

## Indonesia's social capacity for population health: the educational gap in active life expectancy

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**Abstract** In this paper, we lay the initial groundwork for anticipating Indonesia's future burden of disease by developing a demographic model of population health. We develop this model within the analytic framework of a Markov-based multistate life table model to calculate an important indicator of the burden of disease, the expected years of active life of elderly Indonesians. The magnitude of the gap points to the potential consequences of improvements in the nation's educational level for the future burden of disease. The results show that having some education increases life expectancy but it also expands the expected years with a major functional problem. Overall educational attainment levels, however, are very low, indicating that Indonesia's elderly are at the leading edge of improvements in the nation's social capacity for health. The life tables suggest that at the early stages of development, longer life is accompanied by an expansion of morbidity.

**Keywords** Active life expectancy · Aging · Education · Health · Indonesia

After rapid declines in fertility and mortality, Southeast Asian nations are anticipating massive population aging in the decades ahead. Indonesia's success

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in fertility control and mortality reduction is one such case. By 2050, Indonesia's elderly population is projected to be among the largest in the world (United Nations, 2005), at 69.5 million people, and is expected to comprise 22.3% of Indonesia's total population.

The expected growth in the size of Indonesia's elderly population sharpens the importance of understanding potential changes in the population's burden of disease. Growing numbers of elderly living with chronic health problems potentially strain family support systems as well as health care institutions' abilities to meet the elderly population's health care needs. Obviously, most of the future burden of disease will be due to the growing number of elderly persons. Another factor, however, is the expected years of unhealthy life. Mortality declines unaccompanied by declines in chronic health problems will precipitate an expansion of morbidity (Crimmins, Hayward, & Saito, 1994). Long-term declining mortality and morbidity trends are strongly tied to trends in a population's education—a key indicator of a population's social capacity to achieve low morbidity and mortality (Easterlin, 1997; Fogel & Costa, 1997; Hayward, Crimmins, & Zhang, 2005). Social capacity includes institutional and structural factors in a society as well as individual health capital. It also reflects a society's ability to control its own environment—a necessary condition to foster long-term improvements in population health (Fogel & Costa, 1997).

In this paper, we lay the initial groundwork for anticipating Indonesia's future burden of disease. Taking advantage of longitudinal data from the Indonesian Family Life Survey, we develop a demographic model of population health using a Markov-based multistate life table approach. We calculate an important indicator of the burden of disease in the population, the expected years of active (and inactive) life of elderly Indonesians. In our study, active life expectancy refers to the expected years of life that a person can expect to spend free of major functional problems. We gain leverage on the issue of how changes in the social capacity for health will potentially alter the burden of disease in Indonesia by examining educational differences in active life. This is a “thought experiment” that allows us to use the educational gap in active life to gauge the consequences of improved education in the population. That is, as Indonesia's population achieves the educational attainment of the best educated in our study, a reasonable assumption, overall trends in the burden of disease should begin to look like those of the most highly educated group (Hayward et al., 2005). In addition, we assess whether these trends are likely to hold for both men and women.

## Research on the health effects of education

Educational attainment is strongly associated with better adult health (Preston & Taubman, 1994). This association is usually gauged in terms of mortality and self-reported health, but research also reports an association between education and functional limitations (Crimmins, Hayward, & Saito, 1996; Freedman & Martin, 1999). The consistency of these findings across numerous studies is not surprising

given the association between education and the risk of a range of chronic diseases—the primary source of mortality and functional limitations at older ages in developed nations.

The association between education and adult health allows us to assess how shifts in the educational composition of a population are associated with trends in population health. Assuming that the association is stable over time, increases in a population's educational attainment should foster improvements in population health (e.g., lower levels of mortality, the postponement of chronic diseases to older ages, and lower levels of functioning problems). Empirical evidence on historical trends in the association is relatively sparse and largely restricted to developed nations. Some evidence points to a widening of educational disparities in mortality as average levels of education have increased in Western developed nations (Preston & Taubman, 1994). More recent evidence for the United States points to a temporally stable association (Manton & Stallard, 1997; Freedman & Martin, 1999). There is also evidence of an association between education and functional limitations in a developing nation with low average levels of education among its elderly population (Zimmer, Liu, Hermalin, & Chuang, 1998) and between education and chronic diseases in a sample of U.S. Civil War veterans (Costa, 1999). Available evidence, therefore, consistently points to educational differentials in health even at different stages of economic development and the institutionalization of health care systems.

The association between education and chronic health problems partially reflects the creation of health capital over the individual life cycle. As a relatively exogenous factor in the life cycle, education fosters good health by improving economic resources, access to health care, and home and work environments relatively free of risk (Behrman, Sickles, Taubman, & Yazbeck, 1991; Caldwell, 1979; Feinstein, 1993; Freedman & Martin, 1999; Hayward, Crimmins, Miles, & Yang, 2000; Kaneda & Zimmer, forthcoming; Ross & Wu, 1996; Zimmer, Hermalin, & Lin, 2002). Education, because of its association with delayed gratification or because educated people are better consumers of biomedical information, is also associated with the avoidance of health risk behaviors such as smoking, obesity, and substance abuse (Brunner et al., 1996; Lynch, Kaplan, & Salonen 1997; Winkleby, Jatulis, Frank, & Fortmann, 1992). Education also reduces the risk of some chronic diseases by fostering psychological resources including a sense of autonomy and control over one's surroundings and social support (Elo & Preston, 1992; House, Lepkowski, Kinney, Mero, Kessler, & Herzog, 1994; Ross & Mirowsky, 1999).

The association between education and adult health also reflects macro-level factors embodied in aggregate measures of education (Palloni, 1981). Educational attainment *in a population* reflects not only the stock of human capital but also the capacity of a social system to address societal health needs (Easterlin, 1997). At earlier historical stages of rising educational levels, the growth in mass education is made possible by the proliferation of schools. The spread of schools typically coincides with other health-related infrastructural changes in communities such as the introduction of the spread of modern sanitation practices, health care services, and medical technologies—the latter of which has been posited as having a

significant influence on changes in adult health (Preston, 1975; Palloni, 1981). The idea of social capacity for health is closely related to Fogel and Costa's (1997) theory of technophysio evolution. This theoretical framework suggests that as humans have gained unprecedented control over their environment (which is exemplified in high levels of education in a population), extraordinary improvements have occurred in body size, longevity, robustness, and the capacity of vital organ systems.

Evaluating how improvements in a population's educational level lead to improvements in health is an indeterminate problem. As suggested by Easterlin (1997) and Fogel and Costa (1997), the association represents multifarious and complex institutional and individual mechanisms. A useful way to think about a population's educational level, we believe, is in terms of Easterlin's "social capacity" for population health—that is, the *confluence* of individual life course and institutional conditions favorable to improvements in health.

A recent study by Freedman and Martin (1999) provides some important clues about how population health changes as educational levels rise in a population. Their study examined changes in the prevalence of several major functional limitations in the 65 years of age and older population in the United States between 1984 and 1993. Using a decomposition approach, Freedman and Martin's analysis showed that improvements in educational attainment over the nine-year period were associated with declines in the prevalence of functional limitations; indeed, education had the greatest effect among a range of demographic and socioeconomic factors.

Based on projected prevalence rates, Freedman and Martin also posited that the United States will experience continued declines in the prevalence of major functional limitations with rising educational levels of the future birth cohorts entering old age. If we extend Freedman and Martin's logic, their results point to a pattern in which rising educational levels, an indicator of improved social capacity for population health, are accompanied by increased life expectancy, a compression of the years spent with functional problems, and a lower prevalence of functional limitations in the population.

An important issue to keep in mind, however, is that Indonesia's elderly population represents the leading edge of modernization changes. Respondents in the Indonesian Family Life Survey, our dataset, were aged 50–80 years in 1993. They would have been at elementary school age around 1920–1950, a period spanning the Dutch colonial era to shortly after independence (Independence was Aug 17, 1945). During the Dutch colonial era prior to 1942 and the Japanese occupation prior to independence, the development of an educational infrastructure was not a priority (Friedrick & Worden, 1992). Indonesia was largely agricultural and had not yet begun to industrialize. The educational infrastructure was largely limited to urban areas, and religious/ethnic schools had no set curriculum. Educational attendance was largely restricted to privileged children including those who had time to attend schools instead of working in farms, and those whose parents worked as government officials in the colonial government. Since the quality of education in many schools was questionable, we use the prevalence of any formal education as a proxy for Indonesia's social capacity for health. Not unexpectedly, social capacity is likely to be relatively low in the birth cohorts considered here.

## Data and measures

In this study, we examine changes in functional status for older Indonesians aged 50 years of age and older at baseline using two waves of the Indonesian Family Life Survey (IFLS), 1993 and 1997. Although the IFLS was not explicitly designed to study aging, IFLS has a sizeable number of older respondents who were asked questions about health status, household economy, health care utilization, and health behaviors ( $N$  males = 1,773 and  $N$  females = 1,876). Furthermore, it is currently the only source of data on aging in Indonesia that represents 83% of the population.

We use Nagi measures to evaluate functional status. The Nagi measures assess a person's limitation of activities around and outside the home such as:

- To carry a heavy load (like a pail of water) for 20 m,
- To draw a pail of water from a well,
- To bow, squat, kneel, and
- To walk for 5 km.

In our analysis, we examined two definitions of active and inactive to determine the sensitivity of the results to the criteria defining health change. One definition was conservative and emphasized severe functional problems in defining inactivity. According to this definition, "inactive" included persons who reported that they were *unable* to conduct one or more of the four tasks. Those who reported difficulty in performing a task or could do it easily were defined as active. The second definition expanded the definition of inactivity to include both those *unable* and who *had difficulty* with one or more of the four tasks. All other persons were considered to be active. Below we focus on the results using the liberal definition of active because of statistical power concerns using the conservative definition. When alternating between the liberal and conservative definitions, the number of transitions between health states declines substantially for some age/sex/education groups.

A change in functional status was inferred based on the comparison of functional status for the two observation waves. The follow-up wave also identified whether respondents had died over the interval ( $N = 349$ ), and we used this information to estimate the risk of mortality for the active and inactive states. In allocating individuals to the state space, we had nine cases of item nonresponse and we imputed "no difficulty" to these cases. We excluded respondents who attrited over the observation interval with no evidence of mortality. Implicitly, we are assuming that attriters' functioning and mortality experiences do not differ from persons who remained in the sample or who died. In examining the age pattern of attrition, we observed an asymmetric age pattern whereby persons in their 50s attrited at a higher rate than persons at the older ages. One concern we have is that some (unknown) level of attrition may reflect unobserved health transitions that would bias life expectancy in an unknown direction.

We measured education as a dichotomous variable: no formal education and any formal education. As noted above, the prevalence of high school or university education among older Indonesians is quite low.

Our final sample of persons aged 50 years and older is 3,649 at baseline. For this analysis, we excluded cases with missing values on one or more of the covariates (age, sex, and education;  $N = 414$ ) after we ascertained that they were not characteristically different from the rest of the sample. We also conducted the analyses with and without the missing covariate data and obtained similar results.

## Methods

We calculated two types of life table models to assess the disease burden among older Indonesians. First, we calculated population-based life tables that identify the expected years of active and inactive life for persons of a given age. We also calculated life tables for each educational group within sex. This allows us to evaluate how educational achievement, at the population level, is associated with disease burden and how this varies for men and women.

We also calculated status-based life table models to identify the implications of having a major health problem at a given age on active life expectancy. These tables are useful in simulating the implications of postponing health problems for the burden of disease, a pattern that is likely to occur with increasing social capacity for health in Indonesia.

The life table models are calculated using transition rates that identify the force of movement between health states, and from a health state to mortality, for persons of a given age, sex, and educational level. Our two-state model of active life expectancy is bidirectional—people can decline and improve in health, and mortality is allowed to be state-dependent. For the MSLT, transition rates are estimated using a hazard modeling approach (Hayward & Grady, 1990; Land, Guralnik, & Blazer, 1994). In this approach, the instantaneous transition rate,  $\mu_{ij}(x)$ , is the force of transition from state  $i$  to state  $j$ . The rate is defined as:

$$\mu_{ij}(x) = \lim_{\Delta x \rightarrow 0} \frac{p_{ij}(x, x + \Delta x)}{\Delta x} = \mu_{ijx}, \quad (1)$$

where all disability events are assumed to occur at the end of the interval and mortality is assumed to occur in mid-interval. Note that the transition rate is specified to be equal to a constant quantity,  $\mu_{ij}(x)$ , for individuals age  $x$  to  $x + n$ , but may vary across different ages  $x$ . This is a piece-wise exponential transition rate model.

The transition rates used are based on changes in health states across the 4-year observation interval in the IFLS panel. We estimate the rates using a log-linear modeling approach:

$$\ln \mu_{ijx} = \beta_0 + \beta_1 \text{Age}_x + \beta_2 \text{Male} + \beta_3 \text{Education}. \quad (2)$$

Parameter estimates from the model are used to calculate predicted age-specific transition rates,  $m^*(x)$ , for groups defined by sex and education, and the predicted rates serve as the inputs for the multistate life tables. All hazard models are estimated using standardized sample weights to reflect the experiences of the older Indonesian population.

All transition rates are estimated from the parameter estimates regardless of statistical significance. There are two nonstatistical reasons for choosing this approach. First, nonsignificant effects could have substantive impact, especially if the effects have persisted over a long period of time. Second, we wanted to allow for the possibility of reinforcing nonsignificant effects across multiple transitions.

## Results

### Descriptive information

Table 1 shows that educational attainment differs substantially for older men and women with 70.5% of men reporting some formal education compared to only 35.8% of women. There are also noticeable gender differences in functional problems. At baseline 77.9% of men reported having no limitations compared to 62.6% of women. Women are also much more likely than men to have two or more limitations.

Focusing on each of the specific Nagi tasks shown in Table 2, men at baseline are more likely than women to report that they can perform each of the four Nagi tasks easily. Nonetheless, there is consistency among men and women's reports that walking for 5 km seems to be a task that older Indonesians have the most difficulty. The percent unable to perform this task at baseline is more sizeable among women (15.9%) than men (8.5%).

**Table 1** Frequency distribution of education and number of physical limitations (weighted %)

|                           | Men      |       | Women    |       |
|---------------------------|----------|-------|----------|-------|
|                           | <i>N</i> | %     | <i>N</i> | %     |
| <i>Education</i>          |          |       |          |       |
| No formal schooling       | 476      | 29.5  | 1138     | 64.3  |
| Some primary              | 962      | 55.8  | 595      | 30.3  |
| Secondary or more         | 335      | 14.7  | 143      | 5.5   |
| <i>Wave 1 Limitations</i> |          |       |          |       |
| 0                         | 1348     | 77.9  | 1082     | 62.6  |
| 1                         | 179      | 9.6   | 354      | 17.7  |
| 2                         | 99       | 5.2   | 195      | 9.1   |
| 3                         | 76       | 3.8   | 115      | 5.2   |
| 4                         | 71       | 3.4   | 130      | 5.4   |
| <i>Wave 2 Limitations</i> |          |       |          |       |
| 0                         | 909      | 54.8  | 571      | 34.1  |
| 1                         | 244      | 12.2  | 343      | 18.0  |
| 2                         | 182      | 9.6   | 361      | 18.8  |
| 3                         | 106      | 5.6   | 235      | 11.8  |
| 4                         | 129      | 6.7   | 220      | 10.6  |
| <i>Dead</i>               | 203      | 11.1  | 146      | 6.7   |
| Total                     | 1773     | 100.0 | 1876     | 100.0 |

**Table 2** The prevalence of difficulty for the Nagi measures of physical functioning (weighted %)

|                                | Men <sup>a</sup> |               |            | Women <sup>b</sup> |               |            |
|--------------------------------|------------------|---------------|------------|--------------------|---------------|------------|
|                                | Easily (%)       | Difficult (%) | Unable (%) | Easily (%)         | Difficult (%) | Unable (%) |
| <i>Wave 1 Status</i>           |                  |               |            |                    |               |            |
| Carry a heavy load for 20 m    | 88.0             | 6.6           | 5.4        | 79.6               | 11.7          | 8.7        |
| Walk for 5 km                  | 80.1             | 11.4          | 8.5        | 67.4               | 16.7          | 15.9       |
| Draw a pail of water from well | 92.7             | 4.1           | 3.1        | 89.2               | 5.4           | 5.3        |
| Bow, squat, or kneel           | 94.0             | 5.2           | 0.8        | 90.8               | 6.6           | 2.7        |
| <i>Wave 2 Status</i>           |                  |               |            |                    |               |            |
| Carry a heavy load for 20 m    | 75.2             | 18.1          | 6.7        | 56.6               | 29.9          | 13.4       |
| Walk for 5 km                  | 64.6             | 24.9          | 10.4       | 40.7               | 38.4          | 20.9       |
| Draw a pail of water from well | 87.9             | 9.1           | 2.9        | 77.6               | 16.8          | 5.6        |
| Bow, squat, or kneel           | 87.9             | 11.2          | 0.9        | 82.1               | 16.3          | 1.6        |

<sup>a</sup> In Wave 1,  $N = 1773$ ; In Wave 2,  $N = 1730$

<sup>b</sup> In Wave 1,  $N = 1876$ ; In Wave 2,  $N = 1570$

<sup>c</sup> Deceased respondents ( $N = 349$ ) not included in computing percentages at Wave 2

By Wave 2, four years later, the patterns of physical functioning are similar but the proportions changed slightly—mortality and the bidirectional health transitions altered the distributions. Consistent with other findings (Crimmins & Saito, 2001; Hayward et al., 2000), women reported a higher level of functional problems than men but men had higher death rates than women. For both men and women, the greatest loss of physical functioning occurred in the ability to walk 5 km easily. Over the four-year observation period, the percentage of men who can do this task easily declined from 80.1% to 64.6%. The proportion of women who could easily perform this task declined even more.

The crude volume of the bidirectional flows between the two observation waves is shown Table 3, where “inactive” is defined as having difficulty with or being unable to do one or more activities. We observed that 2,430 respondents began the study in the active state and 1,219 in the inactive state (unweighted  $N$ s). Most

**Table 3** Physical functioning status at Waves 1 and 2a (weighted %)

| Wave 1 Status <sup>a</sup> | Wave 2 Status |      |          |      |      |      |       |       |
|----------------------------|---------------|------|----------|------|------|------|-------|-------|
|                            | Active        |      | Inactive |      | Dead |      | Total |       |
|                            | $N$           | %    | $N$      | %    | $N$  | %    | $N$   | %     |
| Active                     | 1292          | 53.2 | 994      | 40.9 | 144  | 5.9  | 2430  | 100.0 |
| Inactive                   | 188           | 15.4 | 826      | 67.8 | 205  | 16.8 | 1219  | 100.0 |
| Total                      | 1480          | 40.6 | 1820     | 49.9 | 349  | 9.6  | 3649  | 100.0 |

<sup>a</sup> Active is defined as having no limitations on the physical functioning measures (walking, carrying heavy load, drawing water, and bow/squat/kneel); inactive is defined as having 1 to 4 limitations

respondents were observed to be in their origin state at Wave 2. Based on changes in functional status between the observation waves, 994 respondents moved from active to inactive, yielding a crude transition rate of 40.9%. One hundred eighty-eight respondents moved from inactive to active, resulting in a crude transition rate of 15.4%. The crude death rate in our sample is 9.6%. Mortality rates for persons who were active in Wave 1 were significantly lower than mortality rates for inactive persons (5.8% compared to 16.8%).

### Loglinear Modeling Results

As noted earlier, IFLS respondents are representative of 83% of the Indonesian population. As a means to gauge how well the IFLS represented the health experiences of the total population, in Table 4 we compared life expectancies based on the mortality experiences of IFLS respondents with life expectancies from the World Health Organization. Results from the IFLS are based on a statistical model in which the log of the risk of death is regressed on sex and age, and the parameter estimates are then used to calculate predicted death rates. These rates, in turn, were used to calculate the IFLS expectancies. We tested a variety of interactions and nonlinearities for functional forms of age but found no statistical significance in these alternate models. Strictly speaking, IFLS life expectancies predict “out of range” death rates based on observed information for persons aged 50–84 years of age. Our life tables indicate that less than one percent of the life table cohort survived to the oldest observed age.

Two sets of life expectancy results are shown for the IFLS data. The first set is based on known deaths that occurred between the two observation waves ( $N = 349$ ). However, the vital status for 113 older persons observed in Wave 1 was unknown at Wave 2 (“unknowns”), and it is likely that some of these persons died during the interval. We compared the health status of the “unknowns” with the “knowns,” and observed that the Wave 1 health status of the “unknowns” was similar to persons who reported functional problems at Wave 1 (results not shown). Because

**Table 4** Predicted life expectancies for IFLS respondents (1993–1997) and World Health Organization life expectancies (2000)

|                 | Men                            |                                |                          | Women                          |                                |             |
|-----------------|--------------------------------|--------------------------------|--------------------------|--------------------------------|--------------------------------|-------------|
|                 | IFLS<br>1993–1997 <sup>a</sup> | IFLS<br>1993–1997 <sup>b</sup> | WHO<br>2000 <sup>c</sup> | IFLS<br>1993–1997 <sup>a</sup> | IFLS<br>1993–1997 <sup>b</sup> | WHO<br>2000 |
| e <sub>50</sub> | 22.8                           | 21.7                           | 22.7                     | 27.9                           | 25.2                           | 25.3        |
| e <sub>60</sub> | 16.9                           | 15.6                           | 15.5                     | 20.8                           | 18.6                           | 17.5        |
| e <sub>70</sub> | 10.9                           | 10.8                           | 9.7                      | 14.9                           | 13.2                           | 10.9        |

<sup>a</sup> IFLS estimates are based on weighted data and are generalizable to 83% of the Indonesian population ( $N = 3649$ ). These estimates assume that attriters did not die between the survey intervals

<sup>b</sup> IFLS estimates assuming that attriters died between the survey intervals ( $N = 4065$ )

<sup>c</sup> Source: World Health Organization (2000). WHO estimates are nationally representative

functional problems at Wave 1 increased the risk of death, we suspect that a significant fraction of those with unknown vital status at Wave 2 died during the interval.

Our second set of IFLS expectancies assumes that all of the “unknowns” died in the interval. This will lead to expectancies that overestimate the mortality experience of the sample. The first set of expectancies, though, probably underestimates mortality. The actual mortality experience of the IFLS respondents thus should fall somewhere between the two sets of expectancies.

The IFLS life expectancies are generally similar to those reported by WHO, especially for men. The WHO expectancy for men aged 50 years is 22.7 compared to the 21.7–22.8 years for the IFLS respondents. The gap in expectancies increases at older ages, with a gap of about 1.3 years at age 70. Assuming that true mortality rates fall somewhere between the two sets of IFLS expectancies, IFLS expectancies are generally greater than those produced by WHO. The IFLS and WHO expectancies are more discrepant among women at older ages. IFLS women’s life expectancies at age 70 are 13.2–14.9 compared to the WHO expectancy of 10.9.

There are several possible sources for the discrepancies. First, the IFLS is representative of 83% of the Indonesian population whereas the WHO estimates are nationally representative. The areas in which the IFLS was not conducted were reported to be geographically remote or politically unstable. Thus, it is reasonable to expect that mortality rates in these areas are higher and would lower life expectancy if IFLS included respondents from these areas. Second, IFLS expectancies are based on deaths directly observed among the sample respondents, whereas WHO expectancies are partly based on model life tables (WHO, 2000). Some scholars have questioned the appropriateness of model life table assumptions for Indonesian mortality estimates (Muhidin, 2002). Thus, it is possible that the discrepancy between IFLS and WHO expectancies is partly due to effects of model life table assumptions. Nevertheless, we proceed cautiously with our multistate life table models.

The associations between age, sex, and education and the (log of the) risks of the health transitions are shown in Table 5. These are the parameter estimates we use to calculate the predicted rates that are used in the inputs for the MSLTs. As expected, incidence rates of inactivity and death increase with age. On the other hand, the rate of recovery (inactive to active) decreases with age. Women have a higher incidence of inactivity compared to men but women face lower mortality risks than men regardless of initial health state. Men have a higher incidence of recovery of physical functioning compared to women. The associations for men and women are similar to those reported for the older population in the United States (Crimmins et al., 1996).

Education decreases the risk of death for both health states although the effect is not statistically significant for inactive persons. On the whole, education is not strongly associated with either the onset or recovery of physical functioning. Thus, the primary way in which education appears to be influencing the process of active life among older Indonesians is via mortality, not morbidity. In developed countries, there is growing evidence that education influences the active life process via both morbidity and mortality. We suspect that the results for Indonesia may partly reflect the overall low levels of education among Indonesia’s older population.

**Table 5** Hazard models predicting transitions between active life, inactive life, and death among persons aged 50 years and older in the Indonesian Family Life Survey (1993–1997), weighted

| Covariates     | Active to Inactive |        | Active to Dead |        | Inactive to Active |        | Inactive to Dead |        |
|----------------|--------------------|--------|----------------|--------|--------------------|--------|------------------|--------|
|                | $\beta$            | S. E.  | $\beta$        | S. E.  | $\beta$            | S. E.  | $\beta$          | S. E.  |
| Intercept      | -4.0803***         | 0.2538 | -7.9659***     | 0.6284 | 1.2728*            | 0.5576 | -6.7963***       | 0.4730 |
| Age            | 0.0409***          | 0.0044 | 0.0529***      | 0.0103 | -0.0708***         | 0.0098 | 0.0513***        | 0.0072 |
| Male           | -0.8134***         | 0.0717 | 0.6600***      | 0.1967 | 0.2971*            | 0.1452 | 0.7584***        | 0.1524 |
| No Education   | 0.0240             | 0.0707 | 0.4441*        | 0.1803 | 0.2125             | 0.1432 | 0.1207           | 0.1491 |
| Log Likelihood | -2208.9            |        | -622.8         |        | -482.6             |        | -654.3           |        |
| N              | 2549               |        | 2546           |        | 1240               |        | 1240             |        |

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

### Multistate life table models

The MLST approach allows us to translate the complex interactions of disability transitions and mortality for a cohort as it ages into expectations of the years of life with and without disability. How sex and education are associated with each of the transitions shown in Table 5 thus will determine sex and educational differences in active life expectancy. The life table models also transform the transition rates into the expected prevalence of inactivity in the life table cohort, an indicator of the societal burden of disease implied by the transition forces.

The expected prevalence rates of inactivity for sex/education groups are shown in Table 6. Not surprisingly, the results show a higher prevalence of physical functioning at age 50 among those with some formal education compared to persons with no formal education. Among males, for example, the transition rates give rise to 72% of uneducated men being active compared to 85% of educated men. At older ages, the educational advantage evaporates. The educational differential in expected prevalence is greater for men than for women due to combined effects of ‘‘male’’ and ‘‘no education’’ on the transition rates.

Implications of the educational and sex effects on the transition rates for active life are shown in Table 7. For men aged 50 years with no education, for example, the total expectation of life is 25.4 years with 9.9 years of that inactive. If men with no education survived to age 60, overall life expectancy declined to 16.4 years with 8.7 of those years inactive.

The results in Table 7 show that gender differences in life expectancy are larger than educational differences. At age 50, for example, the gap in men's and women's life expectancy among persons with no education is 9.4 years. The education gap in life expectancy for men and women at this age is 3.7 and 2.9 years respectively. Although men are significantly disadvantaged in terms of life expectancy, they nevertheless have more years of active life than women. Women's life expectancy advantage thus reflects more years of inactive life.

**Table 6** Implied age-specific prevalence rates for active initial status of cohort<sup>a</sup>

| Age | Men          |               | Women        |               |
|-----|--------------|---------------|--------------|---------------|
|     | No Education | Any Education | No Education | Any Education |
| 50  | 0.717        | 0.853         | 0.553        | 0.578         |
| 60  | 0.596        | 0.570         | 0.292        | 0.262         |
| 70  | 0.371        | 0.348         | 0.118        | 0.102         |

<sup>a</sup> Active is having no limitations on the physical functioning measures (walking, carrying heavy load, drawing water, and bow/squat/kneel); inactive is having 1 to 4 limitations

**Table 7** Population-based active and inactive life expectancy ( $e_x$ ) by sex and education in the Indonesian Family Life Survey (1993–1997)<sup>a</sup>

| Age                   | No Education |          |       | Any Education |          |       |
|-----------------------|--------------|----------|-------|---------------|----------|-------|
|                       | Active       | Inactive | Total | Active        | Inactive | Total |
| <i>Panel A: Men</i>   |              |          |       |               |          |       |
| 50                    | 15.5         | 9.9      | 25.4  | 17.4          | 11.7     | 29.1  |
| 60                    | 7.7          | 8.7      | 16.4  | 7.0           | 10.4     | 18.4  |
| 70                    | 3.0          | 6.9      | 9.9   | 3.1           | 8.1      | 11.2  |
| <i>Panel B: Women</i> |              |          |       |               |          |       |
| 50                    | 10.4         | 24.3     | 34.7  | 10.2          | 27.4     | 37.6  |
| 60                    | 3.9          | 20.0     | 23.9  | 3.6           | 22.4     | 26.0  |
| 70                    | 1.2          | 14.9     | 16.1  | 1.1           | 16.5     | 17.6  |

<sup>a</sup> Active is having no limitations on the physical functioning measures (walking, carrying heavy load, drawing water, and bow/squat/kneel); inactive is having 1 to 4 limitations

The results in Table 7 also suggest that education resulted in an expansion of morbidity among older Indonesians. For example, although educated men have higher total life expectancy at every age, the additional years of life are spent as inactive rather than active. The pattern is also similar for women. Educated women have higher total life expectancy at every age but the gains are spent in the inactive state. These results are consistent, not surprisingly, with hazard results showing the sensitivity of mortality—but not changes in functioning—to educational attainment.

The results shown in Table 7 refer to the average functioning and mortality experiences of all persons alive at a given age. However, not all persons of a given age are equally healthy. Individuals reaching a particular age but who differ in health are likely to have very different health experiences at later ages. The life course health effects of a person's functional status at a given age are shown in Table 8. This table reports the results for status-based MSLTs, i.e., life table models for persons of a given age *and* functional status.

As can be seen, the effect of having a functional problem at a given age substantially alters active and inactive life expectancy. Among men with no formal education, for example, having a functional problem at age 50 reduces total life

**Table 8** Status-based active and inactive life expectancy ( $e_x$ ) by sex and education in the Indonesian Family Life Survey (1993–1997)<sup>a</sup>

| Age                   | No Education |          |       | Any Education |          |       |
|-----------------------|--------------|----------|-------|---------------|----------|-------|
|                       | Active       | Inactive | Total | Active        | Inactive | Total |
| <i>Panel A: Men</i>   |              |          |       |               |          |       |
| Active                |              |          |       |               |          |       |
| 50                    | 17.1         | 9.0      | 26.0  | 18.2          | 11.3     | 29.5  |
| 60                    | 9.9          | 7.4      | 17.4  | 10.7          | 9.1      | 19.8  |
| 70                    | 5.9          | 5.5      | 11.3  | 6.4           | 6.6      | 13.1  |
| Inactive              |              |          |       |               |          |       |
| 50                    | 11.9         | 12.1     | 24.0  | 12.0          | 14.6     | 26.6  |
| 60                    | 4.3          | 10.6     | 14.9  | 4.2           | 12.3     | 16.5  |
| 70                    | 1.2          | 7.9      | 9.2   | 1.2           | 9.0      | 10.2  |
| <i>Panel B: Women</i> |              |          |       |               |          |       |
| Active                |              |          |       |               |          |       |
| 50                    | 12.2         | 23.0     | 35.2  | 11.9          | 26.3     | 38.2  |
| 60                    | 6.5          | 18.4     | 24.8  | 6.5           | 10.7     | 27.2  |
| 70                    | 3.6          | 13.4     | 17.0  | 3.7           | 15.1     | 18.8  |
| Inactive              |              |          |       |               |          |       |
| 50                    | 8.2          | 25.9     | 34.1  | 7.5           | 29.2     | 36.7  |
| 60                    | 2.8          | 20.8     | 23.6  | 2.5           | 23.1     | 25.6  |
| 70                    | 0.8          | 15.2     | 16.0  | 0.7           | 16.8     | 17.5  |

<sup>a</sup> Active is having no limitations on the physical functioning measures (walking, carrying heavy load, drawing water, and bow/squat/kneel); inactive is having 1 to 4 limitations

expectancy by 2 years, but it reduces active life expectancy by 5.2 years and expands inactive life by about 3 years. Educated men with functional problems experience greater drops in life expectancy—almost 3 years—and more than a six-year drop in active life. Inactive life expectancy grows 3.3 years. The implications of having functional problems for women at age 50 are similar, although less pronounced. Clearly, men and women with early onset of functional problems pay a significant price in terms of a shorter life and more years of inactivity. As is evident, education increases life expectancy but incurs more years of inactivity. Most of the additional years of life for educated men and women are years lived with functional problems.

## Conclusion

Indonesia's economic and social development was dramatic until the late 1990s. The nation's development led to major improvements in health care, sanitation, and education, conditions reflecting the societal capacity to address health needs (Easterlin, 1997) and improve population health. Not surprisingly, mortality rates in Indonesia fell across the age range.

In this paper, we conducted a “thought experiment” to better understand possible trends in the implications of falling mortality for the burden of disease that might accrue from improvements in the social capacity for health. Our approach was based on the idea of using Indonesia’s within-population educational differences to approximate the effects of historical gains in educational attainment. These gains reflect a variety of forces: improvements in individuals’ capacity to reduce health risks and societal changes in social systems to address health needs.

Our results showed that education among older Indonesians was not strongly associated with morbidity and mortality compared to the United States and other developed nations (Freedman & Martin, 1999; Hayward et al., 2005; Zimmer et al., 1998). Education reduced the risk of mortality but was not statistically related to functional changes, and the mortality effect was largely confined to active persons. The consequence of these associations was that education led to an expansion of life expectancy that was accompanied by an expansion of life with functional problems. Education led to almost no improvement in active life. Extrapolating to the idea that educational differences in morbidity and mortality reflect gains in societal capacity, it appears that when the spread of mass education is at its earliest stages, the gains in older persons’ health are largely felt in terms of mortality and not functioning.

As is evident in this analysis, educational attainment and literacy levels for the older Indonesian birth cohorts were quite low, especially for women. Schooling was neither widespread nor lengthy. Even among persons who had received some education, attainment was not at a level that allowed individuals to substantially curb health risks. At the same time, the lack of widespread education suggests that other health-related infrastructural resources (e.g., modern sanitation practices, health care services, medical technologies) were also not widespread. Those resources that existed were most likely targeted at managing the fatal consequences of disease, thereby extending inactive life. Taken together, our results suggest that education attainment in the population may need to reach some critical threshold in order for it to become closely tied to social institutions that enhance health and individuals’ ability to mitigate long-term health risks.

These patterns lead us to conclude that Indonesia is in its early stages of the health transition. In the future, we should expect that as mass education becomes more closely tied to other social and economic institutions in Indonesia, the health benefits of compulsory education now instituted among younger cohorts will become more apparent. All else being equal, Indonesia’s burden of disease should decline. However, all else is not equal, and Indonesia will face the challenge of massive population aging in the coming century. Growing numbers of older Indonesians will increase the societal burden of disease, regardless of improvements in the social capacity of health. Whether the long-term benefits of Indonesia’s improvements in the social capacity for population health can be realized before Indonesia’s demographic transformation is not clear.

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