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The impact of socio-economic factors on functional status decline among community-dwelling older adults in China

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Abstract

The purpose of this paper is to examine the impact of baseline socio-economic factors on functional status decline over a period of 3 years among a sample of Chinese older men and women, using the China Health and Nutrition Surveys of 1997 and 2000. In addition, the study tries to determine whether risk differentials by these socio-economic factors can be explained by other demographic, health-related and nutritional risk factors. The eligible study population was defined as women and men aged 55 years and over who at baseline were free from any form of disablement in activities of daily living (ADLs) or instrumental activities of daily living (IADL) tasks. Among subjects with complete data at followed-up ($N=976$), the overall incidence proportions of any functional status decline, IADL only and ADL declines were 25.8%, 18.9% and 6.9%, respectively. Our study found that education is strongly and inversely associated with incidence of combined functional status decline and IADL only but not with the onset of ADL disability. Similarly, household income per capita was inversely associated with functional status decline and IADL disability incidence, with a clear dose–response relationship, even after adjustment for age and gender. However, multivariate analysis demonstrated that the latter association was highly confounded by other demographic factors, especially urban–rural area of residence. Using a combined measure of socio-economic status that includes years of education and household income per capita, the age and gender-adjusted odds ratio for functional status decline and belonging to lower SES class as compared to middle, upper middle and upper classes was 3.82 (95% CI: 2.15, 6.77) and 2.77 (95% CI: 1.52, 5.03) after further adjustment for urban–rural area of residence and living arrangements. Hence, there are wide socio-economic disparities in the functional health of older adults in China, although such disparities are more seen for IADL decline and are almost exclusively attributed to differentials in educational attainment. Finally, nutritional and health-related risk factors do not seem to act as intermediate factors in this association and hence further research should try to uncover other mechanisms by which SES affects changes in functional health among older adults in China.

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Keywords: Aging; Functional status decline; Socio-economic status; China

Introduction

The People's Republic of China is a country that is currently undergoing major changes in its population structure. The proportion of its elderly segment (65 and over) based on recent UN estimates was 10.1% in 2000

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and is projected to increase rapidly in the coming few decades to reach 30% in 2050 (United Nations, 2002). In addition, China accounts for 20% of the global population with a total of more than 1.2 billion, yielding the largest absolute number of elderly persons in the world. Population aging in any country carries great social, economic and public health implications, which include larger expenditures on pensions and health care, need for social security reforms, shrinking of the workforce and hence shortage of active persons that are able to support dependent older adults (Lai, 1999). In addition, the new age structure will dictate a higher prevalence of chronic diseases, mainly of cardiovascular nature. The treatment cost of these diseases is often higher when compared to the cost of curing those occurring among the young. In order to alleviate this problem, efforts throughout the developed world are being made to prevent occurrence of these illnesses through health education and other preventive activities that advocate an active and healthy lifestyle for people approaching their old age (Yip, Lee, Chan, & Au, 2001). The health objectives should not be targeting only mortality and cause of death structure but rather healthy and disability-free years lived among the older segment of the population (LaCroix, Guralnik, Berkman, Wallace, & Satterfield, 1993). Although rates of disablement are lower in developing than in developed countries, the rapid pace of population aging in China will ultimately lead to a disablement level that is comparable to that of a developed country, with little resources to deal with escalating health care costs.

According to Verbrugge and Jette (1994), disability may be defined as difficulty doing activities in any domain of life (from hygiene to hobbies, errands to sleep) due to a health or physical problem. It is often operationalized in terms of limitations in activities of daily living (ADL), mobility and instrumental activities of daily living (IADL). Risk factors for incidence of disability or functional status decline can be grouped under health-related and nutritional, demographic and socio-economic factors.

The impact of socio-economic factors on health has been investigated in many older adult populations all over the world. According to recent studies conducted across various nations and populations, there seems to be a consistent inverse relationship between socio-economic status and mortality, morbidity and disability (Kabir et al., 2003; Liang, Liu, & Gu, 2001; Von dem Knesebeck, Luschen, Cockerham, & Siegrist, 2003; Zimmer & Amornsirisomboon, 2001; Jiang, Tang, Meng, & Futatsuka, 2002; Liang et al., 2000).

While such an inverse association is well-documented, its mechanism of action is not quite clear, especially among older adults. A recent explanatory paradigm proposed by Macintyre (1997) states that social class health gradients can result from an artifact or measurement error, social selection, differential access to material goods, and class differences in health behavior. It is important therefore to distinguish two main mediators between socio-economic status and health indicators. The first one is economic in nature and comprises access to better living and working conditions (Marmot, Theorell, & Siegrist, 2002) as well as high-quality health care, both of which lead to greater well-being (Feinstein, 1993). Other mediating factors are more of a psychosocial nature whereby higher socio-economic status may lead to a greater understanding of behaviors that promote better health, including diet, physical exercise and avoidance of risky behaviors such as smoking and use of alcohol (Lynch et al., 1996; Lantz et al., 2001). In addition, other psychosocial factors include levels of stress, social support, self-efficacy and likelihood to seek medical attention (Zimmer, Chayovan, Lin, & Natividad, 2003). Consequently, there is a need to assess whether socio-economic status is directly affecting the functional status of older adult populations rather than working through other intermediary health-related and socio-demographic factors.

Measuring socio-economic status of older people presents particular difficulties and this itself may have discouraged research, as well as hampering policy making. One major difficulty is that measures of socio-economic status should not be themselves an outcome of health status, as was posited by some (Smith, 1999). Education is often regarded as an indicator of first choice because of being normally fixed early in life, and thus problems of reverse causation are much less serious. Nevertheless, many researchers attempt to formulate a more holistic measure of socio-economic status using income, occupation and household assets as well (Grundy & Holt, 2001).

The majority of epidemiological research on disablement in old age has focused its attention on the relationship between functioning with age, gender and disease conditions (Kaplan, 1992; Strawbridge, Comacho, Cohen, & Kaplan, 1993; Verbrugge & Patrick, 1995). In many of them, socio-economic status was introduced into models only as a potential confounder (Pope, Sowers, & Welch, 2001; Seeman et al., 1995; Launer, Harris, Rumpel, & Madans, 1994). Although the etiology of functional status decline has been assessed in various ways, a review of 78 longitudinal studies showed that among the health-related and nutritional risk factors, those that had the strongest evidence included: cognitive impairment, elevated or low body mass index (BMI), disease burden or co-morbidity, smoking and poor self-rated health (Stuck et al., 1999). In addition, most of these studies have been conducted among the elderly population aged 65 or older, even though prior evidence shows that the onset of functional status decline occurs between the

ages of 40 and 55 years when prevention of modifiable risk factors may be more effective (National Center for Health Statistics, 1997).

The purpose of this paper is to examine the impact of baseline socio-economic factors on functional status decline over a period of 3 years among a cohort of Chinese older adults aged 55 years or more, using the China Health and Nutrition Surveys (CHNS) of 1997 and 2000. In addition, the study tries to determine whether risk differentials among this age group by these socio-economic factors can be explained by other demographic, health-related and nutritional risk factors.

Materials and methods

Sampling and design

The CHNS was designed to meet several objectives. One of them was to examine how the social and economic transformation of the Chinese society is affecting the health and nutritional status of its population. The survey that relied on an extensive interviewer-administered questionnaire and a set of anthropometric and clinical measurements was conducted in 1989, 1991, 1997 and 2000. The interviewers are physicians who work for the public health system, termed the anti-epidemic disease stations. They all work in the nutrition area and receive 2 weeks of intensive training prior to each round of the CHNS.

For our purpose only the last 2 years, 1997 and 2000, for which longitudinal functional health data was readily available, will be used. A multistage, random cluster process was used to draw the sample surveyed in each of eight selected provinces namely Guangxi, Guizhou, Hellongjiang, Henan, Hubei, Hunan, Jiangsu and Shadong. Counties in these provinces were stratified by income (low, middle and high) and a weighted sampling scheme was used to randomly select four counties in each province. In addition, the provincial capital and one lower-income city were selected. Villages and townships within the counties and urban and suburban neighborhoods within the cities were chosen at random. The original sampling frame for 1989–1993 included 190 primary sampling units (PSUs). However, in 1997, this number increased in some urban areas as respondents who moved from one location to another were followed and newly formed households were also sampled in these initial areas. Within each of these PSUs, a fixed number of 25 households was sampled at random and constituted the secondary sampling units (SSUs). Hence, a total of 3875 households with around 14,426 members were selected in 1997, covering 192 PSUs.

Study population

Overall, 2121 individuals were aged 55 years and over in 1997 and lived in 1422 households. Eligible study population was defined as subjects aged 55 years and over who at baseline were free from any form of disablement in ADLs or IADL tasks. This selection relies on criteria that will be defined in the next section. Hence, those who were eligible amounted to 1385 individuals (in 1020 households and 188 PSUs), while around 615 had some form of disability and 121 had some missing data on ADL or IADL items in 1997. Out of the 1385 eligible subjects, 1031 were followed up between 1997 and 2000, while 354 were lost to follow-up. In 2000, 725 individuals were non-disabled, 251 had an incident disability and 55 had unknown outcome in 2000. Using complete case analysis ($n=976$ subjects in 720 households and within 166 PSUs), the overall incidence proportion of functional status decline was therefore 25.8% and those of IADL only and ADL decline were 18.9% and 6.9%, respectively. The total number of non-selected subjects out of those eligible amounted to 409. Multivariate logistic regression analysis shows that the baseline demographic, socio-economic, health-related and nutritional characteristics of those included in the sample did not differ significantly from those who were selected out of the sample.

Variables and measures

Outcome variables

The primary outcome of interest was decline in functional status among older adults aged 55 or more who were initially free of any disablement. Hence, a number of self-reported limitations in ADL and IADL tasks were detected in 2000 after ascertaining their absence in 1997. Whenever one of these was identified in 2000, the subject was considered to have declined in functional status over a period of 3 years. A modified version of the seven Katz-type ADLs was used namely: bathing, clothing, eating, grooming, transferring, toileting and walking across a small room (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963). In terms of IADLs, five tasks were elicited from study subjects namely, shopping, cooking, using public transportation, managing money and using the telephone (Lawton & Brody, 1969). Back translation into English was also performed. Since a limitation in an ADL is usually considered to be more severe than one in IADLs, the outcome was broken down further into "experiencing only incident IADLs" or "experiencing at least one incident ADL", to be consistent with previous literature (Tang et al., 1999; Lee & Choi, 2002). The responses were similar to those used for the US Health and Retirement Survey and other US-based National Center of Health Statistics

surveys. The ADL and IADLs that were elicited from older adults were validated against PULSES scores and other approaches were used to check internal and observer consistency in a separate pilot study (Marshall, Heisel, & Grinnell, 1999). The levels of disablement that were considered as outcome were "needs help to perform the task" or "cannot do it at all". Hence, if a subject "had some difficulty doing the task but still could do it", he was considered a non-disabled individual.

Exposure variables

Exposure variables were all measured at baseline (i.e., in 1997) and can be grouped as socio-economic, demographic, health-related and nutritional risk factors.

Socio-economic risk factors

Education level of each older person was recoded into a categorical variable ranging between 1 and 3, with 1 indicating "illiterate or no formal education", 2 indicating "primary level of education" and 3 indicating "intermediate or more" based on completed years of education. Household income was computed as the sum of all sources of income in the household, which include wages of economically active household members, home gardening, household farms and farm collectives, as well as income from raising livestock, poultry and fishing, welfare income and household asset income among others. In addition, household income was adjusted by price index, which is by urban–rural area of residence, and was deflated to its 1990 purchasing value. We obtained per capita adjusted household income by dividing income by household size. The present study will examine tertiles of per capita income based on the distribution of the continuous form of this variable in the selected study sample. A comprehensive assessment of socio-economic status was constructed based on years of education and household income per capita in its continuous form. Principal component analysis of these two variables was carried out reducing them to a single factor score using the eigenvalue rule >1. The overall variance explained by this factor score amounted to 63% and its distribution was slightly skewed to the right. It was then subdivided into five SES classes with lower class ranging on the standard normal scale between -1.53990 and -0.45156 whereas upper class was ranging between 2.81347 and 3.90181.

Health-related and nutritional risk factors

BMI was calculated by dividing the subject's weight in kilograms by his height squared (in square meters). Ultimately, one dummy variable was used for low and high BMI ($\leqslant 20$) compared to the referent category, which is a BMI greater than 20. Smoking was specified by a series of two questions, which lead to classifying subjects as "current smokers", "smoked previously" and "never smokers". For simplicity the last two categories were grouped together. Self-rated health is usually measured through a single question asking "Right now, how would you describe your health compared to that of other people of your age?" The four possible responses were "excellent", "good", "fair" and "poor". Limitations in cognitive functioning constitute an important indicator of impairment as discussed by Verbrugge and Jette (1994). In the present study, it is measured by a single subjective question that enquires about memory status. Those who responded "bad or very bad" were considered to have a possible cognitive impairment. The presence of co-morbid conditions at baseline was operationalized in terms of selected chronic conditions as well as the presence of physical or visual impairment. The chronic conditions considered were: hypertension, myocardial infarction, diabetes, stroke and bone fracture. While hypertension was assessed averaging out three measurements with a cutoff point of 140/90, all other conditions were self-reported. In addition, physical and visual impairment were also considered as co-morbid conditions, namely loss of use of lower and upper extremities and complete or partial loss of vision. A person having a positive response on any of the chronic conditions or impairments listed above, would be considered as having a co-morbid condition.

Demographic factors

Age in the 1997 survey was originally entered as a continuous variable that was computed based on date of birth. In this study, it will be used in its continuous form for non-parametric analyses, as well as categorized into four groups namely 55–59, 60–64 and 65–69 and 70+ for statistical modeling. Gender is also accounted for, being a well-established confounder of the association between functional status decline and other risk factors. Urban–rural area of residence is based on initial classification of the PSUs as being "urban" or "rural" communities. Living arrangement was identified through marital status of the individual and household size. Marital status was transformed into a dichotomous variable indicating married vs. unmarried (i.e., widowed, never married, divorced or separated). Hence, the potential types of living arrangements are "living alone" which is directly derived from a household size of 1, "living with spouse only" which is specified by a household size of two and married status, "living with others and spouse" defined by a household size of three or more and married status, and finally living with others and no spouse specified by a household size of two or more and unmarried status. It was difficult to assess whether living with others pertained to living exclusively with adult children or with other relatives and non-relatives. The main reason for that is the

absence of an identifier that relates the older person to other members of the household. Instead, only relationship of each member to the head of the household was available.

Statistical analysis

Bivariate analyses were run between exposure variables and main demographic confounders as well as between exposure and outcome variables. Unadjusted associations between categorical variables and functional status decline outcomes were significance tested using Chi-square for homogeneity. Age and gender as well as multivariate-adjusted odds ratios (ORs) were computed using a series of binary logistic regression models which accounted for design effect through specification of the PSU identifying variable as well as post-stratification by urban–rural area of residence. In addition, locally weighted regression (LOESS) was used as a non-parametric smoothing technique to show changes in risk of each outcome by selected continuous exposure variables with a bandwidth of 0.40 (Schimek, 2000), The alpha level for significance adopted was 0.05. Analyses were done using SPSS version 11 and STATA version 8.2 (SPSS, 2003; STATA, 2002).

Results

Characteristics of the study population at baseline are presented in Table 1. Out of the 976 older adults included in the sample, slightly more than half were male and the highest representation was for those in the age group 55–59 (34.7%), with an overall mean age of 63.7 (Standard Deviation = 6.22). In terms of socio-economic factors, around 38% of the sample was illiterate, with significant gender differentials (56% among females vs. 21% among males). In addition, older adults in the age group 70+ had the highest rate of illiteracy with a clear dose–response with increasing age. The proportion of individuals within the highest tertile of household income seemed to be decreasing with age as well. Looking at the overall socio-economic status, disadvantage with respect to both indices was encountered among 36.6% of the sample. Women were more likely to be disadvantaged than men ($P < 0.05$). Moreover, the proportion of subjects who belonged to the middle, upper middle or upper classes decreased almost linearly with aging from 30.8% among those in the age range 55–59 years to 18.1% among those aged 70 years or more.

Urban–rural distribution differed by age whereby older individuals were more concentrated in urban areas as compared to the younger age group (55–59 years). The proportion living alone or with spouse only increased with age while gender differentials were not as important. Over half of the study population were living with others and spouse and this pattern was more prominent among men and among those in the younger age category (55–59). Living with others and no spouse was more common among women and its proportion increased almost linearly with age. It is worth noting that living alone in China is far from being the norm with an overall proportion in our study sample of 4.2% (3% among men and 5.5% among women). In terms of health-related and nutritional risk factors, around one quarter of older adults had a low BMI and this proportion was slightly more elevated for the age group 70+ (38.3%). Smoking status was highly correlated with gender whereby around half of men were current smokers as compared to only 8.4% of women. However, smoking prevalence was homogeneous across age groups and it amounted overall to 30% of the sample. Over one-third of older adults reported fair or poor health status at baseline and this proportion increased with age but did not differ by gender. Cognitive impairment assessed subjectively was reported by around 10% of older adults and the proportion was higher among females and increased systematically with age. Among the assessed co-morbid conditions, hypertension was by far the most prevalent (15.7%), followed by bone fracture (4.6%) and diabetes (1.4%). Overall, co-morbid conditions were more prevalent among men and among subjects aged 70 years or older.

Fig. 1 indicates that the incidence proportion of functional status decline varies significantly across age and gender groups. Overall, an incident ADL or IADL was more probable to occur among women than among men for all age groups. In addition, the rise in the incidence proportion among women was steeper than among men especially with respect to ADLs. In contrast, the incidence proportion among men increased at a much slower pace for all three outcomes without exceeding the value of 50%.

Table 2 identifies the percentage of older adults with IADL, ADL and any functional status decline according to socio-economic, health-related and nutritional risk factors. A strong inverse association with a dose–response relationship was found between all three outcomes and level of education. This association remained significant after adjustment for age and gender for IADL only and any functional status decline outcomes, but not for the ADL outcome. Looking at the effect of household income, we find that the lowest tertile has the highest risk for IADL and any functional status decline outcomes, even after adjustment for age and gender. Residing in rural areas and living with others and no spouse were highly predictive of these two outcomes. Low BMI was a moderate risk factor for ADL as well as any functional status decline after controlling for age and gender, but did not significantly affect the risk for IADL decline. The main effect of smoking was

Table 1
Baseline characteristics of study population by age group and gender: CHNS, 1997

Characteristics	All sample	Gender		Age group			
		Male	Female	55–59	60–64	65–69	70+
No. (%)	976 (100)	507 (51.9)	469 (48.1)	339 (34.7)	271 (27.8)	204 (20.9)	162 (16.6)
Socio-economic factors							
Educational level (%)							
Illiterate/informal	37.9	21.3	55.8[a]	26.9	37.3	46.8	50.6 [a]
Primary	36.3	42.7	29.4	38.2	39.9	34.0	29.4
Intermediate or more	25.8	36.0	14.7	34.9	22.8	19.2	22.1
Household income per capita (%)							
<946.31	33.4	32.9	33.9	33.1	28.8	22.7	20.3
946.31–1852.31	33.1	32.3	33.9	32.5	37.6	21.4	18.7
>1852.31	33.5	34.7	32.2	38.5	33.6	14.6	15.0
Socio-economic status (%)							
Lower class	36.6	26.5	47.4[a]	27.8	36.2	43.6	46.9 [a]
Lower middle class	39.0	41.0	36.7	41.4	40.3	36.1	35.0
Middle, upper middle, upper classes	24.5	32.5	15.9	30.8	23.5	20.3	18.1
Demographic, health-related and nutritional factors							
% Urban	40.4	40.0	41.0	34.1	41.6	44.2	47.3[a]
Living arrangement (%)							
Alone or with spouse only	31.6	33.1	30.0[a]	22.0	34.5	31.4	47.2[a]
With others and no spouse	15.4	8.8	22.5	10.7	12.7	19.1	24.8
With others and spouse	53.0	58.2	47.5	67.4	52.8	49.5	28.0
BMI (%)							
Low (⩽20)	25.3	24.2	26.4	24.3	21.4	21.8	38.3[a]
Moderate or high (>20)	74.7	75.8	73.6	75.7	78.6	78.2	61.7
Smoking (%)							
Non-smoker	69.7	49.3	91.6[a]	69.3	66.4	72.3	72.5
Current smoker	30.3	50.7	8.4	30.7	33.6	27.7	27.5
Self-rated health (%)							
Excellent	8.8	9.2	8.4	10.7	6.7	7.5	9.9
Good	56.5	56.7	56.4	60.4	57.9	54.2	49.1
Fair	30.1	30.2	30.0	24.1	30.2	33.8	37.9
Poor	4.5	4.0	5.2	4.8	5.2	4.5	3.1
Cognitive impairment (% yes)	10.5	7.5	13.8[a]	7.1	8.9	13.2	16.7[a]
Co-morbid conditions (% yes)							
Hypertension	15.7	18.2	13.0[a]	13.4	13.4	18.3	21.0
Myocardinal infraction	0.9	1.4	0.4	0.3	0.7	1.5	1.9
Stroke	0.6	0.8	0.4	0.3	0.4	1.0	1.3
Diabetes	1.4	0.6	2.2[a]	1.5	1.1	1.5	1.3
Bone fracture	4.6	5.0	4.1	4.5	4.9	3.0	6.2
Visual/physical impairment	0.7	0.6	0.8	0.6	0.8	1.0	0.6
Any (%)	21.7	24.3	19.0[a]	19.2	18.8	24.5	28.4[a]

[a]Statistically significant at an alpha level of 0.05.

non-significant after control was performed on age and gender. Self-rated health was a poor predictor of all three outcomes and so were cognitive impairment and co-morbid conditions, especially after adjustment for age and gender was made.

Fig. 2 shows the effect of the continuous SES factor on the incidence proportion of the three outcomes, stratified by gender. Among men, the incidence proportion was inversely associated with the SES factor score, reaching a null value among the uppermost classes and

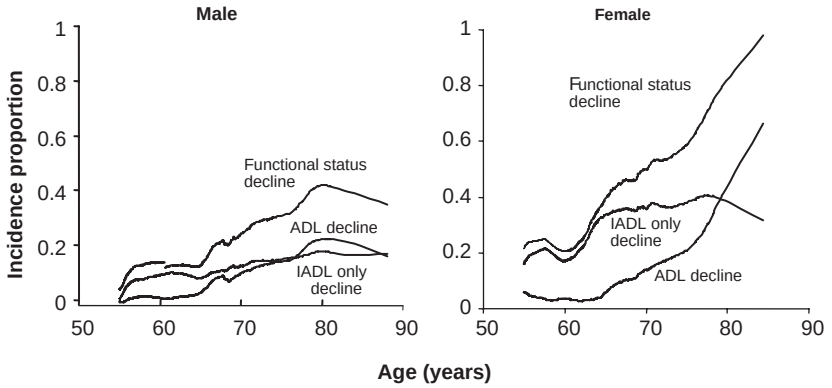

Fig. 1. Incidence proportions of functional status decline, ADL and IADL only declines among male and female older adults by age (years): CHNS 1997–2000.

this for all three outcomes. Hence, the overall trend was linear and downward sloping. In contrast, among women, the trend was rather U-shaped for "any functional status decline" and "ADL decline" while remaining linear for "IADL decline". Therefore, this suggests a potential effect modification by gender for the association between SES and "ADL decline" as well as "any functional status decline", which should be further explored. This effect modification acts in a way to render both lower and upper classes among women more susceptible to ADL decline, while among men only lower classes are at high risk for all three outcomes.

Multivariate-adjusted ORs of functional status decline according to socio-economic factors are presented in Table 3. The effect of educational level remained strong on two of the three outcomes (i.e., any functional status decline and IADL only), after adjustment for age, gender, urban–rural area of residence and living arrangements with a persistent dose–response relationship (Models 1a–c). These covariates were retained in the model after a process of backward elimination, using the change-in-estimate criterion of 10%. In contrast, household income was no longer a significant predictor of "any functional status decline" after controlling for these same demographic factors (Models 2a–c). The inverse association between composite SES and any functional status decline remained significant even after adjustment for age, gender, urban–rural area of residence as well as living arrangements, with an OR of 2.21 (95% CI: 1.29, 3.78) for lower middle SES and 2.77 (95% CI: 1.52, 5.03) for lower SES. This association remained appreciable for IADL decline and non-significant for ADL decline (Models 3a–c).

Discussion

Given the paucity of research conducted in developing countries on the association between socio-economic status indicators and health in old age, this study may have important implications for policy as well as future research efforts. Our analyses support previous evidence of a strong effect of socio-economic factors on functional status decline. In terms of education, a longitudinal study by Ho, Woo, Yuen, Sham, and Chan (1997) showed that old–old subjects in Hong Kong having no formal education had twice the risk of mobility decline when compared to those who had secondary education or higher. Another cross-sectional study in rural China proved a dose–response relationship between degree of disability and number of completed years of education (Anson & Sun, 2003). Similar findings were reported in a study by Liang et al. (2001) which was conducted among older adults in Wuhan, China to look for socio-economic differentials in functional transitions. The authors found a strong inverse relationship between educational attainment and decline in ADL functional health which was partially acting through the intermediate of health status (19% of the effect) and social ties (8% of the effect). Our study found that the level of education is strongly and inversely associated with incidence of combined functional status decline as well as the incidence of IADL only, but was not associated with the incidence of ADL disability. This association was found in all models, even after adjustment for age, gender, living arrangements and urban–rural area of residence. Hence, education was able to predict mild disability incidence, but not that of the severe type.

Similarly, income was inversely associated with functional status decline and IADL disability incidence, with a clear dose–response relationship, even after adjustment for age and gender. However, multivariate analysis demonstrated that such an association was highly confounded by urban–rural area of residence. Earlier studies on the association between income and disability were controversial in their findings. In fact, a cross-sectional study by Cheng, Chi, Boey, Ko, and

Table 2
Crude incidence proportion and age group and gender-adjusted ORs[a] of functional status decline among study population according to socio-economic, health-related and nutritional factors over the period 1997–2000

	IADL Only			ADL			Any functional status decline		
	% Decline	OR	95% CI	% Decline	OR	95% CI	% Decline	OR	95% CI
Educational level	b			b			b		
Illiterate/informal	30.5	5.58	2.85, 10.89[b]	9.8	2.00	0.83, 4.76	40.3	4.66	2.53, 8.59[b]
Primary	16.8	3.30	2.85, 10.89[b]	5.7	1.15	0.48, 2.79	22.4	2.50	1.43, 4.39[b]
Intermediate or more	4.8	1.00		4.0	1.00		8.8	1.00	
Household income per capita	b			b			b		
<946.31	23.6	1.68	1.03, 2.75[b]	9.5	1.30	0.64, 2.65	33.1	1.69	1.10, 2.58[b]
946.31–1852.31	18.6	1.40	0.88, 2.21	4.3	0.69	0.31, 1.55	22.9	1.19	0.76, 1.85
>1852.31	14.4	1.00		6.7	1.00		21.1	1.00	
Socio-economic Status (%)	b			b			b		
Lower class	28.0	4.41	2.32, 8.38[b]	8.5	1.74	0.65, 4.64	36.4	3.82	2.15, 6.77[b]
Lower middle class	18.3	3.13	1.75, 5.59[b]	7.4	1.55	0.63, 3.79	25.7	2.72	1.62, 4.57[b]
Middle, upper middle, upper classes	5.9	1.00		3.4	1.0		9.3	1.00	
Area of residence	b						b		
Urban	9.3	1.00		7.0	1.00		16.3	1.00	
Rural	25.5	4.00	2.41, 6.60[b]	6.8	1.14	0.60, 2.19[b]	32.2	3.20	2.06, 4.97[b]
Living arrangement	b						b		
Alone or with spouse only	16.3	1.00		6.9	1.00		23.2	1.00	
With others and no spouse	30.9	1.80	1.04, 3.13[b]	10.1	1.47	0.62, 3.46	40.9	1.92	1.15, 3.20[b]
With spouse and others	17.1	1.25	0.77, 2.04	6.0	1.31	0.64, 2.70	23.2	1.33	0.87, 2.03
BMI				b			b		
Low (⩽20)	21.1	1.22	0.80, 1.86	10.6	1.79	1.04, 3.06[b]	31.7	1.47	1.01, 2.14[b]
Moderate or high (>20)	18.0	1.00		5.6	1.00		23.7	1.00	
Smoking									
Non-smoker	21.7	1.00		7.4	1.00		29.1[b]	1.00	
Current smoker	12.3	0.80	0.50, 1.28	5.5	0.92	0.38, 2.22	17.7	0.82	0.53, 1.26
Self-rated health									
Excellent or good	18.7	1.00		6.3	1.00		25.0	1.00	
Fair or poor	19.7	0.94	0.63, 1.41	8.1	1.00	0.53, 1.90	27.8	0.95	0.66, 1.37
Cognitive Impairment							b		
No	18.0	1.00		6.3	1.00		24.3	1.00	
Yes	25.5	1.18	0.71, 1.97	9.8	1.43	0.69, 2.97	35.3	1.33	0.81, 2.16
Co-morbid conditions									
No	19.6	1.00		6.3	1.00		25.9	1.00	
Yes	16.0	0.73	0.46, 1.13	9.0	1.14	0.60, 2.17	25.0	0.81	0.56, 1.18

[a]ORs were estimated using the maximum likelihood method.
[b]Statistically significant at an alpha level of 0.05.

Chou (2002) conducted in Hong Kong suggested that functional health among the elderly is highly affected by their self-perceived economic condition. A recent study by Zimmer and Kwong (2004) found that bank savings is the strongest predictor of functional health among older adults in rural and urban China. In Thailand, low income was found to be an independent risk factor for the presence of a functional disorder among older adults with a clear dose–response relationship (Zimmer & Amornsirisomboon, 2001). In contrast, according to Woo, Ho, and Yu (2000), functional status among older Chinese adults as measured by Barthel index does not deteriorate over a 3-year period with lower income at baseline, after adjusting for age and gender.

Overall, our findings suggest that socio-economic status, education in particular, is a strong predictor of

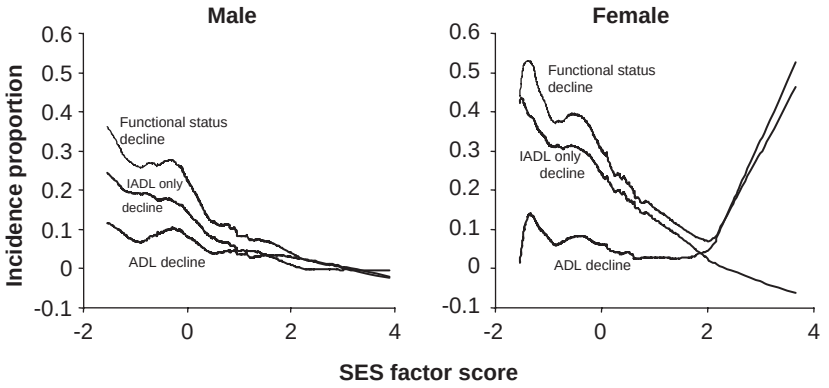

Fig. 2. Incidence proportions of functional status decline, ADL and IADL only declines among male and female older adults by SES factor score: CHNS 1997–2000.

Table 3
Multivariate-adjusted ORs[a,c] of functional status decline among study population according to socio-economic factors, controlling for demographic, behavior and health related factors: 1997–2000

	IADL only		ADL		Any functional status decline	
	Model 1a		Model 1b		Model 1c	
	OR	95% CI	OR	95% CI	OR	95% CL
Educational level						
Illiterate/informal	4.07	2.07, 7.99[b]	1.94	0.73, 5.15	3.59	1.98, 6.53[b]
Primary	2.54	1.44, 4.48[b]	1.15	0.46, 2.87	2.01	1.18, 3.43[b]
Intermediate or more	1.00		1.00		1.00	
	Model 2a		Model 2b		Model 2c	
	OR	95% CI	OR	95% CI	OR	95% CL
Household income per capita						
<946.31	1.24	0.75, 2.04	1.23	0.58, 2.61	1.29	0.83, 1.99
946.31–1852.81	1.16	0.70, 1.90	0.66	0.28, 1.56	1.00	0.62, 1.60
>1852.31	1.00		1.00		1.00	
	Model 3a		Model 3b		Model 3c	
	OR	95% CI	OR	95% CI	OR	95% CL
Socio-economic status						
Lower class	3.00	1.29, 4.52[b]	1.68	0.56, 5.07	2.77	1.52, 5.03[b]
Lower middle class	2.42	1.30, 5.93[b]	1.54	0.60, 3.97	2.21	1.29, 3.78[b]
Middle, upper middle, upper classes	1.00		1.00		1.00	

[a]ORs were estimated using the maximum likelihood method.
[b]Statistically significant at an alpha level of 0.05.
[c]Models 1a, 1c, 2a, 2c, 3a and 3c controlled for age group (55–59, 60–64, 65–69, 70+), gender, urban–rural area of residence and living arrangement. Other covariates were removed by backward elimination using the change-in-estimate criterion of 10%.

functional status decline. Using a combined measure of low socio-economic status that includes years of education and household income per capita, the OR for any functional status decline and lower middle class as compared to middle, upper middle and upper classes was 2.21 (95% CI: 1.36, 3.59). For lower class, the OR was 2.77 (95% CI: 1.74, 4.40), indicating the presence of an SES gradient in this health outcome.

Although our main purpose in this paper was to assess the effect of SES factors on functional status decline, it is worth reviewing the literature with respect to the main covariates that were considered in association with functional health outcomes. In terms of urban–rural area of residence, living in a rural area was a very strong predictor of IADL and any functional status decline but not ADL, independently of age and gender as well as socio-economic factors. Previous research found a similar pattern. A cross-sectional study conducted in Egypt on non-institutionalized elderly persons showed that living in rural areas had an adverse impact on women with respect to functional status limitations, whereas among men the association was not statistically significant (Lamb, 1997). Another cross-sectional study conducted in Beijing showed that in all age groups, disability prevalence rate was lowest in urban areas (Tang et al., 1999). Hence, our findings are consistent with previous studies and suggest that urban areas provide a favorable environment for sustaining functional health in old age. Aside from higher average income, some intermediate factors that may be at play are better access to high-quality health care, superior pension policies and state provision as well as availability of transportation and a reduced need for physical effort to complete certain tasks, especially IADLs.

With respect to living arrangements, those living with non-spouse others had a significantly higher risk of any functional status decline as compared to those living independently (i.e., alone or with spouse only), even after controlling for demographic and socio-economic factors (OR: 1.8, $P<0.05$ for all three multivariate models). There is substantial evidence that baseline household structure can affect incidence of functional status decline in the manner established by our present study. In fact, an earlier study conducted among non-institutionalized urban persons aged 65 years and older showed that persons living with children and without spouses had worse outcomes as compared to those who lived alone (Zyzanski, Medalie, Ford, & Grava-Gubins, 1989). A more recent prospective study suggests that women living alone are less likely to encounter functional status decline than those sharing households with spouses or non-spouses, given that they had no severe impairment at baseline (Sarwari, Fredman, Langenberg, & Magaziner, 1998). A third study has demonstrated that older Medicaid recipients who lived alone enter nursing homes with better physical function than those who lived with others (Egleston, Rudberg, & Brody, 1999). Our findings suggest that in China, although sharing households with other relatives and non-relatives is the norm, living without a spouse is an arrangement that would worsen functional health outcomes in spite of the potential social support provided by other co-residents. However, in-depth qualitative research is needed to ascertain the mechanism of such an association.

A major incongruence was observed when comparing our results to earlier studies, specifically with respect to health-related and nutritional risk factors. In fact, most of these factors were either not associated with the outcomes or their association was highly confounded by age and gender. The latter was the case for smoking and cognitive impairment. Although Pope et al. (2001) did not find a relationship between smoking and functional limitations either, among middle-aged women, this association was established by other studies and for both genders (LaCroix et al., 1993; Nelson, Nevitt, Scott, Stone, & Cummings, 1994). In addition, cognitive impairment was shown to be positively associated with functional status decline in previous studies, specifically for ADL limitations and the association was independent of age, gender, race, history of chronic health conditions and incident health conditions (Moritz, Kasl, & Berkman, 1995).

Surprisingly, co-morbid conditions were non-significant predictors for our outcome even without control for age and gender. In contrast, earlier studies had established a strong influence of chronic and acute conditions on functional status decline, especially arthritis, hypertension, stroke, diabetes, osteoporosis, cancer and bone fracture (Lee & Choi, 2002; Reynolds & Silverstein, 2003; Pope et al., 2001; Ho et al., 1997). It was also found that the larger the number of co-morbid conditions, the more likely the older person will have at least one limitation in ADL (Kabir, Tishelman, & Torres-Aguero et al., 2003). Our finding can be either due to a measurement error of the exposure variable or to real cultural differences in the effect of health-related variables on disability. Similarly, self-rated health fell in the non-significant exposure category, unlike previous research findings. In fact according to Goldman, Korenman, and Weinstein (1995), self-rating of health is independently associated with change in functional ability over periods of 1–6 years. An approximate 2.5 times greater risk for declining in function was found among those with fair or poor self-ratings when compared to those with good self-ratings. The only factor in this category that affected our functional outcomes independently of age, gender and other factors was low BMI. However, its appreciable effect was exclusively noted for ADL limitations and remained significant in the multivariate model. An earlier study by LaCroix et al. (1993) demonstrated that low BMI increased the risk of failure to maintain mobility in later life among men only. In contrast, obesity (or high BMI) was a significant predictor for both genders. In our case, obesity did not seem to affect the outcomes significantly and hence results related to this risk factor were not presented.

Many studies related to disablement examine the effect of gender and age on incident or prevalent limitations. In most of these studies, it was confirmed that increasing age and being female tend to increase the risk of disability or functional status decline (Guralnik et al., 1993; Rautio, Heikkinen, & Heikkinen, 2001; Kabir et al., 2003; Beland & Zunzunegui, 1999). However, there are certain exceptions to this rule (e.g., Reynolds & Silverstein, 2003; Dunlop, Manheim, Sohn, Liu, & Chang, 2002). It is important to note here that in looking at gender differentials, while ADLs may reflect pure disability in performing a task by either men or women, IADL limitations may be reflecting more a need to perform these tasks among women who, if able to do so, undertake usual tasks such as cooking or shopping to a much higher extent than men. Therefore, incidence of IADLs among men and women should be carefully looked at from this perspective.

The results also suggest that health-related and nutritional risk factors are either non-significant risk factors or act through gender and age differentials. Moreover, the effect of SES on functional status decline was not attenuated by these risk factors. Nevertheless, these findings should be interpreted with caution. In fact, the outcome variable as well as the risk factors were operationalized based on few questions and self-reports rather than objective measurements. In addition, translation of the interview schedule from English to Chinese may result in major changes in meaning and wording of questions related to health and disability. Inconsistencies between interviewers may be a source of error as well. However, errors were alleviated by a detailed instruction manual. Loss to follow-up and missing data are considered a major limitation in this study and a threat to external validity. Nevertheless, multivariate analyses between those included and those excluded from the study showed no significant differences in baseline characteristics. It is worth noting that the power to detect differentials with respect to the ADL outcome was limited by the number of incident ADL cases encountered by the year 2000. Future research conducted in China should focus on uncovering other mediating factors between socio-economic status and functional status decline, namely social support, stress and depression as well as access to health care and should control for overall social need to perform different ADL and IADL tasks.

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References

Anson, O., & Sun, S. (2003). Health inequalities in rural China: evidence from HeBei Province. *Health & Place*, *10*, 75–84.

Beland, F., & Zunzunegui, M. V. (1999). Predictors of functional status in older people living at home. *Age and Ageing*, *28*, 153–159.

Cheng, Y. H., Chi, I., Boey, K. W., Ko, L. S. F., & Chou, K. L. (2002). Self-rated economic condition and the health of elderly persons in Hong Kong. *Social Science & Medicine*, *55*, 1415–1424.

Dunlop, D. D., Manheim, L. M., Sohn, M.-W., Liu, X., & Chang, R. (2002). Incidence of functional limitation in older adults: the impact of gender, race and chronic conditions. *Archives of Physical Medicine and Rehabilitation*, *8*, 964–970.

Egleston, B. L., Rudberg, M. A., & Brody, J. A. (1999). Prior living arrangements and nursing home resident admission ADL characteristics: a study of two states. *Journal of Gerontology B Psychological Sciences & Social Sciences*, *54*, S202–206.

Feinstein, J. S. (1993). The relationship between socioeconomic status and health: a review of the literature. *The Milbank Quarterly*, *71*, 279–322.

Goldman, N., Korenman, S., & Weinstein, R. (1995). Marital status and health among the elderly. *Social Science & Medicine*, *40*, 1717–1730.

Grundy, E., & Holt, G. (2001). The socioeconomic status of older adults: how should we measure it in studies of health inequalities? *Journal of Epidemiology and Community Health*, *55*, 895–904.

Guralnik, J. M., LaCroix, A. Z., Abott, R. D., Berkman, L. F., Satterfield, S., Evans, D. A., & Wallace, R. B. (1993). Maintaining mobility in late life: I. Demographic characteristics and chronic conditions. *American Journal of Epidemiology*, *137*, 845–857.

Ho, SC., Woo, J., Yuen, Y. K., Sham, A., & Chan, S. G. (1997). Predictors of mobility decline: the Hong Kong old–old study. *Journal of Gerontology: Medical Sciences*, *52*, M356–M362.

Jiang, J., Tang, Z., Meng, X. J., & Futatsuka, M. (2002). Demographic determinants for change in activities of daily living: a cohort study of the elderly people in Beijing. *Journal of Epidemiology*, *12*, 280–286.

Kabir, Z. N., Tishelman, C., Torres-Aguero, H., Chowdhury, A. M. R., Windblad, B., & Hojer, B. (2003). Gender and rural–urban differences in reported health status by older people in Bangladesh. *Archives of Gerontology and Geriatrics*, *37*, 77–91.

Kaplan, G. A. (1992). Maintenance of functioning in the elderly. *Annals of Epidemiology*, *2*, 823–834.

Katz, S., Ford, A. B., Moskowitz, R. W., Jackson, B. A., & Jaffe, M. W. (1963). Studies of illness in the aged: the index of ADL, a standardized measure of biological and

psychosocial function. *Journal of the American Medical Association*, *185*, 914–919.

LaCroix, A. Z., Guralnik, J. M., Berkman, L. F., Wallace, R. B., & Satterfield, S. (1993). Maintaining mobility in late life: II. Smoking, alcohol consumption, physical activity and body mass index. *American Journal of Epidemiology*, *137*, 858–868.

Lai, D. (1999). Statistical analysis on spatial and temporal patterns of the Chinese elderly population. *Archives of Gerontology and Geriatrics*, *28*, 53–64.

Lamb, V. L. (1997). Gender differences in correlates of disablement among the elderly in Egypt. *Social Science & Medicine*, *45*, 127–136.

Lantz, P. M., Lynch, J. W., House, J. S., Lepkowski, J. M., Mero, R. P., Musick, M. A., et al. (2001). Socioeconomic disparities in health change in a longitudinal study of US adults: the role of health risk behaviors. *Social Science & Medicine*, *53*, 29–40.

Launer, L. J., Harris, T., Rumpel, C., & Madans, J. (1994). Body mass index, weight change and risk of mobility disability in middle-aged and older women. *Journal of the American Medical Association*, *271*, 1093–1098.

Lawton, M. P., & Brody, E. (1969). Assessment of older people: self-maintaining and instrumental activities of daily living. *The Gerontologist*, *9*, 179–186.

Lee, Y., & Choi, K. (2002). Functional disability of older persons in long-term care facilities in Korea. *Archives of Gerontology and Geriatrics*, *34*, 93–106.

Liang, J., Liu, X., & Gu, S. (2001). Transitions in functional status among older people in Wuhan, China: socio-economic differentials. *Journal of Clinical Epidemiology*, *54*, 1126–1138.

Liang, J., McCarthy, J. F., Jain, A., Krause, N., Bennett, J. M., & Gu, S. (2000). Socioeconomic gradient in old age mortality in Wuhan, China. *Journal of Gerontology B Psychological Sciences & Social Sciences*, *55*, S222–S233.

Lynch, J. W., Kaplan, G. A., Cohen, R. D., Tuomilehto, J., & Salonen, J. T. (1996). Do known risk factors explain the relation between socioeconomic status risk of all-cause mortality, cardiovascular mortality and acute myocardial infarction? *American Journal of Epidemiology*, *144*, 934–942.

Macintyre, S. (1997). The Black Report and beyond: what are the issues. *Social Science & Medicine*, *44*, 723–745.

Marmot, M., Theorell, T., & Siegrist, J. (2002). Work and coronary heart disease. In Stansfeld, S., & Marmot, M. (Eds.), *Stress and the Heart. Psychosocial Pathways to Coronary Heart Disease*. London: BMJ Books.

Marshall, S. C., Heisel, B., & Grinnell, D. (1999). Validity of the PULSES profile compared with the Functional Independence Measure for measuring disability in a stroke rehabilitation setting. *Archives of Physical Medicine and Rehabilitation*, *80*, 760–765.

Moritz, D. J., Kasl, S. V., & Berkman, L. F. (1995). Cognitive functioning and the incidence of limitations in activities of daily living in elderly community sample. *American Journal of Epidemiology*, *141*, 41–49.

National Center for Health Statistics. (1997). Health*, United States, 1996–1997 and Injury Chartbook*. DHHS Publication No. (PHS) 97-1232. Hyattsville, MD, US: Department of Health and Human Services.

Nelson, H. D., Nevitt, M. C., Scott, J. C., Stone, K. L., & Cummings, S. R. (1994). Smoking, alcohol, and neuromuscular and physical function of older women. *Journal of the American Medical Association*, *272*, 1825–1831.

Pope, S. K., Sowers, M., & Welch, G. W. (2001). Functional limitations in women in midlife: the role of health conditions, behavioral and environmental factors. *Women's Health Issues*, *11*, 494–502.

Rautio, N., Heikkinen, E., & Heikkinen, R. L. (2001). The association of socio-economic factors with physical and mental capacity in elderly men and women. *Archives of Gerontology and Geriatrics*, *33*, 163–178.

Reynolds, S. L., & Silverstein, M. (2003). Observing the onset of disability in older adults. *Social Science & Medicine*, *57*, 1875–1889.

Sarwari, A. R., Fredman, L., Langenberg, P., & Magaziner, J. (1998). Prospective study on the relation between living arrangement and change in functional health status of elderly women. *American Journal of Epidemiology*, *147*, 370–378.

Schimek, M. G. (2000). *Smoothing and regression: approaches, computations and application*. Wiley series in probability and statistics.

Seeman, T. E., Berkman, L. F., Charpentier, P. A., Blazer, D. G., Albert, M. S., & Tinetti, M. E. (1995). Behavioral and psychosocial predictors of physical performance: MacArthur studies of successful aging. *Journal of Gerontology: Medical Sciences*, *50*, M177–M183.

Smith, J. P. (2002). Healthy bodies and thick wallets: The dual relation between health and economic status. *Journal of Economic Perspectives*, *13*, 145–166.

Statistical Package For The Social Sciences (SPSS). (2003). Version 11.0. URL: http://www.spss.com

STATA (2002). *Statistics/data analysis: release 8.2*. Texas: Stata Corporation.

Strawbridge, W. J., Comacho, T., Cohen, R. D., & Kaplan, G. A. (1993). Gender differences in factors associated with change in physical functioning in old age: a 6-year longitudinal study. *The Gerontologist*, *33*, 603–609.

Stuck, A. E., Walthert, J. M., Nikolaus, T., Bula, C. J., Hohmann, C., & Beck, J. C. (1999). Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Social Science & Medicine*, *48*, 445–469.

Tang, Z., Wang, H.-X., Meng, C., Wu, X.-G., Ericson, K., Winblad, B., & Pei, J.-J. (1999). The prevalence of functional disability in activities of daily living and instrumental activities of daily living among elderly Beijing Chinese. *Archives of Gerontology and Geriatrics*, *29*, 115–125.

United Nations. (2002). *World population prospects: the 2002 revision*. URL: http://www.un.org/popin/data.html

Verbrugge, L. M., & Jette, A. M. (1994). The disablement process. *Social Science & Medicine*, *38*, 1–14.

Verbrugge, L. M., & Patrick, D. L. (1995). Seven chronic conditions: their impact in US adults' activity levels and use of medical services. *American Journal of Public Health*, *85*, 173–182.

Von dem Knesebeck, O., Luschen, G., Cockerham, W. C., & Siegrist, J. (2003). Socioeconomic status and health among

the aged in the United States and Germany: a comparative cross-sectional study. *Social Science & Medicine*, *57*, 1643–1652.

Woo, J., Ho, S. C., & Yu, A. L. M. (2000). The influence of income on morbidity, mortality and dependency in elderly Hong Kong Chinese. *Archives of Gerontology and Geriatrics*, *30*, 55–61.

Yip, P. S. F., Lee, J., Chan, B., & Au, J. (2001). A study of demographic changes under sustained below-replacement fertility in Hong Kong SAR. *Social Science & Medicine*, *53*, 1003–1009.

Zimmer, Z., & Amornsirisomboon, P. (2001). Socioeconomic status and health among older adults in Thailand: an examination using multiple indicators. *Social Science & Medicine*, *52*, 1297–1311.

Zimmer, Z., Chayovan, N., Lin, H. -S., & Natividad, J. (2003). *How indicators of socioeconomic status relate to physical functioning of older adults in three Asian societies*. Working papers (No. 172), Policy Research Division, Population Council.

Zimmer, Z., & Kwong, J. (2004). Socioeconomic status and health among older adults in rural and urban China. *Journal of Aging and Health*, *16*, 44–70.

Zyzanski, S. J., Medalie, J. H., Ford, A. B., & Grava-Gubins, I. (1989). Living arrangements and well-being of the elderly. *Family Medicine*, *21*, 199–205.