Modeling Disability Trajectories among the Oldest Old in China

by

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SHORT ABSTRACT

The purpose of the paper is to identify and describe common disability and mortality trajectories among the oldest-old in China and assess the extent to which these trajectories are associated with socio-demographic characteristics. Data come from the Chinese Longitudinal Healthy Longevity Survey, which was conducted in 22 of 34 Chinese provinces. A total of about 9,000 individuals aged 80 and older were interviewed in 1998, and survivors were followed up in 2000, 2002, and 2005. Mortality was recorded for non-survivors. The key outcome variable consists of a count of the number of the following activities of daily living (ADLs) that the respondent is unable to do without assistance: bathing, moving inside the house, eating, dressing, using the toilet. A semi-parametric finite-mixture model is used to determine typical trajectories in number of limitations. Mortality is modeled simultaneously. Covariates from the following domains—demographic, socioeconomic, social network, health behaviors, chronic conditions – are employed to determine characteristics of those who fall into trajectory groups. Preliminary results indicate there are three basic trajectories. The 'healthy' trajectory group describes individuals remaining fairly disability-free over time. A 'developing' group begins at age 80 with few or no limitations, but number of limitations grows as they age. A 'high' trajectory group already has disabilities at age 80 and the number increases as they age. Women, more than men, are likely to be in the 'developing' and the 'high' disability group. Further analyses will examine additional covariates and how drop-out due to mortality associates with trajectories.

EXTENDED ABSTRACT

Introduction

Because disability among older adults is a highly dynamic process, researchers face considerable challenges in ascertaining, summarizing, and modeling the multi-directional changes in disability that older people experience. Nevertheless, results of such efforts may be of considerable value in tailoring policies and programs that prevent the onset and progression of disability and facilitate recovery. The need for such analysis is particularly critical in China. Disability, which represents a gap between the capacities of individuals to complete tasks and the environments in which they live and work, increases significantly with age and is associated with formal and informal health care needs. Nearly every population around the world is experiencing population aging, but as a consequence of dramatic decreases in both fertility and mortality in the last half of the 20th century, China is among the populations aging most rapidly. The swiftness of demographic change in China necessitates an understanding of the health dynamics of older adults and their potential demands on the healthcare system.

The increase in the number of older people who are at risk of disability in China has resulted in some interest in estimating rates of disability and "disability-free" or "active" life expectancy (Kaneda, Zimmer, and Tang 2005; Zeng et al. 2001). Although such analyses have been valuable for assessing population-wide levels, they have not captured the dynamics of disability at the individual level. Estimates of disability rates and their trends at the macro-level summarize a multitude of individual transitions into and out of disability. Some disability research in China has focused on onset or progression and transitions from different originating states, such as free from or with disability, to various destination states, such as free from or with disability or dead (Beydoun and Popkin 2005; Gu and Zeng 2004; Liang, Liu and Gu 2001). These studies have indicated that over a period of years, and even among the oldest old, besides deterioration, there is stability as well as improvement in disability status, findings that are consistent with those from the United States and other developed countries. Moreover, these transition studies, which focus on one period to the next, have found that changes in disability can be predicted by a number of factors, such as those represented by demographic, socioeconomic, social network, health behavior, and chronic condition domains. These domains will act as controls in a multivariate model in the current analysis.

Method, Data and Measures

Despite progress in the study of disability transitions in China and elsewhere, there are methodological challenges that have limited understanding of disability trajectories, that is, individual pathways over multiple periods. The primary challenge stems from the fact that as the number of periods, possible starting states for each period (e.g., not disabled, mildly disabled, severely disabled), and possible outcomes for each period (e.g., not disabled, mildly disabled, severely disabled, dead) grows, the number of possible individual trajectories multiplies. If particular tasks (e.g., bathing, dressing) beyond a summary measure of disability are considered, the size of the enterprise increases further. Summarizing this information is difficult and only a handful of studies around the world, let alone in China, have attempted to classify trajectories.

Typically, these studies of trajectories have adopted one of two types of strategies. The first, and most popular, involves subjective categorization of pathway types. The second involves some form of growth-curve modeling, such as hierarchical modeling or latent curve analysis. For a variety of reasons, neither of these strategies is ideal (Nagin, 2005). Subjective categorization means that patterns are often established *a priori,* and resultant typologies may over- or under- fit the data. Moreover, there is no easy test for affirming the actual existence of

each subjectively determined group or for assessing the probability of group membership. Indeed, subjective categorization may be due to random variation and there is little basis for calibrating the underlying precision of classification decisions. Growth-curve modeling has advantages over subjective categorization with respect to formal testing, but growth models assume that the population distribution of trajectories varies continuously across individuals in a form that can be represented by a multivariate normal distribution. Growth-curve modeling requires that growth be determined by a mean pattern of increase or decline, with deviations from the mean being explained by selected determinants. This assumption does not seem to fit the disability experience, which involves distinctive qualitative groupings that may not be linearly related. Moreover, growth-curve modeling is even less well suited for dealing with mortality than is subjective categorization, since the probability of death is not randomly distributed across disability trajectories.

The method for the current study attempts to provide a practical solution to the challenges of trajectory modeling by building on a group-based approach that has been used in developmental psychology for monitoring deviant and aggressive adolescent behavior (Nagin and Tremblay 2001;Nagin, 1999, 2005). The procedure uses a semi-parametric finite-mixture model to identify a parsimonious number of trajectory shapes, estimate the probabilities of membership in each group, and create profiles of individuals following a particular trajectory. Co-authors of this paper, Nagin and Jones, developed the SAS procedure, called PROC TRAJ, which implements this approach (Jones, Nagin and Roeder 2001; Nagin and Jones, 2007). Moreover, they have recently developed an enhancement that allows for the simultaneous modeling of dropping out (in our case, mortality), and we will be testing a beta version of the new routine in this paper. Our analysis will begin by describing disability transitions and mortality from one survey wave to another. We will then use the grouped-based modeling approach to identify common disability and mortality trajectories by age for males and females and estimate the probability of membership in the trajectories. The prediction of counts of disabilities by age will be estimated using a censored-normal equation, and inferences on trajectory grouping will be determined using Bayesian Information Criterion. The final analytical step will involve multinomial modeling to link trajectory membership to a variety of covariates described below.

Data are from the Chinese Longitudinal Healthy Longevity Survey (CLHLS) (Zeng et al. 2001). The survey covered 22 provinces, which together constitute 85 percent of the Chinese population. It is by far the most extensive longitudinal dataset available for analyzing disability among older adults in China. The sample includes 8,805 individuals that were aged 80 to 105 at the 1998 baseline. The great majority of these individuals were either interviewed again or identified as deceased in 2000 (90.4%), 2002 (83.9%), and 2005 (80.8%). Our analysis is based on participants from the baseline survey that responded to a later wave or died.

A count of the number of disabilities at each survey wave is the measure used to determine trajectory grouping. We define a disability as being unable without assistance to do any one of the following activities mentioned in the CLHLS: eating, dressing, bathing, getting up from bed, and using the toilet. Covariates that will be considered as predictors of trajectory groupings may be static or time varying (e.g., marital status). They fall in the following domains: demographic (e.g., marital status and rural/urban residence); socioeconomic (e.g., education and occupation); social network (e.g., family size and satisfaction with relationships); health behaviors (e.g., smoking and alcohol consumption); and chronic conditions (e.g., cardiovascular disease and arthritis).

Preliminary Results

Preliminary results that combine both sexes indicate a three-group solution best fits the data. Table 1 shows the censored normal parameter estimates for these three groups, and Figure 1 uses the estimates to plot the predicted number of ADL limitations by age for

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individuals aged 80 to 100. Groups 1 and 2 are best described with a linear and a quadratic term. A quadratic term was tested but was not significant for Group 3 and thus was omitted. The quadratic terms for Groups 1 and 2 are negative, indicating a de-acceleration in the positive slope of number of ADL limitations with increasing age. In contrast, the slope is continually positive with age for Group 3.

Group 1, into which about 43% of the population falls, is a 'healthy' group. These individuals have no disability until they are extremely old, after which some develop no more than a single ADL limitation. Group 2, which also contains about 43% of the population, is a 'developing' disability group. Individuals falling into this group are disability free at age 80 but develop a small number of ADL limitations as they age. This group is predicted to have one limitation by about age 88 and two by about age 98. Group 3 is a 'high' disability group and contains about 14% of the population. This group is characterized by a number of disabilities at age 80, which increases quite rapidly over time.

Table 1 also indicates the estimates for the impact of being female on trajectory membership. These coefficients indicate the log-odds of being in the group versus the baseline (which is designated as Group 1) when X=1, which in this case means female. The coefficients for both Groups 2 and 3 are positive, indicating that females are more likely to fall into Groups 2 and 3 in contrast to Group 1. Males, on the contrary, are less likely to be in Groups 2 and 3. For instance, a coefficient of .637 for Group 2 means that females are $e^{.637}$ or 1.89 times as likely to be in Group 2 versus Group 1 (95% CI: 1.40, 2.56). Females are therefore more likely to be characterized by developing and rising disabilities, while males are more likely to be in the group that is characterized as disability-free.

Further Analysis and Conclusion

Our further analysis will introduce a multinomial model that will include a series of additional covariates to better explain and predict what type of characteristics are typical of those in the three groups. In addition, the results shown here include adjustments for mortality. Our further analysis will examine how mortality relates across the three groups. The conclusion will focus on the implications of the results for population aging in China and on the efficacy of the group-based modeling approach for assessing disability trajectories.

Table 1: Maximum Likelihood Estimates for Trajectories Using a Censored Normal Distribution (standard errors in parentheses)

	Group 1	Group 2	Group 3
Intercept	-4.155 (.650)	0.812 (.298)	4.829 (1.060)
Linear term	6.645 (1.679)	2.994 (.322)	3.629 (.738)
Quadratic term	-3.260 (1.437)	-2.034 (.509)	na
Sex (1=female)	---	0.637 (.154)	0.413 (.163)
% in group	43.1	43.0	13.9

σ = 3.218 (.110)
BIC = - 29.301.2

Figure 1: Predicted ADL count by age for three trajectory groups
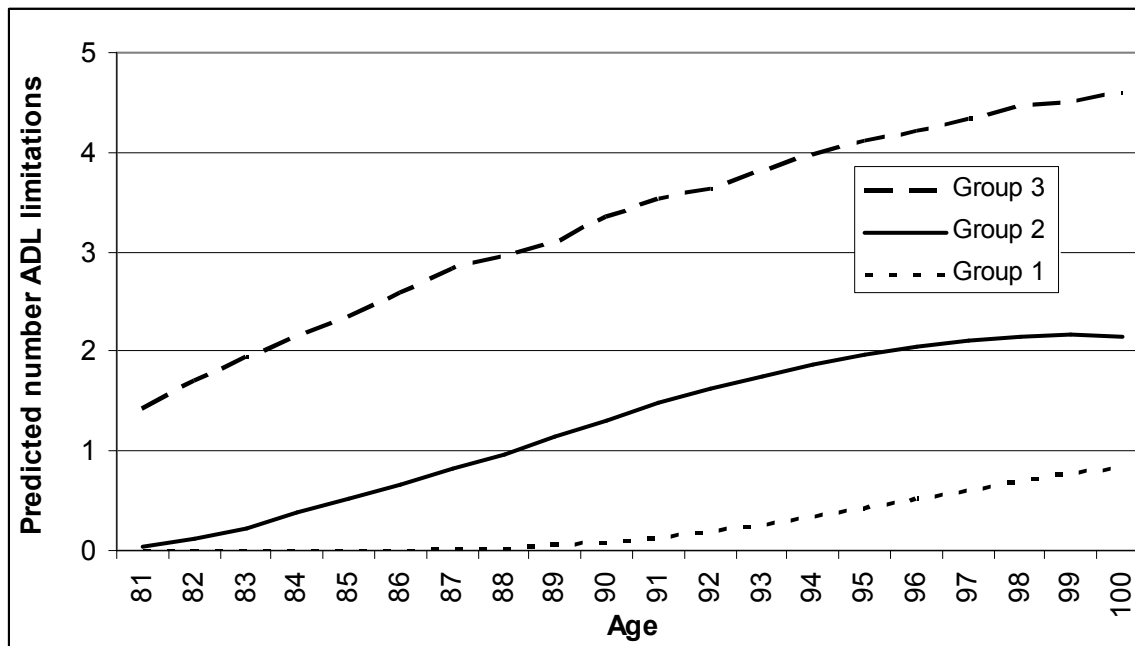
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