Exploring Risk Factors for Retirement Mortality

Hyuk-Sung Kwon
Department of Statistical and Actuarial Sciences
University of Western Ontario
London, Ontario N6A 5B7

Abstract

Brown and McDaid (2003) found that there are several key factors that affect retirement mortality. When dealing with the mortality for a specific age group, we should understand how each factor affects the mortality and also how those factors are related to each other. In this paper, how various factors affect the mortality of the older age group will be investigated. It is found that the effect is often different for older ages than for younger ages. The method to develop actuarial models that take into account the factors we have considered will be discussed.

1　Introduction

The motivation and necessity of a more sophisticated mortality model is well addressed in Factors Affecting Retirement Mortality (Brown, 2003). The paper identified and discussed 13 risk factors affecting retirement mortality. The motivation of developing a mortality model can be described by the changing environment. As medical science develops, human life expectancy has been increasing and the proportion of elderly in the population is exploding. Elderly people are getting more concerned about their retirement income due to extended life expectancy. If annuitization of retirement income becomes more popular, fair valuation of annuities will be very important and mortality assumptions will be important as well. Also, insurance products are getting more complicated covering various diseases. That needs more complex mortality and morbidity models for actuarial valuation. Since many factors affecting mortality and morbidity have been found by previous studies, we can construct various risk classes in a mortality model. This will allow us to evaluate the proper liability so that we can manage the mortality risk.

2　Factors Affecting Mortality

Many kinds of risk factors have been identified as significant predictors of mortality and morbidity. We can classify those factors into several groups as follows.

1. Socio-Economic/Demographic factors

   - Age
   - Gender
   - Education
   - Occupation
   - Ethnicity
   - Religion
   - Marital Status

2. Behavioral risk factors

   - Smoking Status
   - Alcohol Intake

- Dietary habit
- physical activity

3. Health Parameters

- Blood Pressure
- Blood Sugar Level
- Obesity
- Cholesterol Level
- Physical Fitness

The basic mechanism of mortality or morbidity can be explained by interactions among groups of risk factors. The socio-economic factors mainly affect the behavioral risk factors. Also, the behavioral risk factors make differences in health parameters. For instance, there is a gender difference for some health parameters. The behavioral risk factors influence the health parameters and vice versa. Finally, the health parameters indicate the status of health for each individual. What makes it difficult to model mortality and morbidity using those risk factors is that several factors are confounding. If we contain all of those confounders in a model, the model tends to be no longer significant because of parameter redundancy. We need to consider parsimony in our model as well. Therefore, all of the variables can not simply be included in the mortality model before considering confounders. In this paper, some risk factors that have important characteristics will be discussed. The effects of risk factors on mortality will be focused on the elderly population.

3 Discussion of risk factors

Among the risk factors introduced in the previous section, there are some factors that need to be handled with care. Several important characteristics were investigated. Those characteristics are so important that they should be considered in a mortality or morbidity model. In this section, the factors which have many important characteristics will be discussed.

3.1 Socio-Economic status

Socio-economic status(SES) can be represented by income, education and occupation. These three variables are highly correlated with each other, as expected. Generally, high SES is associated with low mortality. However, the effect is weaker for the elderly population than for middle aged adults. Because the behavioral risk factors and the health parameters mediate the relation between SES and mortality, it has been suggested that the effect of SES on mortality can be eliminated by precisely determined health variables. (Bassuk, 2002). In order to do that, the difference of the behavioral risk factors and the health parameters among different SES groups needs to be verified. Although each factor is a significant predictor of mortality, if we include all of those three variables in a mortality model, the effect is insignificant due to the correlation among them. Out of many socio-economic factors, income turned to be the strongest single predictor from previous health research. However, in order for income to represent SES for the elderly population by itself, a more balanced wealth measure is needed to explain retirement income which structure is different from that of middle aged adults. Also, many papers dealing with SES found that the effect is stronger for men than women. It has been found that there is some relation between SES and self-related health. (Salas, 2000) This finding is related to some extent to the relation between SES and health behaviors.

3.2 Smoking status

Smoking is a well known risk factor that mainly causes specific diseases. Usually, smoking is a risk factor of cardiovascular disease for younger adults and a risk factor of cancer for elderly people. Also, smoking accelerates the bad effect of heavy drinking. Because there is a correlation between smoking and drinking, those two behavioral risk factors are considered confounding variables. Blood pressure is affected by smoking status. It should be remarked that smoking habit is different by gender. Therefore, when smoking habit is explored with longitudinal data to investigate the long term effect of smoking, gender differences should be reflected in a mortality or morbidity model. There are some interesting findings about the effect of reducing or stopping smoking. Godtfredsen (2002) found that the benefit

of reducing smoking is not significant and Tessier (2000) got a result that cessation of smoking for 20 years can reduce the mortality rate to non-smoker level. These findings suggest that previous smoking habits should be taken into account in a mortality model.

3.3 Alcohol intake

Alcohol intake is another significant behavioral risk factor. Much previous research found a U or J shaped relation between the amount of alcohol intake and mortality, which is identical for all old ages (Gronbaek, 1998). Usually, alcohol drinking increases blood pressure. However, it has been found that moderate alcohol intake provides some benefit, increasing HDL cholesterol. By the way, there are two main difficulties in handling alcohol intake as a variable to be included in a model. One is that the capacity to take alcohol is different for each person mainly depending on heredity. Therefore, the appropriate boundaries of moderate intake and heavy drinking need to be defined. The other thing is that drinking habits change over time. This might be affected by health status. Because the benefit of moderate intake may come from a long drinking habit, the relation between drinking habit over time and mortality should be explored. Klatsky (1992) found that the effect of heavy drinking is stronger for women than men. This needs to be verified with more research.

3.4 Obesity

Obesity is one of the important health indicators. Although, there is a positive correlation between obesity and mortality for the middle aged population, the results from several papers agree that thin people have much higher mortality than normal or obese population in older adults. (Grabowski, 2002) This can be explained by the fact that thin people in older age are likely to suffer from diseases, frailty or malnutrition because of poverty. The obesity is usually measured by body mass index (BMI) and BMI can be categorized by some criteria. The one thing that needs to be considered is that the variability of obesity is different by gender, which implies that the boundaries defining thin and obese person may be different for each gender. What is well known is that obese persons are likely to get adult diseases such as hypertension and diabetes. Because obesity changes over time, the

relation between changes of BMI and mortality must be investigated. It is found that a poverty indicator can explain to some extent the high mortality of persons with low BMI. It is related to retirement income.

3.5   Blood pressure

Like the relation between obesity and mortality, the effect of blood pressure on mortality is different for different age groups. It has been found that the relation between blood pressure, which is usually measured by the systolic or diastolic blood pressure, and mortality follows a U or J shaped relation for the elderly population. (Taylor, 1991) It may be explained by the fact that frail persons are likely to have low blood pressure. Blood pressure is affected by health behaviors such as smoking, drinking and dietary habit. Also, blood pressure is related to age, gender and heredity. Although blood pressure has been measured by systolic blood pressure, recent studies agree that pulse pressure, which is the difference between systolic and diastolic pressure, is the best single predictor of mortality. In this case, there is a positive correlation between pulse pressure and mortality. Glynn (2000) found that the relation is stronger for ages 65 to 74. Also, Kannel (1997) found that the benefit of medication for high blood pressure is reduced for the elderly population. Blood pressure changes over time gradually with age and is affected by other factors. So, we need to explore the behavior and the difference of mortality among various risk classes.

3.6   Physical fitness

Physical fitness is one of the important health indicators which is more pronounced for older populations. This is usually measured by a maximal exercise test indicating cardiorespiratory fitness. Cardiorespiratory fitness is a very important health measure for the elderly population because the variability of fitness is much larger than that for middle aged adults. Blair (1989) found that there is a strong negative correlation between cardiorespiratory fitness and overall mortality and cause specific mortality. Also, he found that the relation between them is consistent for men and women. Physical fitness is affected by the history of the health behaviors of each individual. One of the key factors to maintain a desirable fitness level is regular exercise and

avoiding a sedentary lifestyle.

4 Future research

As discussed, the relations among risk factors are very complicated. The first thing that should be done before constructing a mortality and morbidity model is to explore the method to handle confounding variables. After that, we can select the factors to be included in the models. Also, there are many factors that change over time. The behavior of those factors should be investigated using longitudinal data. To reflect the dynamics of risk factors, the Markov chain will be utilized. That will allow us to set mortality and morbidity models which include various risk classes and to apply the model to many kinds of insurance products, annuities and pension plans.

References

Brown, R.L. and McDaid, J. (2003). Factors Affecting Retirement Mortality, *North American Actuarial Journal*, Vol 7, No 2, 24-43.

Bassuk, S.S., Berkman, L.F. and Amick III, B.C. (2002). Socioeconomic Status and Mortality among the Elderly: Findings from Four US Communities, *American Journal of Epidemiology*, 155:520-533.

Salas, C. (2002). On the empirical association between poor health and low socioeconomic status at old age, *Health Economics*, 11:207-220.

Godtfredsen, N.S., Holst, C., Prescott, E., Vestbo, J. and Osler, M. (2002). Smoking Reduction, Smoking Cessation, and Mortality: A 16-year Follow-up of 19,732 Men and Women from the Copenhagen Centre for Prospective Population Studies, *American Journal of Epidemiology*, 156:994-1001.

Tessier, J.F., Nejjari, C., Letenneur, L., Barberger-Gateau, P., Dartigues, J.F. and Salamon, R. (2000). Smoking and eight-year mortality in an elderly cohort, *International Journal of Tuberculosis and Lung Disease*, 4:698-704.

Gronbaek, M., Deis, A., Becker, U., Hein, H.O., Schnohr, P., Jensen, G., Borch-Johnsen, K. and Sorensen, T.I.A. (1998). Alcohol and mortality: Is there a U-Shaped relation in elderly people?, *Age and Ageing*, 27:739-744.

Klatsky, A.L., Armstron, M.A. and Friedman, G.D. (1992). Alcohol and Mortality, *Annals of Internal Medicine*, 117:646-654.

Grabowski, D.C. and Ellis, J.E. (2001). High Body Mass Index Does Not Predict Mortality in Older People: Analysis of the Longitudinal Study of Aging, *Journal of The American Geriatric Society*, 49:968-979.

Taylor, J.O., Cornoni-Huntley, J., Curb, J.D., Manton, K.G., Ostfeld, A.M., Scherr, P. and Wallace, R.B. (1991). Blood Pressure

and Mortality Risk in the Elderly, *American Journal of Epidemiology*, 134:489-501.

Glynn, R.J., Chae, C.U., Guralnik J.M., Taylor, J.O. and Hennekens, C.H. (2000). Pulse Pressure and Mortality in Older People, *Archives of Internal Medicine*, 160:2765-2772.

Kannel, W.B., D'Agostino, R.B. and Silbershatz, H. (1997). Blood pressure and cardiovascular morbidity and mortality rates in the elderly, *American Heart Journal*, 134:758-763.

Blair, S.N., Kohl III, H.W., Paffenbarger, Jr, R.S., Clark, D.G., Cooper, K.H. and Gibbons, L.W. (1989). Physical Fitness and All-Cause Mortality: A Prospective Study of Health Men and Women, *Journal of the American Medical Association*, 262:2395-2401.