, there was an effort to prevent the spread of the germs. The development of belief in mortality risks has started to change to a more scientific concept. In 1972, Crosby and Alfred[1] found that mortality risks comprised exposure and resistance to disease components such as non-hygienic sanitation environment in the family, inappropriate health behavior, community environmental problems, nutrition and standard of living[2,3]. However, there have been a number of debates about the causes of death of the labor-force-age population. Do they have a high risk of death and are the causes of death related to socio-demographic and social context risk factors?

In 2001, it was found that death rate was high and that the primary cause of death for this population in Thailand were malignancy, followed by death from external causes, and disease of the cardiovascular system, with deaths from infectious and parasitic diseases following in succession[4,5]. Overall, they were

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still dying because communicable diseases were still appearing, even if the society has been developed.

In considering the population of Thailand, the aged population has a tendency to increase, while child-age population who would later become labor force age would decrease in the next 20 years[6]. As a result, it is crucial to maintain our existing and limited labor forces. Therefore, efforts should be made to prevent the labor force age population from dying prematurely deaths due to illness and other major causes of death[7,8]; for if there should be a high death rate in the labor force aged population, it would affect the national economic status. Thus, it was necessary to analyze overall mortality risks, in order to gain greater insight into the mortality risk of this age group. This understanding would benefit both public policies and the search for solutions, prevention planning and improvement of living standards of the public, and the results of the research could be applied for improvement in the development of the quality of life of the public. The present study therefore required analysis of household components, such as sanitation and economic status, as well as community components, i.e., population density and accessibility to healthcare services, in order to determine if and how they would affect the mortality risks of this age group, over a period of time.

Material and Method

The present analysis employed a longitudinal data between 1994 and 2000 from the Survey of Social Change and Migration in Thailand, a case study in Nang Rong district, Buri Ram province made by the Institute for Population and Social Research, Mahidol University in collaboration with the Carolina Population Center (CPC), University of North Carolina at Chapel Hill. Nang Rong is located in the southern part of Buri Ram province. The main characteristic of Nang Rong is that it is a mix between a primitive, labor-intensive society and modernized development of households, equipped with modern facilities including mechanical agricultural technology. To obtain the actual causes of death, the study employed "verbal autopsy" as a means of investigation and used the data obtained for analysis of the most immediate circumstances of death. Data from medical records and death certificates were used to analyse the variables on mortality of patients admitted into healthcare facilities before death. Adjustments were then made to the causes of death data acquired from verbal autopsy. This was compiled and modified by physicians, and checked for validity and reliability through the use of sensitivity and specificity calculations before actual usage. The population under study was the labor force age population (ages 13-60) in the year 1994; this group was kept in track up to the year 2000. It was found that out of the 28,298 labor force aged population under survey, 27,664 persons have survived and 634 have died from communicable diseases during the said period. Characteristics and descriptive statistics of the sample are presented in Table 1.

Statistical analysis

Event History Analysis is used to determine the hazard of death in the equation of the piecewise exponential hazard model, which determines the probability of death for each age group. This model is based on the conditional approach estimated by the computer package estimating a poisson regression. The basic idea of the piecewise exponential hazard model is to split the time axis into time intervals (j) $0 = \tau_1 < \tau_2 < \tau_3 < \ldots < \tau_n$, when τ_n is larger than the largest observation time, and possibly infinite. The hazard in interval j is given by (τ_{j-1}, τ_j) is λ_t, in which the baseline hazard in each interval is assumed to be constant, but the baseline hazards are allowed to vary across intervals. The baseline hazards are vectors of parameters that determine the shape of the hazard rate over time[9-12]. The hazard rate of piecewise exponential model is calculated as follows:

$$\lambda(t_{ij;} X_i) = \lambda_0(t)\, e^{(\ 0 + \ 1 p_{2i} + \ 2 p_{3i} + \ 3 p_{4i} + \cdots \ n p_{ji})}$$

where λ_{ij} = Hazard for observation i and interval j

t_{ij} = Exposure for observation i and interval j

Since only the labor force age population has been selected, there is a possibility that this group had contacted disease before coming into labor force age. In order to reduce problems stemming from sample selection bias, this analysis uses the "Left Truncation" data cut-off. A p-value > 0.10 was considered significant. Truncation of survival data occurs when only those individuals whose event time lies within a certain observational window (t_s, t_c) are observed[12,13]. An individual whose event time is not in this interval is not observed and no information on this subject is available to the investigator.

Results

Four models of piecewise exponential hazard models with left truncated were used. The cutoff point

Table 1. Descriptive statistics of demographic characteristics, household factors and community contexts in Nang Rong, 1994

Demographic characteristic	Death		Survive	
	Number (634)	Percent	Number (27,664)	Percent
Demographic factors				
Age group				
13-19	29	4.5	5,937	21.5
20-24	72	11.4	8,819	31.9
25-29	80	12.6	3,294	11.9
30-34	78	12.3	2,891	10.5
35-39	73	11.5	2,149	7.8
40-44	59	9.3	1,705	6.2
45-49	54	8.5	1,389	5.0
50-54	59	9.3	1,204	4.4
> 55	130	20.5	276	1.0
Gender				
Male	461	72.7	13,794	49.9
Female	173	27.30	13,850	50.10
Occupation				
Unemployed	35	5.50	2,513	9.10
Agricultural & animal husbandry	447	70.5	18,038	65.6
Labor	121	19.1	6,931	19.5
Commerce & others	31	4.9	1,564	5.7
Migration history				
Never migrated	153	24.1	16,967	61.3
Used to migrate	481	75.9	10,697	38.7
Education				
Never attended school	21	3.3	597	2.2
Primary school	562	88.6	23,718	85.9
Secondary school	39	6.1	2,503	9.1
Diploma or higher	12	1.9	792	2.9
Household Density				
1-4	72	11.4	4,397	16.9
5-9	413	65.4	17,065	61.7
10-14	141	22.2	5,491	19.8
>15	8	1.3	441	1.6
Air ventilation				
Poor air ventilation	266	42.0	11,592	41.9
Good air ventilation	368	58.0	16,072	58.1
Ethnicity				
Thai Korat or central Thai	470	74.10	19,871	71.8
Cambodia/Suay/Laos/others	164	25.90	7,793	28.2
Debt				
No debt	254	40.10	11,011	39.8
Have debt	380	59.90	16,653	60.2
Number of vehicles				
0	419	63.4	17,930	65.0
1-2	207	31.4	9,318	33.8
3-4	33	5.0	319	1.2
≥5	1	0.2	21	0.1
Environmental problems				
No environmental problem	152	15.00	6,295	22.8
Having environmental problem	482	85.00	21,369	77.2

Table 1. Descriptive statistics of demographic characteristics, household factors and community contexts in Nang Rong, 1994 (cont.)

Demographic characteristic	Death		Survive	
	Number (634)	Percent	Number (27,664)	Percent
Drinking-water quality				
No problem	95	24.00	23,266	84.1
Having problem	539	76.00	4,398	15.9

Demographic characteristic	Deceased			Survive		
	Min	Max	Mean	Min	Max	Mean
Household factors						
Economic status	0.00	42,969	7,602.15	0.00	66,149	7,806.80
Community contexts						
Population density (per Rai*)	0.08	558	51.31	0.08	558	41.23
Distance from house to healthcare facility (km)	2.00	56	22.26	2.00	56	23.00
Number of health personnel	5.00	21	12.54	5.00	21	12.48

Note: * 1 Rai = 1,600 square meter

was five years. Each model had a different examination purpose. Model 1 was the base line model. This model observed the impact of time on the labor force aged mortality without covariates. Model 2 mainly investigated the influence of demographic factors while controlling household and community factors. Model 3 examined the influence of demographic and household factors while controlling community contexts. Similarly, model 4 explored the influence of demographic, household factors and community contexts. It was found that increase in age would significantly increase mortality risk from communicable diseases. When considering the personal components after other variables are controlled. More males are likely to die than females. Mortality risk for those who work is less likely than for those who are jobless, with the statistically significant exception of laborers, where mortality risk for laborers is greater than for those jobless. Migrants are more likely to die than those non migrated. The Thai or Thai-Korat are less likely to die when compared with the other ethnic groups. When considering household components that have positive effects on death from communicable diseases, namely the number of animals raised around the household area, density of household, debt and economic status, the hazard of death increases with the increase in the density of the household population, and people who live in households with debt are more likely to die than those who live in debt-free households. Components that have negative effects on mortality risk from communicable diseases are air ventilation in houses and number of vehicles (Table 2).

Discussion

Upon analysis, it was found that age has a positive effect on mortality, i.e. mortality risk increases as age increases. This could be explained that when considering only the age component, it is found that the relative risk of dying increases with age, which is in conformity with the epidemiological concept that deterioration in physical condition is caused by increase in age, and that older one becomes, the more severe disease becomes in along with a decreasing immunity due to weak physical condition[8,14]. It also conforms to Makeham's theory[15] of partial forces of mortality, which states as a primary principle that "the hazard of death in older age groups is higher than in younger age groups". Besides age, males are more likely to die 1.54 times more than females. In general, the male death rate is higher than female[16]. The reason more males are dying than females could be explained by the fact that from data on causes of death it was found that HIV/AIDS is one of the significant communicable diseases causing death. The mortality risks for males is higher than females because of the personal behavior in prevention of diseases (Fig. 1).

Table 2. Relative risk estimate from piece-wise exponential hazard model when the person being investigated died from a communicable disease

Variable	Model 1		Model 2		Model 3		Model 4	
	Exp.	(S.E.)	Exp.	(S.E.)	Exp.	(S.E.)	Exp.	(S.E.)
Intercept	***	(0.44)	***	(0.78)	***	(0.82)	***	(0.91)
Age								
20-24 (1)	8.58***	(0.52)	8.67***	(0.52)	8.67***	(0.52)	8.67***	(0.52)
25-29	16.28***	(0.49)	17.29***	(0.49)	17.46***	(0.49)	17.46***	(0.49)
30-34	16.44***	(0.50)	20.91***	(0.50)	20.91***	(0.50)	20.91***	(0.50)
35-39	14.44***	(0.52)	23.57***	(0.52)	23.57***	(0.52)	23.34***	(0.52)
40-44	10.80***	(0.56)	22.87***	(0.56)	22.87***	(0.56)	22.42***	(0.56)
45-49	28.22***	(0.51)	74.44***	(0.51)	74.44***	(0.51)	72.97***	(0.51)
50-54	23.81***	(0.54)	68.03***	(0.55)	68.72***	(0.55)	67.36***	(0.55)
54-59	28.79***	(0.56)	86.49***	(0.56)	87.36***	(0.57)	86.49***	(0.57)
>59	44.26***	(0.57)	144.03***	(0.58)	144.03***	(0.58)	145.47***	(0.58)
Demographic factors								
Male (2)			1.52**	(0.18)	1.54**	(0.19)	1.54**	(0.19)
Social factors								
Agricultural (3)			2.41*	(0.53)	2.41*	(0.53)	1.40	(0.53)
Laborer			2.94**	(0.54)	2.80*	(0.54)	2.80*	(0.54)
Commerce			1.51	(0.64)	1.48	(0.64)	1.46	(0.65)
Migration history (4)			12.55***	(0.21)	12.55***	(0.22)	12.68***	(0.22)
Primary school (5)			0.85	(0.47)	0.84	(0.47)	0.81	(0.47)
Secondary school			0.83	(0.58)	0.87	(0.59)	0.86	(0.59)
Higher than secondary school			0.17	(1.12)	0.80*	(0.13)	0.79*	(0.14)
Major dialect is Khmer,Lao, Suay (6)					1.06	(0.20)	1.14	(0.23)
Social context at household level								
Number of animals					1.00	(0.00)	1.00	(0.00)
Household density					1.06**	(0.03)	1.08**	(0.03)
Air ventilation					0.77*	(0.16)	0.80*	(0.13)
Debt (7)					1.23	(0.17)	1.21	(0.17)
Number of vehicles					0.43	(0.15)	0.92	(0.16)
Economic status					1.00	(0.00)	1.00	(0.00)
Social context at community level								
Population density							1.00**	(0.00)
Environment problems							1.16*	(0.08)
Drinking water quality problem (8)							1.58*	(0.26)
Health accessibility (kms.)							1.00	(0.00)
Number of health personnel							0.94**	(0.03)
Loglikelihood	-1070.00		-959.09		-957.39		-949.73	

Note: * p value < 0.10, ** p value < 0.05, *** p value < 0.001
1. age < 20 year, 2. female, 3. unemployed, 4. never migrated, 5. did not attend school, 6. major dialect in household was Thai or Thai-Korat, 7. no debt, 8. no drinking water quality problem

With regard to the migration component, those who have a history of migration have more risk of dying than those who do not, meaning that their exposure to disease or the probability of their contacting external disease is higher than those who have not migrated. Moreover, from the characteristics of Thai society, when migrants become ill and realize that they could die, they usually return to their places of birth[17] (Fig. 2 and Fig. 3).

Two other significant variables affecting mortality are education and occupation, both reflecting the social status. Mortality risks for those who are laborers was 2.80 times greater than those who had no jobs, and mortality risks for those who were educated

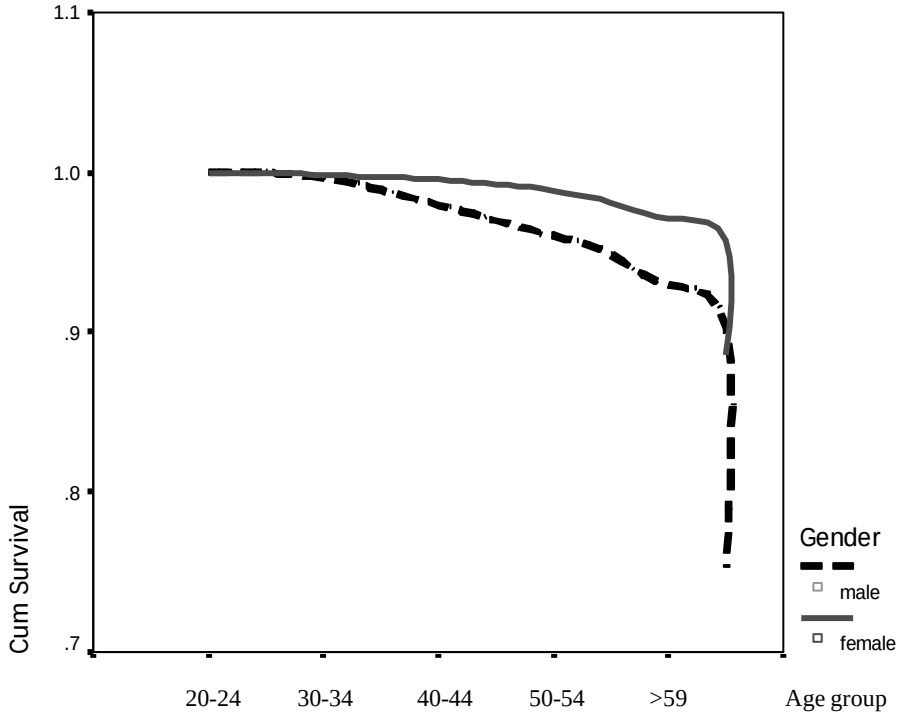

Fig. 1 Survival function of gender

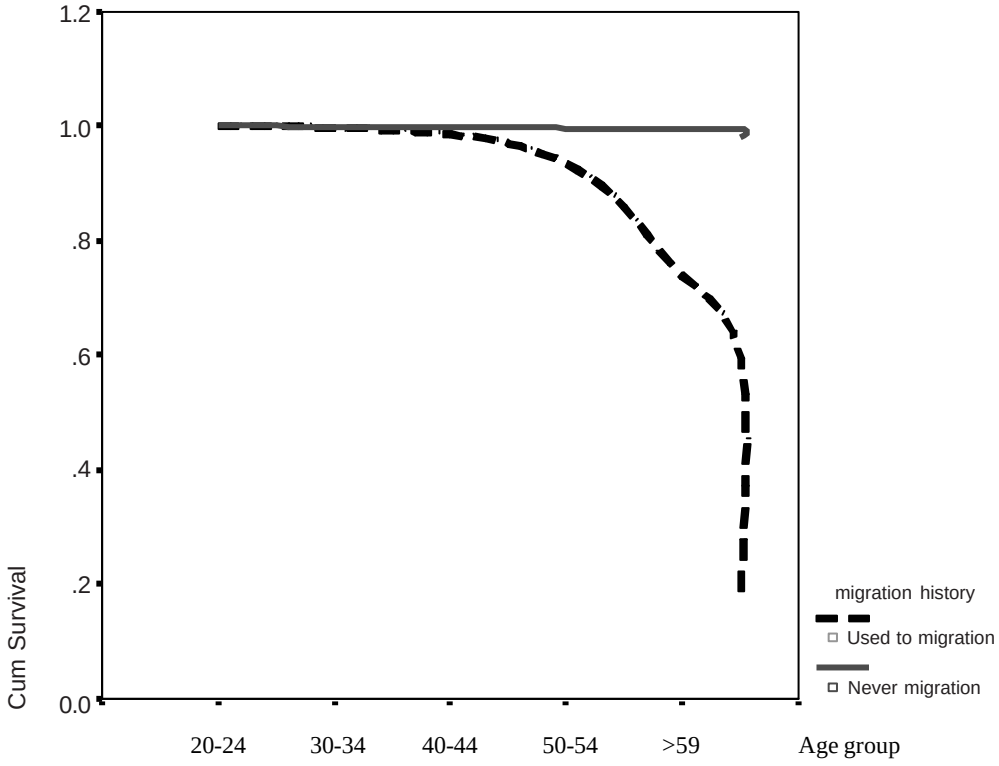

Fig. 2 Survival function of females who used to migrate and never migrated

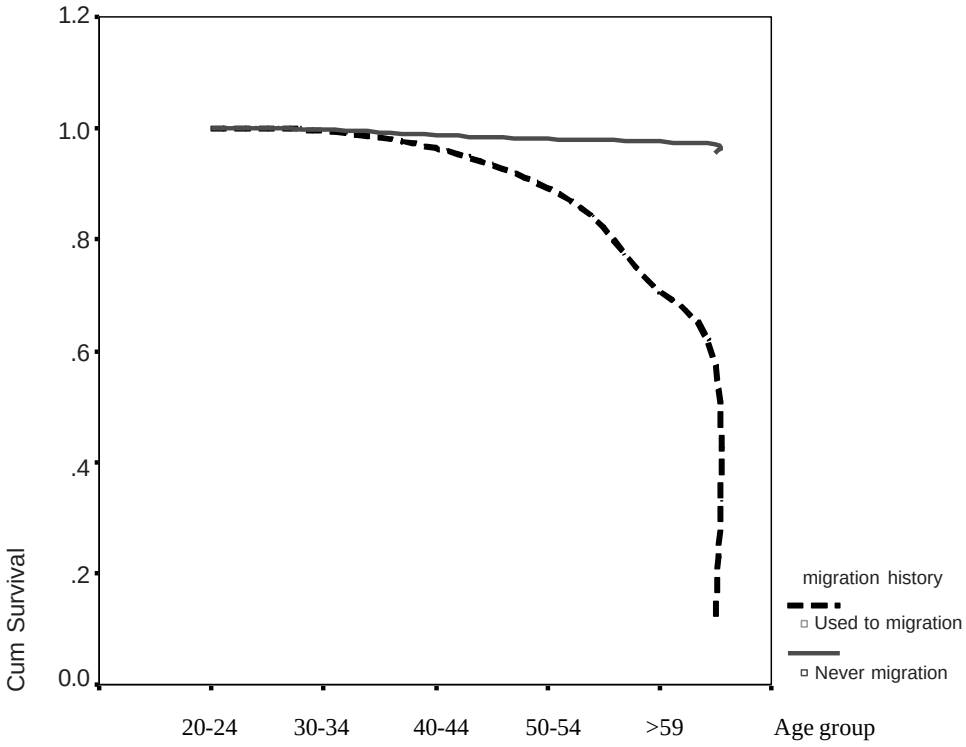

Fig. 3 Survival function of males who used to migrate and never migrated

were less than for those who were uneducated, which conforms with the study made by Richard[18] who found that the mortality risks for those who are jobless and uneducated are high. Similarly, in a study made by Johnson, Sorlie and Backlund[19] on the impact of specific occupation on mortality in the United Nations, the hazard of death for professional/technical groups is less likely than those who are unskilled laborers. This is due to the fact that unskilled laborers have a lifestyle that has more risk of death. For example, coal miners are susceptible to air pollution in the mines, or farmers have more risk from pesticides. Those who are highly educated have more interest in their health and are likely to take more appropriate healthcare as well. At the same time, the educational level would affect income, resulting in improved living conditions (Fig. 4).

With regard to the ethnic variable, a comparison was made for ethnic variables in two groups, namely those of Thai or Thai-Korat race with other races such as Laos, Khmer, Suay Tribes and others. The relative risk for those of Thai race is less than those who are not of Thai race. When the variable on individual characteristic is controlled and in consideration of household components that influence death, there are variables that have positive effects on mortality. These variables are the number of animals in the household, density of household population, ethnicity, debt and economic status. People living in households with poor sanitation have increased risk of death, since raising of animals in household areas would lead to an increase in germ breeding places, especially from animal droppings. Moreover, animals could become disease-carriers, resulting in increased disease and illnesses, such as cholera and diarrhea[2]. Household density has a positive effect on mortality. This conforms to the theory on epidemiology, which states that environmental components, including population density, have positive effects on mortality. This could be explained by the fact that an increase in household population would increase the probability of air-borne diseases, such as tuberculosis, and other respiratory tract infections[21].

With regard to the debt variable, hazard of death for those households who are in debt increases since indebtedness is an indicator of the household economic level. Households with debts have less reserved funds for healthcare and do not usually pay attention to healthcare maintenance and prevention, regarded as luxury. Besides, the probability of accessi-

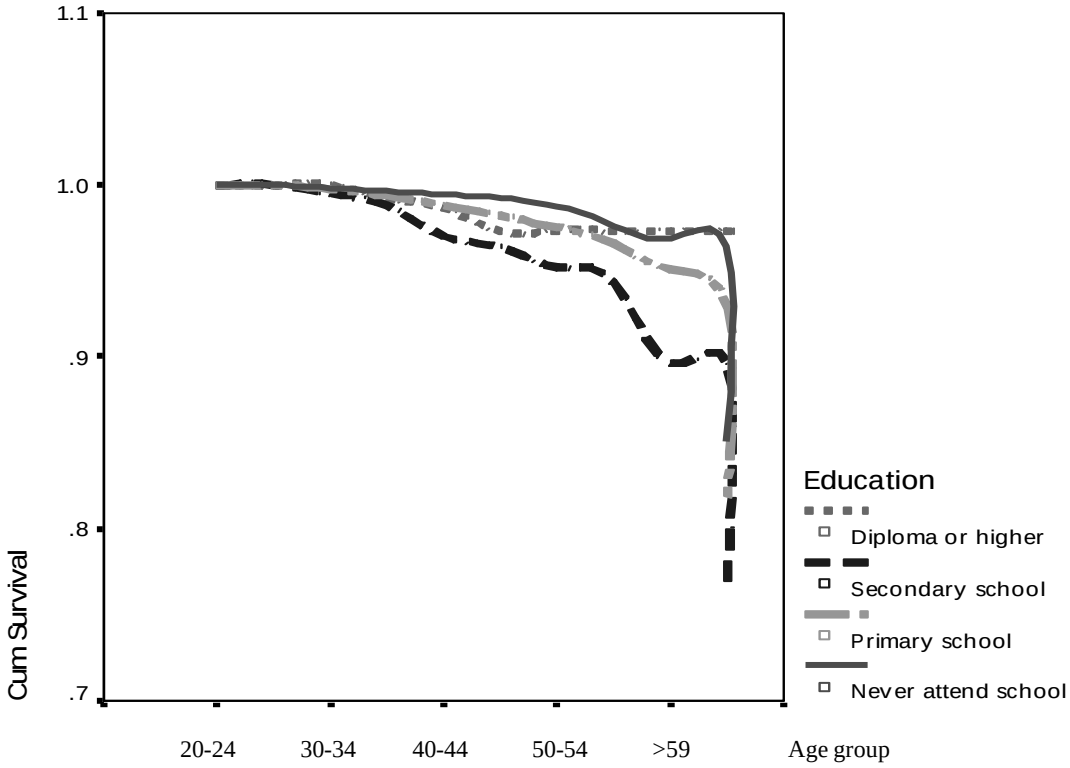

Fig. 4 Survival function of education

bility to continuous healthcare would lessen since they would pay more attention to making a living in order to pay off their debts[4]. There are two household components that have negative effects on mortality, namely air ventilation and number of vehicles. The hazard of death for those who live in houses with bad air ventilation is greater than for those who live in houses with good air ventilation. Air ventilation is being measured by the number of windows and number of windows impenetrable by insects. This could be explained by the fact that the probability of disseminating of diseases would lessen if the house has good air ventilation. It is in conformity with Mckeown and Thomas[20] where it was found that the production department with several workers sharing limited space and without a good ventilation system brought about the dissemination of air-borne diseases that were easily contacted because of the high density of the population.

Considering community components, the society that has a higher population density would have increased mortality. This could be explained that if the population in a community increases, mortality risk would also increase, as the population density would speed up the dissemination of diseases, especially communicable diseases in the respiratory system. Communities with environmental problems would increase the mortality risk as it would increase germ-breeding places and facilitate the dissemination of diseases[22]. Poor-quality drinking water would lead to certain diseases such as calculus, intestinal diseases and stones. Communities that suffer continuous drinking-water quality problems, would increase the risk for occurrence of such diseases[23]. Likewise, accessibility to healthcare facilities measured by the distance from the household to the healthcare facilities has a positive relationship to mortality. This means that hazard of death increases the further a community is situated from a healthcare facility. This is in conformity with the study of Barker, Nathangeni and Millard[14] who found that the distance from home has a positive relationship to death from tuberculosis. It is also similar to the study made by Jones, Bentham and Horwell[24] who found that when the confounding factors are under control, the accessibility to healthcare service measured by traveling time has a relationship to death from asthma in that the longer it takes to travel the hazard of death increases. Interestingly, it was found that if the number

of healthcare personnel increased, the hazard of death would be reduced, since the increased number of personnel would be better able to provide healthcare service in promotion, prevention and cure. They would also be better able to rehabilitate the patients and this would decrease the hazard of death[25]. This conforms to the concept of epidemiological transition, which states that the medical and public health determinants have a reverse effect on mortality[26,27].

Although many theories say that communicable disease is declining, the results show that the death rate from communicable disease is still high. The Thai government has launched a policy to reduce risk factors that would cause premature death, focusing on individual behavior such as the non-smoking project, promotion of exercise for the public, etc. According to the result of this examination, household and community factors have both positive effects e.g. household sanitation and community density, and negative effect e.g. air ventilation and number of health personnel on mortality. It should be noted that besides adjusting household environmental quality, the environmental quality in the community should also be adjusted. In order to improve community environmental quality, every partner in the community such as the local people, governmental officers, teachers, monks, etc. should also cooperate at all stages of environmental development. With regard to the public health components, that is the number of health personnel and distance to health facility, the healthcare personnel dispersing strategy to villages and community levels should be developed in suitable proportions to the size of population in each areas. Moreover, there should be zoning responsibilities for health facilities at village and community levels in proportion to the size of population living in that area, to lessen the severity of preventable diseases and to obtain appropriate capacity for the care of patients. An important recommendation for future researches is there should be an analysis of health risk behavior and there should be a longitudinal study. A follow-up study should be made on mortality from birth, or made for each separate disease that is a major cause of death. These studies could be used for planning reduction of the risks.

Acknowledgements

This study was financially supported by the Thailand Research Fund through the Royal Golden Jubilee Ph.D. Program. The authors wish to thank Prof. Barbara Entwisle, Director of Carolina Population Center, and Prof. Ron Rinfuss, Nang Rong Project Director, for their valuable advice and guidance for the analysis.

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ผลกระทบของภาวะเสี่ยงทางด้านประชากรและสังคมแวดล้อมต่อการตายด้วยโรคติดต่อของประชากรวัยแรงงาน

วรางคณา ผลประเสริฐ, โยธิน แสวงดี, เยาวรัตน์ ปรปักษ์ขาม, Guang Guo, บุปผา ศิริรัศมี

การศึกษานี้เป็นการใช้ข้อมูลต่อเนื่องระยะยาว เพื่อศึกษาผลกระทบของภาวะเสี่ยงทางด้านประชากรและสังคมแวดล้อมที่มีผลต่อการตายด้วยโรคติดต่อของประชากรวัยแรงงาน ทำการวิเคราะห์ข้อมูลโดยวิเคราะห์การรอดชีพ ในรูปของสมการ Piece wise exponential hazard model with left truncated กลุ่มตัวอย่างที่ศึกษาคือประชากรวัยแรงงานจำนวน 28,298 คน ผลการวิจัยพบว่า เพศชายมีโอกาสตายสูงกว่าเพศหญิง (Exp. = 1.54, S.E. = 0.19) โอกาสเสี่ยงต่อการตายในกลุ่มผู้มีงานทำต่ำกว่าผู้ที่ไม่ได้ทำงาน (Exp. = 2.80, S.E. = 0.54) ผู้ที่มีประวัติการย้ายถิ่นมีโอกาสตายสูงกว่าผู้ที่ไม่เคยย้ายถิ่น (Exp. = 12.68, S.E. = 0.22) ผู้ที่อาศัยในครัวเรือนที่มีหนี้สินก็มีโอกาสตายสูงกว่าผู้ที่อาศัยในครัวเรือนที่ไม่มีหนี้สิน (Exp. = 1.21, S.E. = 0.17) และผู้ที่อาศัยในชุมชนที่มีปัญหาด้านสิ่งแวดล้อมและปัญหาเรื่องคุณภาพน้ำดื่ม จะมีโอกาสตายด้วยโรคติดเชื้อสูงอย่างมีนัยสำคัญทางสถิติ จากผลการศึกษานี้จะเห็นได้ว่าจำเป็นอย่างยิ่งที่จะต้องมีการวางแผนและกำหนดนโยบายการส่งเสริมสุขภาพและป้องกันโรคในกลุ่มประชากรวัยแรงงานทั้งในมิติของบุคคล ครอบครัวและชุมชน