

An Alternative Index of Population Aging: Accounting for Education and Elderly Health in the Case of Korea*

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In this study, I propose an alternative index of population aging that accounts for education and elderly health using Korean data. Population aging is a worldwide phenomenon, and most industrialized countries are concerned about its consequences, such as the increasing burdens associated with the provision of elderly support. Most discussion is based on measures that solely consider the age structure of the population. The current study is based on the characteristics approach to population aging, which accounts for changing population composition as well as age structure. In particular, I attempt to propose an alternative index of population aging that accounts for improvements in education and elderly health. Analyses show that the alternative index grows more slowly than the conventional Old Age Dependency Ratio (OADR). Accounting for education and elderly health yields a less gloomy picture for the future. Finally, I discuss policy implications and further development of the new index.

Keywords: population aging, development, elderly health, education, Korea

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Introduction

I propose an alternative aging index that accounts for changes in educational attainment and elderly health using Korean data. Population aging is a worldwide phenomenon, and most studies focus on describing the socioeconomic burdens associated with it and developing policy measures to lessen its consequences. According to Goldstein (2009), the median age of the world population was 26.7 in 2000 and is expected to increase to 38.1 in 2050. Such rapid population aging would entail a disproportionate increase of the elderly compared with working-age people, and concerns about the consequences of such an increase have been rising in most industrialized societies. These countries have directed their energy toward slowing down population aging and/or devising policies to cope with it (Kalwij 2010; McDonald 2002). The Old-Age Dependency Ratio (OADR), namely, the ratio of population aged 65+ to population aged between 15 and 64, has been widely used to illustrate the burdens of population aging. This makes sense because age is arguably the most important characteristic that determines the productivity of individuals, and age structure in a given society should be informative to show societal burdens associated with population aging. In addition, because the low fertility in Korea during the past decades should have a long-lasting impact on age structure due to population momentum (Whang and Choi 2015), concerns about changing age structure are highly relevant. The sole focus on the age structure of the population, however, omits an important aspect of population aging, namely, socioeconomic development that potentially mitigates the negative consequences of population aging. Recently, research in population aging has developed indices for population aging by accounting for other characteristics such as education and health in addition to chronological age, which is called “the characteristics approach” (Sanderson and Scherbov 2013). The current study aims at contributing to this approach by proposing an alternative index of population aging that accounts for education and elderly health.

Population aging proceeds along with other socioeconomic changes, such as improvements in educational attainment and elderly health, all of which have important implications for the consequences of population aging (Lee and Mason 2010). First, improvement in education should increase the capacity of the population to support the elderly. Compared with societies with low levels of individual educational attainment, societies composed of highly educated individuals are likely to have a better capacity to support

their elderly. Societies of the latter type would be economically better off and able to allocate more resources to elderly support. Given that population aging proceeds in tandem with educational expansion, using the OADR as a sole measure of population aging to assess its consequences may exaggerate the socioeconomic burdens. Second, population aging also progresses with improvement in elderly health. Studies have shown that increasing life expectancy is also associated with increasing healthy life expectancy. In other words, people live in better health conditions as well as live longer.¹ Such an improvement in health would reduce the socioeconomic burdens associated with population aging because the healthy elderly would be more independent compared to the sick elderly. Once again, a conventional OADR does not incorporate this change and is likely to exaggerate the burdens of population aging. The current study attempts to develop an alternative index of population aging that accounts for improvements in educational attainment and elderly health using data pertaining to Korea, which is experiencing extremely rapid population aging. In doing so, this study will contribute to the literature on population aging and help develop appropriate policy measures to cope with it. This paper is organized in the following order. The next section briefly reviews the characteristics approach to population aging on which the current study is based. Then, I discuss why education and elderly health should be key characteristics taken into account. Based on this discussion, I propose an alternative index of population aging, “Education–Health Adjusted Old-Age Dependency Ratio (EHA-OADR),” and discuss its properties. Then, I present the estimates of EHA-OADRs using Korean data, compare them with the conventional OADR, and discuss implications of using the new measures.

Characteristic approach to measuring population aging: Accounting for population heterogeneity other than chronological age

Age has been the most important variable in demographic research because demographic processes (e.g., fertility, mortality, and migration) greatly differ

¹ According to Howse (2006), rising life expectancy may be related with rising healthy life expectancy (dynamic equilibrium hypothesis) or halting healthy life expectancy (expansion hypothesis). While these competing hypotheses are subject to empirical testing, dynamic equilibrium hypothesis is likely to be the most appropriate, given the recent trends in rising healthy life expectancy.

by age, and also, population growth is dependent on age structure. Age is also an important determinant of an individual's economic productivity, and age structure has crucial implications for economic development. The discussion about "population bonus or onus" is based on this fact (Bloom, Canning, and Sevilla 2003). In this sense, demographic research is based on the assumption that age is a key characteristic to determine population heterogeneity. Research in population aging shares this assumption and measures the degree of population aging using the OADR and the median age of population. This conventional approach, however, encounters an important challenge; the meaning of chronological age changes as longevity increases. For example, a 60-year-old person in 1970 differs from a 60-year-old person in 2010 in terms of many life conditions, including health and economic resources. Because the conventional measures of population aging cannot account for the changing meaning of chronological age, recent research has proposed alternative indices of population aging by considering characteristics other than chronological age to explain population heterogeneity. There are two distinctive approaches to address this issue.

First, one type of research relies on prospective age instead of chronological or retrospective age. Conventional measures of population aging are based on chronological age. This is a retrospective age because it measures how long a person has lived since birth. As mentioned before, chronological age matters greatly for demographic and socioeconomic behaviors. However, comparison of conventional aging indices based on chronological age over time or across countries may not be very informative because the meaning of chronological or retrospective age is changing. In other words, retrospective age loses its merit as a key characteristic to determine population heterogeneity. To overcome this limitation, several alternative indices based on prospective age or remaining life expectancy, such as Proportion Remaining Life Expectancy 15- (*Prop. RLE 15-*), Prospective Median Age (*PMA*), and Population Average Remaining Life Expectancy (*PARYL*), have been proposed.² In contrast to the conventional indices, these new ones estimate how long a person will live to measure age, which is prospective. In this approach, prospective age is a characteristic to account for population heterogeneity. These new measures are a substantial improvement over the conventional aging indices because the remaining life time or prospective age is arguably easier to compare over time as chronological age loses its merits. Aging indices based on prospective age

² Please see Lutz et al. (2008) and Sanderson and Scherbov (2013) for details.

show much slower increasing trends than the conventional ones (Sanderson and Scherbov 2013). This diverging trend illustrates that chronological age is limited in describing trends in population aging.

Another approach directly introduces population heterogeneity in constructing indices for population aging. Using data from Scandinavian countries, several studies show that the size of the elderly population with serious illness is likely to decrease substantially in the future because of improvement in educational attainment among the elderly (Batljan, Lagergren, and Thorslund 2009; Batljan and Thorslund 2009; Joung et al. 2000; Lutz 2009). When ignoring the association between education and likelihood of experiencing bad health, the size of the elderly with serious illness is projected to increase enormously because the relative size of the oldest-old will increase as life expectancy is ever increasing. However, this projection may not capture the likely trends because elderly health will improve over time given the improvement in elderly education. When accounting for the improvement in educational attainment among the elderly, the projected trends are radically different; the number of the elderly with serious illnesses is projected to decrease instead. Skirbekk et al. (2012) also shows that societal ranking of the degree of population aging differs when accounting for cognitive ability among the elderly. For example, while India's age structure is much younger than that of the United States, the order is reversed in terms of the relative size of the cognitively unhealthy elderly to working-age people. Sanderson and Scherbov (2010) also propose an index that adjusts for adult disability, and reach a similar conclusion. These studies emphasize the fact that population aging proceeds with improvement in health among the elderly. Both cross-national and cross-temporal comparisons show that accounting for improvement in elderly health yields a different outlook than analyses based solely on the age structure of the population.

Recently, Kye et al. (2014) expanded this approach by accounting for changes in the configuration of the offspring's generation, who are supposed to support the elderly. In addition to improvement in elderly health, improvement in offspring's educational attainment is likely to offset the negative societal implications of population aging. When we consider the elderly support system, we should account for four elements: the size of the elderly, the composition of the elderly, the size of the working-age population and the composition of that population. The conventional OADR considers the relative sizes but not the compositional aspects. The studies discussed in the previous paragraph add another aspect, namely, health composition of

the elderly. However, none of studies account for the composition of working-age people. This omission is unfortunate because the last element is necessary for the complete description of elderly support or dependency structure. By applying a demographic model that accounts for assortative mating, differential fertility and intergenerational mobility, Kye et al. (2014) showed that improvement in the offspring generation's education in addition to improvement in elderly health can mitigate to some degree the negative implications of population aging. The current study expands Kye et al.'s (2014) research in two respects. First, Kye et al.'s (2014) measures are not directly comparable with the conventional OADR. They use Generational Support Ratios (GSRs), that is, the ratios of the number of offspring to elderly parents. The numerator (size of the offspring population) includes the elderly as well as working-age people (e.g., a 70-year old whose parents are 90-year olds). Consequently, although informative, the measures are not directly comparable with the OADR. Second, they apply a complex demographic model that requires detailed individual-level variables such as respondent's education, spouse's education, number of children, children's education, and health. Hence, cross-national or cross-temporal comparison based on these measures may be difficult. As discussed below, the current study uses relatively simple information available from census aggregate data and repeated cross-sectional data. Furthermore, the proposed measure can be directly comparable with the conventional OADR.

Why education and elderly health?

A key proposition advanced in the current study is that we should consider improvements in education and elderly health when developing population aging indices. I assume that education and health are key sources of population heterogeneity and indicators of socioeconomic development. Hence, the usefulness of the proposed index depends on the validity of this assumption. To evaluate its validity, we need to consider three criteria: relevance, differential reproduction rates, and feasibility (Lutz et al. 1998).

First, education and health are relevant because education and elderly health represent capacity and burdens, respectively. I assume that working-age people who are better educated will provide the elderly with more support than their less educated counterparts. At the individual/family level, within-education variation may be fairly large, questioning this assumption. However, it should be safe to assume that societies composed of better-

educated individuals possess more resources for allocation toward elderly support than those with less-educated individuals.³ In fact, Lee and Mason (2011) show that improvement in educational attainment can offset negative consequences of population aging by improving societal capacity to provide upward generational transfer for elderly support. Studies on optimal fertility also show that below-replacement level fertility may be optimal for sustainable development because improvement in human capital can offset the reduction in the relative size of working-age people (Lutz, Sanderson, and Scherbov 2004; Lutz, Butz, and KC 2014; Striessnig and Lutz 2014). It is reasonable to assume that the level of education among working-age people is a good indicator of societal capacity for elderly support provision. Hence, accounting for education is necessary to develop the aging index. I also assume that the unhealthy elderly are more burdensome than the healthy elderly. Studies show that worker's productivity decreases with aging due to health deterioration (Robertson and Tracy 1998), and subjective well-being among the elderly is highly correlated with functional limitations (Iwarsson and Isacson 1997). This empirical evidence suggests that deterioration of health hinders independent life among the elderly. Hence, it is reasonable to assume that the level of elderly health is a good indicator of the societal burden for elderly support provision. In this sense, education and health are relevant to develop population aging indices.

Education and elderly health also represent the degree of socioeconomic development. Education is a key dimension of human capital, and improvement in educational attainment is conducive to economic development. For example, Lee (2008) examines the accumulation of human capital in terms of education and economic development in Korea and concludes that these two elements were closely related with each other during the rapid economic development experienced by Korea since the 1960s. A comparative study also suggests that the rapid educational expansion in Korea is largely responsible for its unprecedented economic development (Lee and Francisco 2012). In this sense, it is reasonable to assume that improvement in educational attainment captures socioeconomic development fairly well. The relationship between health and economic development has been also extensively examined. Differences in aggregate-level health are partly responsible for cross-national disparity in income (Weil 2007), and improvement in health fostered rapid economic development

³ At the individual level, we also have evidence that children's education is positively associated with parental health and survival (Friedman and Mare 2014; Zimmer et al. 2002).

during the era of industrialization (Arora 2001). In this sense, using health as an indicator for socioeconomic development appears to be relevant.

Second, I consider differential rates, in the sense that demographic reproduction rates should differ across different categories of added dimensions. This criterion is especially important for population projection. For example, accounting for education would not be crucial in population projection if there were no educational differentials in mortality and fertility. Of course, education satisfies this criterion, given the evidence for educational differentials in fertility and mortality (Bongaarts 2003; Elo and Preston 1996). Health is also closely related with mortality.

Third, we need to consider the empirical feasibility of adding the new dimensions. Feasibility refers to data availability. While some measures are relevant and demographic behaviors are dependent on them, data on these measures may not be widely available. For example, intelligence may satisfy the above two requirements (Preston and Campbell 1993), but fail on this criterion. However, data on education levels are mostly collected in censuses or large-scale surveys. Many large-scale surveys also collect data on health measures. Hence, using education and health as new dimensions is feasible.

The above discussion suggests that education and elderly health largely satisfy the three criteria suggested by Lutz et al. (1998). Despite the adequacy of education and elderly health as indicators of capacity and burden for elderly support provision respectively, other indices may be equivalently valid. One strong candidate is a measure of economic resources such as income, asset, and poverty. If a reliable economic measure is available, it may be equally desirable or better to use it instead because it captures capacity and burden more directly. I choose to use education and elderly health instead of economic resources for practical reasons. Income is much more volatile than education and health, and measuring income requires richer information, which the current data do not contain. This means that income may fail the third criterion (*feasibility*) to some extent. Thus, depending on data availability, it would be desirable to construct an alternative index of population aging based on direct measures of economic resources in the future.

Methods

The current study proposes an index of population aging that accounts for elderly health and educational attainment of working-age people. I call this

new index Education–Health Adjusted Old-Age Dependency Ratio (EHA-OADR). The EHA-OADR accounts for population composition in terms of working-age people’s educational attainment and elderly health. The key advantage of the EHA-OADR over the conventional OADR is that the former can incorporate changing educational attainment and elderly health in the population as well as changes in age structure. I compare the trends of the new measures with that of the conventional OADR. The two trends are supposed to differ from each other given the improvements in educational attainment and health. This comparison will provide better grounds for assessing the societal burdens associated with population aging than relying solely on the conventional OADR. I describe the calculation process for each measure in this section.

Old-Age Dependency Ratio (OADR)

OADR is the most widely used index of population aging. It is simply *a ratio of population aged 65+ to population aged 15-64*. The OADR started falling during the demographic transition because early gain in life expectancy largely came from reductions in infant and child mortality (Dyson 2010; Livi-Bacci 2007). As fertility and adult mortality declined, the OADR started increasing. The OADR has been ever increasing in most industrialized countries as a result of persistent below-replacement-level fertility over an extended period and reduction in mortality among the elderly. Societies with higher OADR are supposed to be more concerned about socioeconomic burdens of population aging than those with lower OADR because old people are assumed to be dependent on working-age people. As discussed previously, this interpretation may be misleading because the OADR does not account for population heterogeneity in terms of education and elderly health.

Education–Health Adjusted Old Age Dependency Ratio (EHA-OADR)

To account for population heterogeneity in terms of educational attainment and elderly health, the current study proposes an alternative measure, the EHA-OADR. The construction of the EHA-OADR is simple. Here, for simplicity, I classify working-age people and the elderly into two groups: college-educated vs. non-college-educated and the healthy vs. the unhealthy, respectively. Of course, we can use more detailed classifications depending on the research purpose and data availability. Using this classification, we can

compute four EHA-OADRs as follows.

$$OADR_{h_{nc}}: (\text{Healthy, age 65+})/(\text{No college, age 15-64}) \quad (1)$$

$$OADR_{h_c}: (\text{Healthy, age 65+})/(\text{College, age 15-64}) \quad (2)$$

$$OADR_{uh_{nc}}: (\text{Unhealthy, age 65+})/(\text{No college, age 15-64}) \quad (3)$$

$$OADR_{uh_c}: (\text{Unhealthy, age 65+})/(\text{College, age 15-64}) \quad (4)$$

(*h*: healthy, *uh*: unhealthy, *nc*: not college-educated, *c*: college-educated)

Each index measures the number of healthy or unhealthy elderly (age 65+) per working-age people for a given education category. This is distinctive from the conventional OADR because it accounts for educational attainment of working-age people and elderly health. As we know, the OADR in South Korea has been increasing because of declining fertility and rising life expectancy (Statistics Korea 2011). The trend of the EHA-OADR is not clear because of improvements in educational attainment and health. First, educational expansion will decrease $OADR_{uh_{nc}}$ and $OADR_{h_c}$ as the denominator becomes larger. Second, the implication of improvement in health is complicated. Improvement in health is supposed to decrease $OADR_{uh_c}$, but we need to consider increasing longevity due to health improvement. Although the proportion of unhealthy elderly is expected to decrease, leading to a reduction in $OADR_{uh_c}$, the volume of the elderly itself may increase. Because the overall increase in the size of the elderly should increase both $OADR_{uh_c}$ and $OADR_{h_c}$, the trends should be subject to empirical investigation.

The measures proposed above (equations 1-4) are informative to examine population aging, accounting for population heterogeneity in terms of education and health.⁴ However, it is difficult to directly compare these measures with the conventional OADR. Depending on the number of education and health status categories, the number of EHA-OADRs can be numerous, making comparison with the OADR complicated. To facilitate easy comparison, the EHA-OADRs should be combined into one measure, which I call the Weighted Education–Health Adjusted OADR (WEHA-OADR). Algebraically, the WEHA-OADR can be computed using the following formula.

$$WEHA-OADR = (W_{-h} \times E_{-h} + W_{-uh} \times E_{-uh})/$$

⁴ For example, Kye et al. (2014) use the similar measures to examine the implications of educational expansion for population aging in Korea.

$$(W_{-nc} \times WK_{-nc} + W_{-c} \times WK_{-c}) \quad (5)$$

where

E_{-h} : Number of healthy elderly (age 65+),

E_{-uh} : Number of unhealthy elderly (age 65+),

WK_{-nc} : Number of non-college-educated (age 15-64),

WK_{-c} : Number of college-educated (age 15-64),

W_{-h} : Weight assigned to E_{-h} ,

W_{-uh} : Weight assigned to E_{-uh}

W_{-nc} : Weight assigned to WK_{-nc} ,

W_{-c} : Weight assigned to WK_{-c} ,

(where $W_{-h} \leq W_{-uh}$, $W_{-nc} \leq W_{-c}$, $W_{-h} + W_{-uh} = W_{-nc} + W_{-c}$)

Computation of the WEHA-OADR in equation (5) is based on the assumptions that 1) the healthy elderly are less burdensome than the unhealthy and 2) college-educated working-age people provide more elderly support at the societal level ($W_{-h} \leq W_{-uh}$ and $W_{-nc} \leq W_{-c}$, respectively). Here, I want to emphasize that the EHA-OADR and WEHA-OADR speak of socioeconomic burdens at the societal level rather than at the individual or family level. There should be substantial variations in elderly support among families with the same elderly health status and offspring's educational attainment. Some unhealthy elderly are independent of their children because they possess other means of supporting themselves, including savings, pension, and assets, while some healthy elderly are dependent on their offspring because they do not have financial resources other than their children's support. In terms of offspring's educational attainment, college-educated offspring may not provide their elderly parents with more support than the non-college-educated because the former's consumption level may be higher than the latter's. The measures developed here focus on the burdens associated with population aging at the societal level. Societies with a greater number of sick elderly need to allocate more resources to support them than those with a greater number of healthy elderly. Societies with more college-educated working-age people can have more resources to support the elderly than those with fewer college-educated working-age people. If there are no differentials in burdens by elderly health status and support capacity by educational attainment of working-age people ($W_{-h} = W_{-uh}$ and $W_{-nc} = W_{-c}$, respectively), then the WEHA-OADR equals the conventional OADR.

We can think of multiple ways of deciding weights. First, we can use empirical data to estimate weights. Because elderly health and educational attainment of working-age people represent the levels of societal burdens of

the elderly and societal capacity, respectively, we may examine the differentials in health-related expenditure by elderly health conditions and income or tax differentials by educational attainment to compute these weights. Second, we can use hypothetical weights. For example, we may assume that the burdens of unhealthy elderly are 10 percent higher than those of the healthy elderly. Then, we can determine that $W_{-uh} = 1.10$ and $W_{-h} = 1.00$. Similarly, we can determine that $W_{-c} = 1.10$ and $W_{-nc} = 1.00$. This hypothetical computation can tell us how differential burden and capacity by elderly health and education of working-age people change the dependency structure in an aging society. The current study uses the second option to compute weights. Although the first option can provide realistic weights to estimate the WEHA-OADR, I do not follow this strategy due to lack of data. Below, I will discuss the weighting issue in more detail.

Interpretation of EHA-OADRs

We can account for changing population compositions by using the EHA-OADRs because education attainment and health status as well as age structure are reflected in these measures. The interpretation of these new indices, however, warrants some caution. First, the EHA-OADRs measure societal burdens, not individual ones. For example, the $OADR_{uh,c}$ is measuring the relative size of unhealthy elderly to working-age people with college education. Of course, unhealthy elderly are not only dependent on those with college education but also on those with no college education. Hence, the $OADR_{uh,c}$ is not measuring how unhealthy elderly depend on those with college education. Rather, this represents societal burdens associated with population aging by accounting for population composition along with age structure. Hence, it should be interpreted as an aging index accounting for age structure and population composition rather than burdens for specific sub-groups.

Second, the value of EHA-OADRs depends on the relative weight given to each sub-group. For example, the $OADR_{uh,c}$ is constructed by giving weight one to the unhealthy elderly and working-age people with college education while giving weight zero to the healthy elderly and those with no college education. Other EHA-OADRs ($OADR_{uh,nc}$, $OADR_{h,c}$ and $OADR_{h,nc}$) are constructed in the same way. Each EHA-OADR illustrates how population composition matters for population aging. By comparing the trend of the conventional OADR with the EHA-OADRs, we can see the implications of changing population composition for population aging.

However, each EHA-OADR is limited in its ability to assess the full implication because the weight is constructed unrealistically. Of course, healthy elderly also rely on the working-age people, and those with no college education also contribute to elderly support to some extent. The $OADR_{uh,c}$ ignores this basic fact, and is of limited value. The same is the case for the other EHA-OADRs. To overcome, this limitation, we need to develop more realistic weights for sub-groups. This is why I propose the WEHA-OADR. It would be ideal to derive these weights from empirical data such as health expenditure and tax rates. However, this information is not available at this stage of research. In addition, the weights themselves may change over time. For example, return to college education may change over time. Depending on the trend of college premiums, the weight should change. For these reasons, the current study relies on hypothetical sets of weights to construct the WEHA-OADR. The results presented here are illustrative to understand the implications of changing population composition for population aging although they fall short of predicting the future trend realistically.

Third, I measure elderly healthy by subjective health as I will describe in the next section. Although subjective health is known to be a good measure of general health condition, this is by no means the best health measure. It might be problematic to compare subjective health over time or across countries. For example, the discrepancy between subjective health and functional limitation among the Korean elderly is much larger than that in Canada and the United States (Glymour et al. 2010; Kye et al. 2014; Menec, Shooshtari, and Lambert 2007). Nonetheless, subjective health is the only measure that has been repeatedly and consistently measured in Korea. Several repeated surveys asked about more objective measures such as functional limitations and chronic diseases, but questionnaire items were not constant over time. Hence, I use subject health as a measure of elderly health. Hence, the results should be interpreted with caution.

Here, improvement of educational attainment and elderly health are used as indicators of societal development. The measure itself uses the aggregate of individual characteristics: college-educated working-age, non-college-educated working age, healthy elderly, and unhealthy elderly. However, I am using these figures as indicators of societal development that proceeds in tandem with populating aging. First, increase in the proportion of the college-educated improves societal capacity to support the elderly. Although this change may be associated with the technological change that reduces available jobs, this should improve societal capacity to support the elderly. Second, although the healthy elderly may compete for some jobs with

young people, this also implies that they are less dependent. Hence, we should account for the improvement of such independence when discussing the implications of population aging. The proposed measure should be better than the conventional OADR in this regard.

Data

To estimate the EHA-OADRs, we need three sets of data: age distribution, educational attainment among working-age people, and health status among the elderly. Because no single data source contains all this information, I combine multiple data sources. First, we need the number of people (age 15+) in each age group for each period. I use data from official population projections (Statistics Korea 2011). The official projection provides estimates of age distribution between 1960 and 2060 by sex. The Korean population projection uses the adjusted generalized log gamma model for future fertility (Kaneko 2003), the coherent Li and Lee model combined with the logistic model for the oldest old for future mortality (Li and Lee 2005), and model migration schedules for future migration (Wilson 2010).⁵ Second, we need estimates of health status among the elderly (aged 65+). To obtain these estimates, I use the Korean National Health and Nutrition Examination Survey (KNHNES) data for 2001-2011. The KNHNES is a repeated cross-sectional survey that contains various health measures. I use self-rated health as a measure of health because other measures (e.g., functional limitations and chronic diseases) are not comparable across survey years. In the analysis, I dichotomize elderly health status into two categories: good health (very good and good) and bad health (neutral, bad, and very bad). Third, I need data on education distribution among the working-age people. For this, I use the one-percent micro sample of the 2000-2010 Korean census. As I mentioned above, I dichotomize educational attainment into two groups: college-educated vs. non-college-educated.

Projections

All the data described above have direct measurements of relevant variables for the period of 2000-2010. Computation of aging indices is simple for this

⁵ Please see Statistics Korea (2011) for details.

period. Despite rising concerns about population aging in Korea, the current OADR is somewhat manageable and does not pose a great concern. According to Statistics Korea (2011), the OADR in 2010 was 15.2 percent, 5.1 percent points higher than in 2000. While the OADR shows a rapid rise, we are more concerned about the future than the present. In some sense, Korea is still going through the window of “population bonus” while it is heading toward the period of “population onus.” Hence, estimates of the future EHA-OADRs are of more interest than the past and present values. In other words, to evaluate the usefulness of the new aging index, we must project the future EHA-OADRs, for which we need several estimates.

First, we need to estimate the size of the elderly in the future. Using the official population projections for Korea (Statistics Korea 2011), we can obtain the estimates of the elderly in each age group in the future. Next, we need estimates for the proportion of the healthy elderly by age and period, to decide the size of the healthy and unhealthy elderly. To arrive at these estimates, I use the KNHNES data. We can employ multiple ways to obtain these estimates for the future. First, we may compute age-specific proportions of the healthy elderly in the future by simply assuming that its value during 2000-2010 remains constant in the future. This assumption is likely to underestimate the proportion of the healthy elderly in the future, given educational expansion and the association between education and health. For example, people aged 70-74 in 2020 are likely to be healthier than the same age group in 2010 because the former is better educated. Second, we can estimate the education-specific proportion of the healthy elderly in each age group using the KNHNES data for 2001-2011. These estimates can be used to calculate the proportion of the healthy elderly in the future. These estimates should yield a higher proportion of the healthy elderly than the first option because they account for improvement in educational attainment among the elderly. These estimates also appear to be more plausible than the earlier ones. To arrive at these estimates, I classify educational attainment into three categories: 0-6, 7-12, and 13+ years of schooling. Third, we may extrapolate the age-specific proportion of the healthy elderly for the period beyond 2010. Using the KNHNES data for 2001-2011, we may compute the annual rates of changes (probably increases) in the age-specific proportions of the healthy elderly. For example, if the proportion of the healthy elderly aged 70-74 increases by one percentage point in each year between 2001 and 2011, then we may assume that this trend will continue. This can account for the improvement in elderly health in a way. However, the approach does not account for the possibility that there may be some ceiling for elderly health

improvement. Preliminary computation suggests that the linear extrapolation yields an unreasonably high proportion of the healthy elderly in the future. Hence, I exclude this option and use the above two estimates.

We also need estimates of the proportion of college-educated in the future. It is easier to obtain the estimates for old people because educational attainment is determined relatively early in the course of life. Although it is possible for people to enrol in college after their mid-20s, the implications of late college enrolment for the proportion of college-educated after age 25 should be minimal. Hence, I assume that the cohort proportion of the college-educated for people aged 20 and over in 2010 remains constant for the remaining years. However, we do not have direct estimates for those younger than 20 in 2010. For example, the proportion of college-educated aged 15-19 in 2010 should be lower than that aged 20-24 in 2015 because many of them will receive college education between 2010 and 2015. Hence, I assume that the proportion of the college-educated among people younger than 20 in 2010 is the same as that of people aged 20-24 in 2010. There might be educational expansion in the future, making it difficult to estimate realistically the proportion of the college-educated. Nevertheless, I simply assume that the proportion of the college-educated aged 25 and younger in the future remains the same as that in 2010. This is likely to underestimate the proportion of the college-educated in the future, given the rapid educational expansion in Korea. However, the bias would not be substantial because college enrolment rates among young Koreans are already extremely high.⁶

The current study does not consider differential mortality. Obviously, the healthy elderly and college-educated people tend to live longer than the unhealthy elderly and non-college-educated people. Accounting for differential mortality may make EHA-OADRs lower to some extent due to increases in the size of the elderly population on the one hand. On the other hand, this may yield higher estimates due to higher survival chances among the better educated than the less educated. Although it is difficult to predict the direction of the bias due to this omission, the bias should not be great because the implications of educational differentials in mortality for population composition in Korea are not substantial (Kye et al. 2014).

⁶ Another concern is people aged 15-19. Many of them do not graduate from college and are classified as non-college-educated, although most of them would attend college, given the high rates of college enrollment in Korea. In addition, many of them are not economically active. In this sense, exclusion of this group would be desirable. However, I include them in my analysis to make the comparison with the conventional OADR easier.

Results

Observed trends, 2000-2010

Table 1 shows the population size and educational composition of working-age people and the population size and health status composition of the elderly between 2000 and 2010. In terms of population size, the elderly increased much faster than working-age people during this period; while working-age people increased slightly, the elderly increased by almost 50 percent. At the same time, the percent of the college-educated among working-age people increased sharply, from 31 percent to 43 percent. The elderly health condition fluctuated somewhat. The percent of the healthy stagnated between 2000 and 2005 and increased sharply in 2010. Unlike other estimates, the percent of the healthy among the elderly is estimated using the KHNES survey data, the annual sample size of which is about 3,000. Although the sample size is large enough to estimate this simple proportion reliably, it is subject to sampling errors. Hence, this fluctuation may be due to sampling variability. With this reservation, the data show that 1) the percent of elderly people increased much faster than that of working-age people, 2) the educational attainment of working-age people improved, and 3) elderly health improved with some fluctuation.

Table 2 shows the OADR, EHA-OADR, and WEHA-OADR between 2000 and 2010. The first row presents the conventional OADR. The OADR increased from 10.1 elderly per 100 working-age people in 2000 to 15.2 in 2010. Over one decade, the OADR increased by 50 percent. This sharp increase in OADR is the basis for the concerns about rapid population aging. However, this figure does not account for the changing configurations of the elderly and working-age people, as I discussed earlier. The EHA-OADRs,

TABLE 1
SIZES OF WORKING-AGE PEOPLE AND THE ELDERLY, AND PERCENT OF HEALTHY AND COLLEGE-EDUCATED, 2000-2010

		Year		
		2000	2005	2010
Age 15-64	Size (in thousands)	33,702	34,530	35,983
	Percent of college-educated	31.0	38.1	43.4
Age 65+	Size (in thousands)	3,395	4,367	5,452
	Percent of healthy elderly	18.7	17.5	29.5

TABLE 2
TRENDS IN OADR, EHA-OADR, AND WEHA-OADR (PERCENT)

	Year		
	2000	2005	2010
OADR	10.1	12.6	15.2
EHA-OADR			
$OADR_{h_{nc}}$	2.8	3.8	8.3
$OADR_{h_c}$	5.8	5.6	10.0
$OADR_{uh_{nc}}$	12.1	17.3	19.5
$OADR_{uh_c}$	25.4	26.0	23.4
WEHA-OADR			
5 percent weight	9.8	12.3	14.6
10 percent weight	9.6	11.9	14.1
20 percent weight	9.1	11.3	13.1
30 percent weight	8.7	10.7	12.1

presented below, tell a somewhat different story. While there were 25.4 unhealthy elderly per 100 college-educated working-age people in 2000, this number somewhat decreased to 23.4 in 2010. Presumably, the unhealthy elderly need more societal support than the healthy elderly, and college-educated people tend to contribute to societal elderly support more than those who have not received a college education. Hence, the stagnation of $OADR_{uh_c}$ suggests that these compositional changes may offset the increasing burdens associated with population aging indicated by the trend in the OADR.

While the EHA-OADRs are informative, these results cannot be directly compared with the conventional OADR because each EHA-OADR does not account for the entire population. The WEHA-OADR can serve this purpose. In Table 2, I also present four sets of WEHA-OADRs using different hypothetical weights. A five-percent weight indicates that the unhealthy elderly are five percent more burdensome than the healthy elderly, and college-educated working-age people provide society with more elderly support by five percent. Ten-, twenty-, and thirty-percent weights are constructed in the same way. This choice is symmetric and is not based on any theoretical justification. Although the weight is constructed conveniently, this exercise is also helpful to illustrate the main point. We can see that such weighting makes the dependency ratio somewhat smaller than the conventional OADR. As the weights increase, the dependency ratios

decrease. This raises an important issue in aging research. Population aging is assumed to have negative societal consequences, and the conventional OADR is ever-increasing. This provokes many policy and academic debates, including those concerning pension reform. However, if we are interested in measuring societal burdens and the capacity to cope with them, we need to account for population composition as well as age structure, which are not captured well by the conventional OADR. Given the improvement of educational attainment and elderly health, accounting for population composition should indicate a less gloomy future. The WEHA-OADR does this job. The WEHA-OADR is smaller than the OADR, suggesting that the consequences of population aging will be less burdensome than the OADR implies. Although the weights are constructed conveniently, this exercise illustrates the importance of accounting for population composition in developing the aging index.

Projection

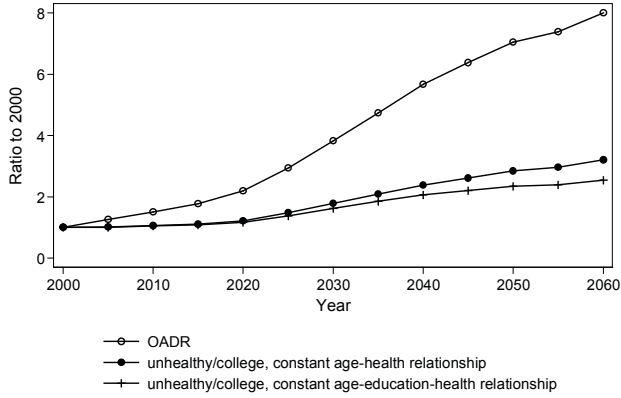
From Table 2, we see that accounting for education and elderly health tells a different story about trends in population aging between 2000 and 2010. Here, I present the projected trends based on the estimates of educational attainment and elderly health described above. Table 3 presents the estimates for the proportion of the healthy elderly. The bottom rows for each sex show the proportion of the healthy elderly by sex and age using the pooled KNHNES data without accounting for the educational differentials in health. These estimates are used for scenario 1, which projects the proportion of the healthy elderly in each elderly group, assuming that the future association between age and health by sex are the same as the patterns observed between 2000 and 2010. The other cells in Table 3 present the estimates for the proportion of the healthy elderly by sex, age, and educational attainment. Initially, I had planned to use the observed proportions of the healthy elderly in each group for scenario 2, which projects the proportion of the healthy elderly in each age-education group, assuming age and health associations by sex and education stay the same as the patterns observed between 2000 and 2010. However, the sample sizes for some cells (college-educated women aged 75-79 and 80+) are too small to provide reliable estimates. There are only five observations in these cells. Furthermore, none of the five college-educated women aged 75-79 reported that they were healthy. Hence, I obtain the estimates in the following ways. For men, I use the observed proportion of the healthy elderly in each group because there is no issue with sample size

TABLE 3
ESTIMATES FOR PROPORTIONS OF THE HEALTHY ELDERLY BY SEX, AGE, AND
EDUCATIONAL ATTAINMENT

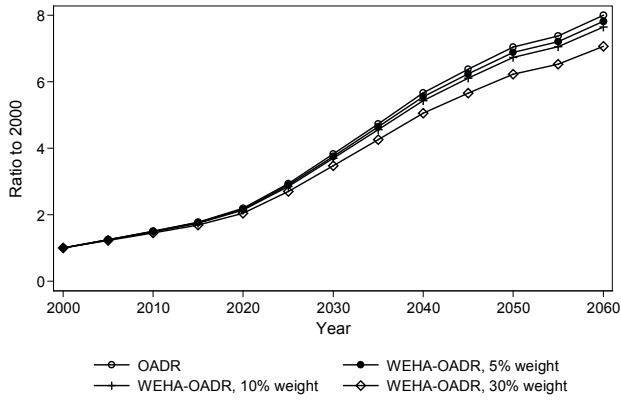
Male		Age		
Education	65-69	70-74	75-79	80+
0-6	0.283	0.233	0.235	0.247
7-12	0.352	0.295	0.175	0.200
13+	0.513	0.466	0.404	0.217
Overall	0.338	0.285	0.242	0.237
Female		Age		
Education	65-69	70-74	75-79	80+
0-6	0.153	0.151	0.163	0.234
7-12	0.250	0.248	0.265	0.361
13+	0.413	0.409	0.431	0.543
Overall	0.174	0.164	0.170	0.240

for men. For women, I estimate the logistic regression to predict the proportion of the healthy elderly in each group, wherein age and education dummies are used as covariates without including the interaction between them. These estimates of the proportion of the healthy elderly in each group are presented in Table 3 and are used for projection.

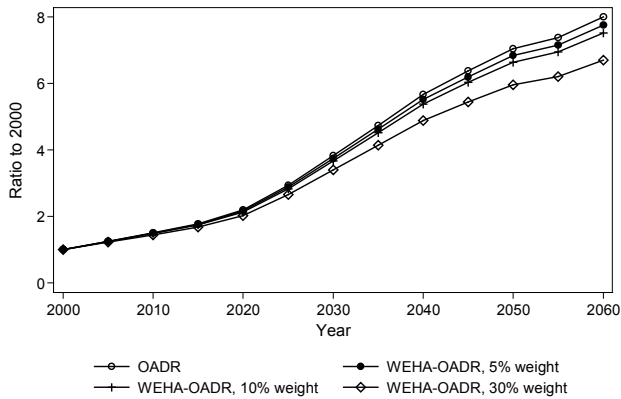
Figure 1 shows the projection results. The graphs show the ratio of each estimate to the one for 2000, presenting proportionate changes in each measure over time. Panel A shows the trend in the EHA-OADR, namely, the ratio of the unhealthy elderly to college-educated working-age people. This result clearly shows that the ratio of the unhealthy elderly to college-educated working-age people will grow much slower than the conventional OADR. While the conventional OADR will increase by about 8 times between 2000 and 2060, the EHA-OADR will grow by only 2 to 3 times during the same period. When accounting for improvement in educational attainment among the elderly, increases in the EHA-OADR become somewhat slower. Panel B shows the trend in the WEHA-OADR when we assume the relationship between age and health remains constant over time for each sex. The weights are constructed in the same way as in Table 2. Changes in the WEHA-OADR are somewhat slower than those in the conventional OADR, depending on the weights. As the weights increase, the difference becomes wider. However, the five- and ten-percent weights do not seem to make any meaningful



A. EHA-OADR



B. WEHA-OADR (constant age-health relationship)



C. WHEA-OADR (education accounted for)

Fig. 1.—Projection results

difference. When the weight is 30 percent, the difference becomes sizeable. Panel C assumes that the age–education–health relationship will remain constant over time, and the results are almost identical to those in Panel B. This means that accounting for improvement in educational attainment does not make a large difference in the trend of the WEHA-OADR, unless educational differentials in the capacity to support the elderly and elderly health differentials of the societal burden are fairly large, say, by 30-percent weight. While it is not an easy task to determine the realistic values of the weights, the current analyses highlight the importance of this job because the trends in the new index are heavily dependent on the weights.

Summary and discussion

In this study, I propose an alternative index of population aging that accounts for population heterogeneity in terms of educational attainment and elderly health. The key finding suggests that accounting for this heterogeneity yields a less gloomy picture than that provided by the conventional OADR because of improvements in education and elderly health. However, the difference between the new and old measures is not substantial unless the weights assigned to education and elderly health are fairly large (e.g., 30 percent). This calls for more elaboration of the index. The current index does not account for mortality differences by education and elderly health. Demographic research has consistently shown the positive association between education and survival chances (Elo and Preston 1995; Elo 2009). The current study does not account for such educational differentials in mortality, thus underestimating the proportion of college-educated people among working-age people. In addition, the healthy elderly are more likely to survive than their unhealthy counterparts. Because I do not account for such mortality differentials by elderly health status, the proportion of the healthy among the elderly is also likely to be underestimated to some extent. These omissions are partly responsible for the results indicating no substantial differences in the trends in the OADR and WEHA-OADR when weights are small. Future analyses should incorporate these mortality differentials, which would make the difference between the old and new indices more noticeable.

Besides this limitation, a couple of conceptual issues should be discussed. First, I assume that improvements in education and elderly health reduce the societal burdens associated with population aging. This is based on the assumption that better-educated people possess a higher capacity to

provide the elderly with support and that the healthy elderly are less burdensome than their unhealthy counterparts. However, these assumptions should be subject to empirical testing, and it is desirable to construct weights based on real data instead of arbitrary choices. In addition, future trends are unpredictable. We may expect that educational differentials in capacity are likely to decrease over time in Korea. Returns to college education seem to decrease in Korea, reflected in the high unemployment rates among young college graduates. This suggests that improvement in education may not compensate for the negative consequences of population aging, as assumed in the current study. Another issue is the meaning of elderly health. The healthy elderly are likely to be less burdensome, but maintenance of good health also requires consuming resources. In other words, the healthy elderly are healthy because they consume more resources worried about their health than do the unhealthy elderly. In this sense, the assumption that improvement in elderly health mitigates the consequences of population aging might be problematic. This calls for cautious interpretation of the alternative index. Second, it is necessary to think carefully about the meanings of the weights for education and elderly health. High weights in education and elderly health suggest large differences in educational capacity and large differences in independence and the imposed burden, respectively. Hence, large weights suggest strong socioeconomic inequality by education and elderly health. In this sense, the finding that higher weights yield a more favorable trend in WEHA would be somewhat troublesome. Logically, this leads to the conclusion that higher inequality buffers the consequences of population aging. This is somewhat disconcerting and may be unlikely to happen given the negative influences of strong social inequality on various societal outcomes (Wilkinson and Pickett 2009). These considerations highlight the need for more elaborate conceptualization to develop an alternative index of population aging.

Although the current study has several limitations, it can contribute to developing a new measure of population aging. Given the importance of population aging and its intrinsic relationship with other socioeconomic development, future research should expend more energy to understand the complex nature of population aging. In this regard, we may reconsider the current policy emphasis on boosting fertility to cope with population aging. Of course, raising fertility would delay the pace of population aging. However, it is difficult to imagine that the period total fertility rate in the lowest-low fertility countries, like Korea, would rise to the replacement level in the near future. In some sense, persistent below-replacement-level fertility will be our inescapable future. In addition, focusing solely on age may not be

desirable because the meaning of chronological age is changing as longevity increases. An implication of the current study is that improvements in education and health can counterbalance the ever-increasing trends of population aging. This suggests that efforts should be directed toward improving education and elderly health as well as delaying population aging. In sum, we should focus on quality as well quantity in our examination of population aging.

(Submitted: July 19, 2016; Revised: August 29, 2016; Accepted: September 6, 2016)

References

- Arora, Suchit. 2001. "Health Human Productivity and Long-Term Economic Growth." *The Journal of Economic History* 613(3): 699-749.
- Batljan, Ilija and Mat Thorslund. 2009. "The Effect of Change in Educational Composition on Population Aging." *European Journal of Aging* 6(3): 191-200.
- Batljan, Ilija, Marten Lagergren, and Mats Thorslund. 2009. "Population Aging in Sweden: The Effect of Change in Educational Composition on the Future Number of Older People Suffering Severe Ill-Health." *European Journal of Aging* 6(3): 201-11.
- Bloom, David, David Canning, and Jaypee Sevilla J. 2003. *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change*. Santa Monica: Rand Corporation.
- Dyson, Tim. 2010. *Population and Development: The Demographic Transition*. New York: Zed Books.
- Elo, Irma. 2009. "Social Class Differentials in Health and Mortality: Patterns and Explanations in Comparative Perspective." *Annual Review of Sociology* 35: 553-72.
- Elo, Irma and Samuel Preston. 1996. "Educational Differentials in Mortality: United States 1979-85." *Social Science Medicine* 42(1): 47-57.
- Friedman, Esther and Robert Mare. 2014. "The Schooling of Offspring and the Survival of Parents." *Demography* 51(4): 1271-93.
- Glymour, Maria, Mahasin Mujahid, Qiong Wu, Kellee White, and Eric Tchetgen. 2010. "Neighborhood Disadvantage and Self-Assessed Health Disability and Depressive Symptoms: Longitudinal Results from the Health and Retirement Study." *Annals of Epidemiology* 20(11): 856-61.
- Goldstein, Joshua. 2009. "How Population Age." Pp.7-18. In *International Handbook of Population Aging*, edited by P. Uhlenberg . New York: Springer.
- Howse, Kenneth. 2006. "Increasing Life Expectancy and the Compression of

- Morbidity: A Critical Review of the Debate.” Oxford Institute of Aging Working Papers 206.
- Iwarsson, Susanne and Ake Isacson. 1997. “Quality of Life in the Elderly Population: An Example Exploring Interrelationships among Subjective Well-Being ADL Dependence and Housing Accessibility.” *Archives of Gerontology and Geriatrics* 26(1): 71–83.
- Joung, Inez, Anton Kunst, Evert van Imhoff, and Johan Mackenbach. 2000. “Education Aging and Health: To What Extent can the Rise in Educational Level Relieve the Future Health Care Burden Associated with Population Aging in the Netherlands?” *Journal of Clinical Epidemiology* 53(9): 955–63.
- Kalwij, Adrian. 2010. “The Impact of Family Policy Expenditure on Fertility in Western Europe.” *Demography* 47(2): 503–19.
- Kaneko, Ryuichi. 2003. “Elaboration of the Coale-McNeli Nuptiality Model as the Generalized Log Gamma Distribution: A New Identity and Empirical Enhancements.” *Demographic Research* 9: 223–62.
- Kye, Bongoh, Erika Arenas, Graciela Teruel, and Luis Rubalcava. 2014. “Education Elderly Health and Differential Population Aging in South Korea: A Demographic Approach.” *Demographic Research* 30: 753–94.
- Lee, Jong-Wha and Ruth Francisco. 2012. “Human Capital Accumulation in Emerging Asia 1970–2030.” *Japan and the World Economy* 24(2): 76–86.
- Lee, Jong-Wha. 2008. “Economic Growth and Human Development in the Republic of Korea 1945–1992.” New York NY: United Nations Development Programme. Occasional Paper 24.
- Lee, Ronald and Shripad Tuljapurkar. 1997. “Death and Taxes: Longer Life Consumption and Social Security.” *Demography* 34(1) 67–81.
- Lee, Ronald and Andrew Mason. 2010. “Fertility Human Capital and Economic Growth over the Demographic Transition.” *European Journal of Population* 26(2): 159–82.
- Lee, Ronald and Andrew Mason. (eds). 2011. *Population Aging and the Generational Economy: A Global Perspective*. Northampton: Edward Elgar.
- Li, Nan and Ronald Lee. 2005. “Coherent Mortality Forecasts for A Group of Populations: An Extension of Lee-Carter Method.” *Demography* 42(3): 575–94.
- Livi-Bacci, Massimo. 2007. *A Concise History of World Population* 4th ed. Malden: Blackwell Publishing.
- Lutz, Wolfgang, 2009. “The Demography of Future Global Population Aging: Indicators Uncertainty and Educational Composition.” *Population Development Review* 35(2): 357–68.
- Lutz, Wolfgang, William Butz, and Samir KC. (eds). 2014. *World Population and Human Capital in the Twenty-First Century*. Oxford: Oxford University Press.
- Lutz, Wolfgang, Warren Sanderson and Sergei Scherbov. eds. 2004. *The End of World Population Growth in the 21st Century: New Challenges for Human Capital Formation & Sustainable Development*. New York: Earthscan.

- Lutz, Wolfgang, Warren Sanderson, and Sergei Scherbov. 2008. "The Coming Acceleration of Global Population Ageing." *Nature* 451: 716-9.
- Lutz, Wolfgang, Anne Goujon, and Gabriele Doblhammer-Reiter. 1998. "Demographic Dimensions in Forecasting: Adding Education to Age and Sex." *Population and Development Review* 24(supplement): 42-58.
- McDonald, Peter. 2002. "Sustaining Fertility through Public Policy: The Range of Options." *Population English Edition* 57(3): 417-46.
- Menec, Verena, Shahin Shooshtari, and Pascal Lambert. 2007. "Ethnic Differences in Self-Rated Health among Older Adults: A Cross-sectional and Longitudinal Analysis." *Journal of Aging and Health* 19(1): 62-86.
- Preston, Samuel and Cameron Campbell. 1993. "Differential Fertility and the Distribution of Traits: The Case of IQ." *American Journal of Sociology* 98(5): 997-1019.
- Robertson, Ann and C. Shawn Tracy. 1998. "Health and Productivity of Older Workers." *Scandinavian Journal of Work Environment & Health* 24(2): 85-97
- Sanderson, Warren and Sergei Scherbov. 2010. "Remeasuring Aging." *Science* 329(5997): 1287-8.
- Sanderson Warren and Sergei Scherbov. 2013. "The Characteristics Approach to the Measurement of Population Aging." *Population and Development Review* 39(4): 673-85.
- Skirbekk, Vegard, Elke Loichinger, and Daniela Weber. 2012. "Variation in Cognitive Functioning as a Refined Approach to Comparing Aging across Countries." *Proceedings of the National Academy of Sciences* 109(3): 770-4.
- Statistic Korea. 2011. *Population Projection Based on 2000 Census*. (in Korean).
- Striessnig, Erich and Wolfgang Lutz. 2014. "How does Education Change the Relationship between Fertility and Age-Dependency under Environmental Constraints? A Long-Term Simulation Exercise." *Demographic Research* 30: 465-92.
- Weil, David. 2007. "Accounting for the Effect of Health on Economic Growth." *The Quarterly Journal of Economics* 122(3): 1265-306.
- Whang, Choyi and Seulki Choi. 2015. "Age Structure and Population Momentum in South Korea." *Development and Society* 44(2): 345-63.
- Wilkinson, Richard and Kate Pickett. 2009. *The Spirit Level*. New York: Bloomsbury Press.
- Wilson, Tom. 2010. "Model Migration Schedules Incorporating Student Migration Peaks." *Demographic Research* 23: 199-222.
- Zimmer, Zachary, Albert Hermlin, and Hui-Sheng Lin. 2002. "Whose Education Counts? The Added Impact of Adult-Child Education on Physical Functioning Of Older Taiwanese." *Journal of Gerontology* 57B(1): 23-32.

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