Soc. Sci. **2015**, *4*, 940–966; doi:10.3390/socsci4040940

OPEN ACCESS

social sciences

ISSN 2076-0760

www.mdpi.com/journal/socsci

Review

Population Aging: An Emerging Research Agenda for Sustainable Development

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Academic Editor: Martin J. Bull

Received: 6 July 2015 / Accepted: 25 September 2015 / Published: 5 October 2015

Abstract: In recent years, population aging has been recognized as an emerging challenge in many parts of the world. Earlier studies discussed its impacts on the sustainability of social security systems and national economic growth; however, they tended to focus on the issues at the national level and were limited to developed countries. With the knowledge that population aging will be a predominant trend in both developed and developing countries, this paper aims to: (i) describe the global population aging trend and its regional demography; (ii) provide a structural review of population aging challenges at the national, communal and individual levels; and (iii) elaborate future research topics on population aging with a particular emphasis on developing countries. Several indicators suggest rapid population aging in the coming decades, especially in Asia, Latin America and Africa. The structural review presents the diverse challenges that affect both young and older population groups. Finally, the need for linking population aging with the sustainable development concept and the possible rural decline caused by rapid urbanization are suggested as future research topics. Further studies to establish a body of knowledge on population aging in developing countries are required to place population aging on the agenda of future sustainable development discussions.

Keywords: population aging; sustainable development; rural decline; community function

1. Introduction

In recent years, population aging has been recognized as an emerging social challenge in many parts of the world. Some clear evidence of population aging is observed; for example, the share of the aged 60-plus population in the world increased from eight percent in 1950 to 12 percent in 2014, and it is predicted to be 21 percent by 2050 [1]. The global life expectancy also increased from 47 years in 1950 to 70 years in 2014, and a further increase to 75 years is expected by 2050 [2–4]. Only a few decades ago, the major concern regarding world demography was its rapid growth and increasing pressure on the ecosystem and food security [5,6]. While population growth will continue in some fast-growing countries in Sub-Saharan Africa and South Asia [7], the population aging phenomenon will have profound impacts on various dimensions of society, and this aging trend will be intensified in the coming decades [8,9].

Although there is an accumulation of studies about population aging covering diverse topics, existing literature concentrates on population aging mainly in developed countries. Population aging is largely seen as a threat to: (i) sustainable economic growth due to the possible shrinkage of the labor force [10,11]; and (ii) social security systems to support the elderly, such as pension plans, healthcare schemes and long-term care insurance [12–15]. In contrast to these alarmist views, some call attention to the emerging "silver market" to illustrate a positive economic outlook ([16], pp. 22–23; [17,18]). Moreover, possible mitigation of economic decline is suggested by way of increasing female labor participation and policy reforms regarding the legal retirement age [19].

Despite the wide coverage of the earlier literature, these issues may represent only part of the entire picture of population aging because they are limited to macro-scale changes derived from population estimations. Furthermore, compared to the volume of knowledge on the cases of developed countries, little is known about the actual changes that people, both elderly and young population groups, are and will be experiencing in developing countries.

With the increase of life expectancies and the actual size of the older population defining an era of aging societies, in which increasing proportions of older populations will continue in the coming decades, what kinds of challenges should we expect? Given the expected impacts of population aging in the coming decades, this paper aims to: (i) describe population aging trends in the world and the regional demography; (ii) provide a structural review of population aging challenges at three levels, namely the national, the communal and the individual levels; and (iii) elaborate future research topics on population aging that particularly emphasize the situation of developing countries. For the third objective, this study briefly introduces the current state of rural Japan, which is possibly the most aged region in the world. The case of rural Japan is presented to illustrate the emerging population aging challenges in rural areas where the aging phenomenon is happening rapidly.

2. The Era of Aging Societies

2.1. Population Aging in the World and the Regional Demography

As was briefly mentioned in the previous section, the world demography is shifting to an era of population aging. Figure 1 presents the demographic changes of the world and three sub-regions[1] with four age groups, and the share of older populations (aged 60-plus) from 1950–2100. As the figure of the "World" clearly shows, aging will emerge as a strong trend in the world demography. At the same time, Figure 1 also illustrates different patterns of population aging in three sub-groups.

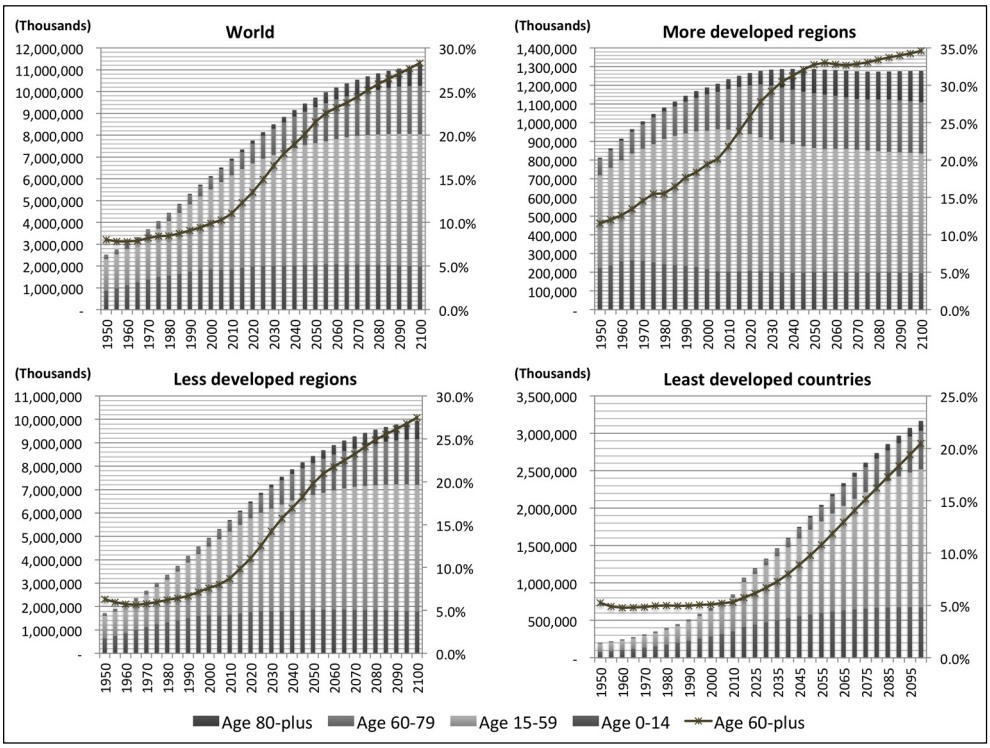

Figure 1. Population trends of the world and three sub-groups with four age groups and the shares of the aged 60-plus population. Note: Created from population estimations for 1950–2010 and population projections with a medium fertility rate for 2015–2100 by the United Nations.

In the world demography, the older population group remained below 10 percent from 1950–2010 ("World" in Figure 1). The predictions suggest a steady increase of this age group from 2015 onward. The share of the older population is predicted to reach 21.5 percent by 2050 and 28.3 percent by 2100. Although some scholars suggest that the world population may stabilize at around 10 billion people after 2050 [20], aging will remain as a clear trend in the world demography in the coming decades.

[1] Definitions of "more developed regions", "less developed regions" and "least developed countries" are adopted from the UN population statistics. The more developed regions include all countries in Europe, North America, Australia, New Zealand and Japan. The less developed regions include all countries in Africa, Asia (except Japan), South America, Latin America and the Caribbean. The least developed countries represent a list of 48 countries set by the UN. The least developed countries are also included in less developed regions.

In the case of more developed regions, population aging was already present in the late 1970s as the share of the older population exceeded 15 percent by 1975, and it further increased to 21.9 percent by 2010 ("More developed regions" in Figure 1). One key demographic feature of developed regions is that the total population will be stabilized at around 1.28 billion from 2030 onward. At the same time, the size of the older-old (age 80-plus) group is expected to increase steadily. This demographic pattern will create a further increase in the share of the older population to 32.8 percent by 2050 and to 34.6 percent by 2100.

In the less developed regions, population aging will quickly evolve from 2020–2060 as the share of the older population is predicted to double from 11.9 percent to 21.8 percent ("Less developed regions" in Figure 1). Although the acceleration of population aging will be slower, the aging trend will continue to be on the rise, with an increase to 27.5 percent by 2100.

In contrast to the other two sub-regions, the least developed countries will experience rather gradual population aging. As Figure 1 shows, the share of the older population is predicted to increase gradually from 5.3 percent in 2010 to 9.8 percent by 2050 ("Least developed countries" in Figure 1). From 2050 onward, aging will be accelerated in these countries, with the proportion of the older population expected to reach 20.5 percent by 2100.

Along with its share, the actual size of the older population is also important. Figure 2 presents the projection of the aged 60-plus population in six regions of the world. Among them, Asia will be home to 1.3 billion of the elderly by 2050 and 1.6 billion by 2100. Africa will be the region with the second largest population of older people by 2100, with 844.4 million people. Latin America will also experience a drastic increase of the older population from 70 million in 2015 to 200 million by 2050, and a further increase to 269.9 million by 2100. In contrast, in Europe, Northern America and Oceania, the pace of older population increase will not be as significant as the other regions (Figure 2).

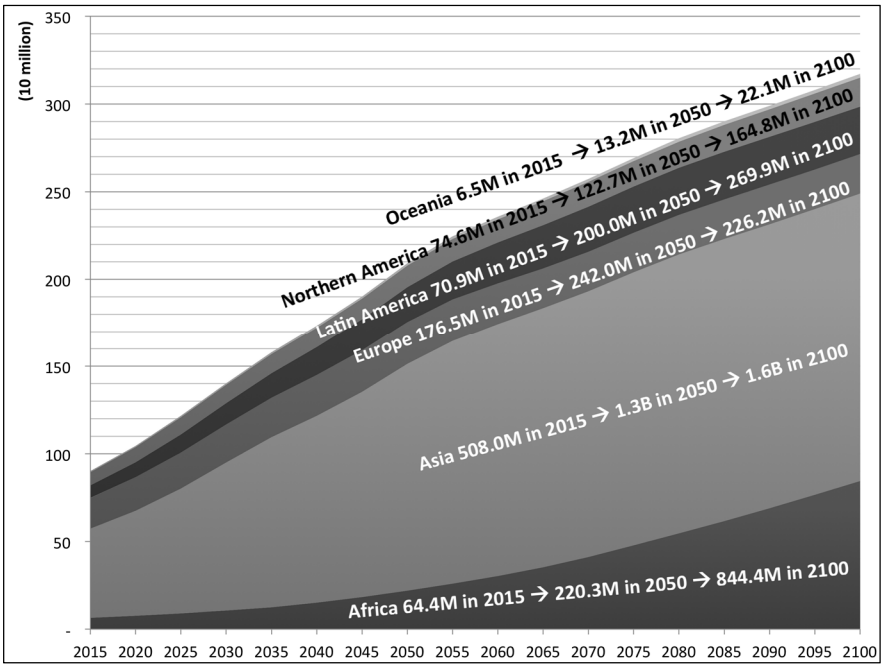

Figure 2. Trends of the aged 60-plus population in six regions of the world. Note: Created from population estimations for 1950–2010 and population projections with medium fertility rate for 2015–2100 by the United Nations.

2.2. Demographic Causes of Population Aging

Population aging is mainly caused by two demographic changes: (i) decline in fertility rates; and (ii) increase in life expectancy ([7,21,22]; [23], pp. 13–20; [24,25]). These two demographic changes are long-lasting and largely irreversible as countries achieve social and economic development [26].

As Figure 3 shows, the decline in the fertility rate has been a long-term trend in both the world and regional demography. The total fertility rate in 1950 at the global level was 4.9 births per woman. The figure dropped to 2.6 births by 2010, and a further decline to 2.0 births is expected by 2050. At the regional level, the decline in fertility rate has been particularly noticeable in Europe and Asia. In Europe, the figure dropped from 2.7 births per woman in 1950 to 1.5 in 2010, and an additional slight decline to 1.5 births by 2050 is predicted. As for Asia, the figure was 5.8 births per woman in 1950, but it dropped to 2.3 by 2010 and is projected to be 1.9 by 2050. Although Africa still has as high as 4.8 births per woman today, the region is on a long-term declining trend. The projection suggests that the fertility rate of Africa will decline to 3.1 births per woman by 2050. As Figure 3 illustrates clearly, low fertility rates are common across all regions, and this trend will be accelerated in the coming decades [27].

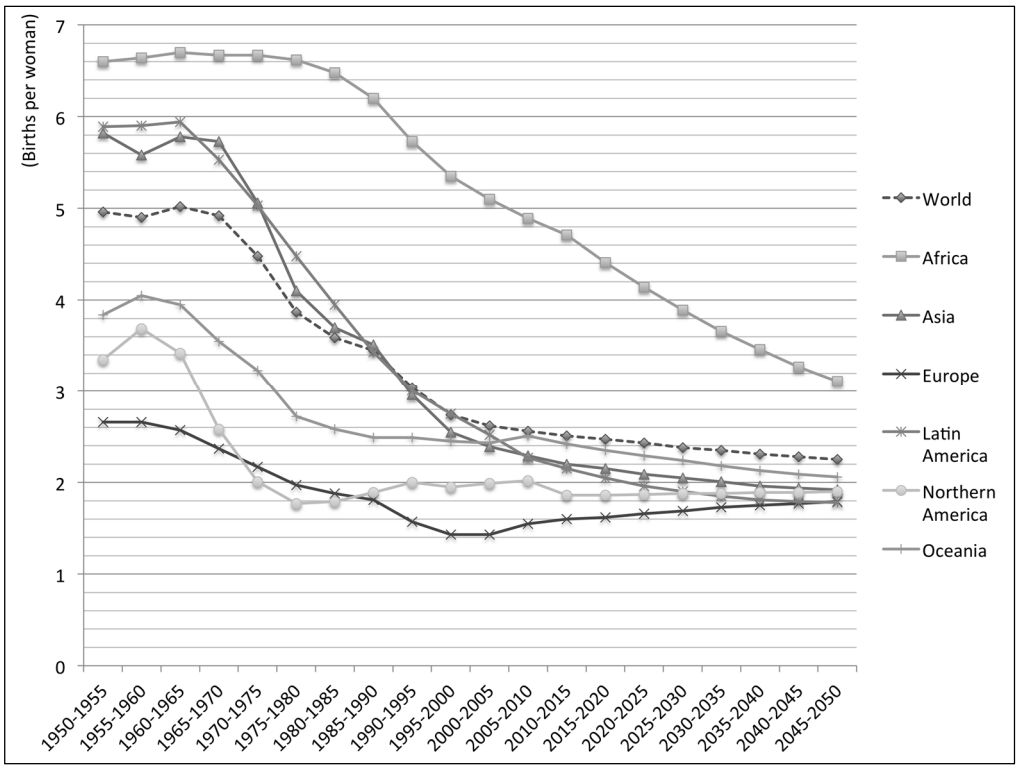

Figure 3. Trends in the total fertility rate in the world and six regions. Note: Created from total fertility estimations for 1950–2010 and projections with a medium fertility variant for 2015–2050 by the United Nations.

The second demographic cause of population aging, the increase of life expectancy, increased significantly both in the world and regional demography. Figure 4 depicts a long-term trend of life expectancies for the world and six regions. The world average was 46.8 years in 1950, and it increased to 68.8 years by 2010 (22-year increase). Asia and Africa were two regions with lower life expectancies than the world average in 1950 at 42.1 years and 37.3 years, respectively. By 2010, Asia surpassed the

world average at 71.6 years, although Africa still remained much lower than the world average at 56.5 years. Latin America had about a five-year longer life expectancy than the world average in 1950 at 51.2 years, and it increased to 74.5 years by 2010. Northern America was the region with the longest life expectancy at 68.6 years in 1950. This region already surpassed 70 years by 1970 and further increased to 79.2 years by 2010. Europe and Oceania regions also had about 15–18-year longer life expectancies than the world average in 1950. These regions also experienced an increase, to 77.5 years by 2010. Towards 2050, the life expectancies in Asia, Northern America, Latin America, Europe and Oceania are projected to increase further. Asia is expected to reach 78.0 years, and the remaining four regions are expected to reach somewhere between 81.0 and 84.0 years. Although Africa will continue to have lower life expectancy than the world average, the region's figure is expected to increase sharply to 66 years by 2030 and nearly 70 years by 2050. Overall, as Figure 4 also presents, the world average life expectancy increase will be a 30-year increase from 1950–2050.

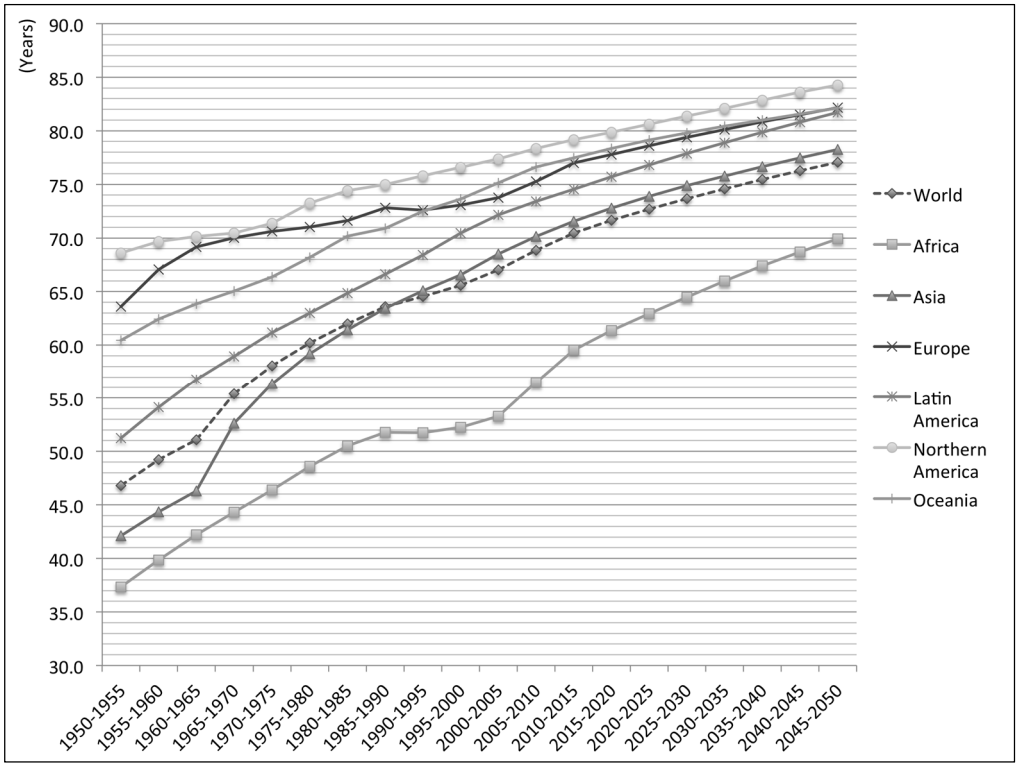

Figure 4. Trends in life expectancy at birth in the world and six regions. Note: Created from life expectation estimations at birth from 1950–2010 and projections with medium fertility variant for 2015–2050 by the United Nations.

In addition to the increase in life expectancy at birth, the increase of life expectancy at older ages is also a major contributor to population aging. Shrestha (2000) [28] states that population aging is defined by demographers as "an increasing median age of a population or an alteration in the age structure of a population, so that elderly persons are increasingly represented within a country's overall age structure". However, population aging is also about people living longer lives than they did in the past, as life expectancies, particularly at older ages, have improved [29]. Table 1 shows the trends of life expectancy at age 60 in the world and six regions for males and females. In the world population, a 60-year-old male could expect a remaining 13.1 years in 1950, while this increased to 17.8 years by

2000 and is predicted to reach 21.7 years by 2050. As for a 60-year-old female, it was 15.3 years in 1950, 20.8 years in 2000, and it is expected to be 24.3 years by 2050. In each region, in general, there is an increasing trend in life expectancy of about 6–10 years from 1950–2050. Females, throughout this time, have about a two- to three-year longer life expectancies than males.

Table 1. Life expectancy at age 60 in the world and six regions.

Life expectancy at age 60 (Male)										
Region	1950–1960	1960–1970	1970–1980	1980–1990	1990–2000	2000–2010	2010–2020	2020–2030	2030–2040	2040–2050
World	13.1	14.1	15.2	16.0	16.7	17.8	19.0	19.9	20.8	21.7
Africa	12.2	13.0	13.7	14.3	14.6	15.2	16.1	16.7	17.4	18.0
Asia	11.3	12.8	14.6	15.6	16.3	17.5	18.4	19.4	20.4	21.3
Europe	15.5	15.7	15.9	16.5	16.9	18.3	20.0	21.1	22.3	23.2
Latin America	14.8	15.6	16.0	16.4	17.6	19.2	20.4	21.4	22.5	23.7
Northern America	16.0	15.9	16.7	17.9	19.1	20.7	22.2	23.2	24.2	25.4
Oceania	14.9	15.1	15.8	17.2	18.8	20.9	22.4	23.6	24.3	24.9
Life expectancy at age 60 (Female)										
Region	1950–1960	1960–1970	1970–1980	1980–1990	1990–2000	2000–2010	2010–2020	2020–2030	2030–2040	2040–2050
World	15.3	16.7	18.1	19.0	19.8	20.8	21.8	22.7	23.5	24.3
Africa	13.3	14.2	15.0	15.7	16.1	16.7	17.6	18.4	19.3	20.1
Asia	13.0	14.6	16.5	17.7	18.8	19.9	20.9	21.9	22.8	23.7
Europe	18.1	19.1	19.8	20.7	21.3	22.5	24.0	25.0	26.0	26.9
Latin America	16.2	17.4	18.3	19.2	20.6	22.3	23.6	24.8	25.8	26.8
Northern America	19.3	20.1	21.5	22.6	23.1	23.9	25.1	26.0	26.8	27.7
Oceania	18.3	19.0	20.1	21.6	22.9	24.4	25.5	26.4	27.2	27.9

Note: Created from estimated life expectancy by the Division of Economics and Social Affairs, the United Nations, 2015. Figures from 1950–2010 are estimations, and figures from 2020–2050 are predictions.

3. Pervasiveness and Acceleration of Population Aging

As previous sections illustrate, one key characteristic of the population aging phenomenon is its pervasiveness both in developed and developing countries. In terms of geographical expansion, those areas with more than 20 percent of their population being age 60-plus are concentrated in Europe, North America, Oceania and Japan in 2014. However, by 2050, countries with the same proportion of elderly people will expand to both North and South America, the entirety of the Eurasian continent and a wide area of the Asia and Pacific region, even in some countries in Northern Africa and the Middle East [30–32].

In developing countries, the expansion of population aging is happening at a much faster pace than developed countries. Another common indicator to measure the degree of population aging is to examine the time (number of years) elapsed for the increase in the share of the aged 65-plus population

or the elderly dependency ratio (EDR) from 7–14 percent [22,33–35]. Furthermore, some scholars have put forward 21 percent (or 20 percent or higher) as another figure to illustrate a super- or hyper-aging society [10,36–38]. Reflecting these possible benchmark figures, Figure 5 presents the number of years taken or predicted to take for three aging transitions at the societal level. Each phase of transition is in multiples of 7–28 percent. As for the first transition, from 7–14 percent, European and North American countries took a half to one century to achieve this transition. For example, France, Norway and Sweden took more than 80 years; Australia, Canada and the United States needed more than 60 years; and even the shortest cases—Germany, Spain and the United Kingdom—took more than 40 years. In contrast, the first transition took place or is predicted to happen within 30 years in Asian and South American countries. It will be particularly short, less than 20 years, in Brazil, Colombia, South Korea and Vietnam.

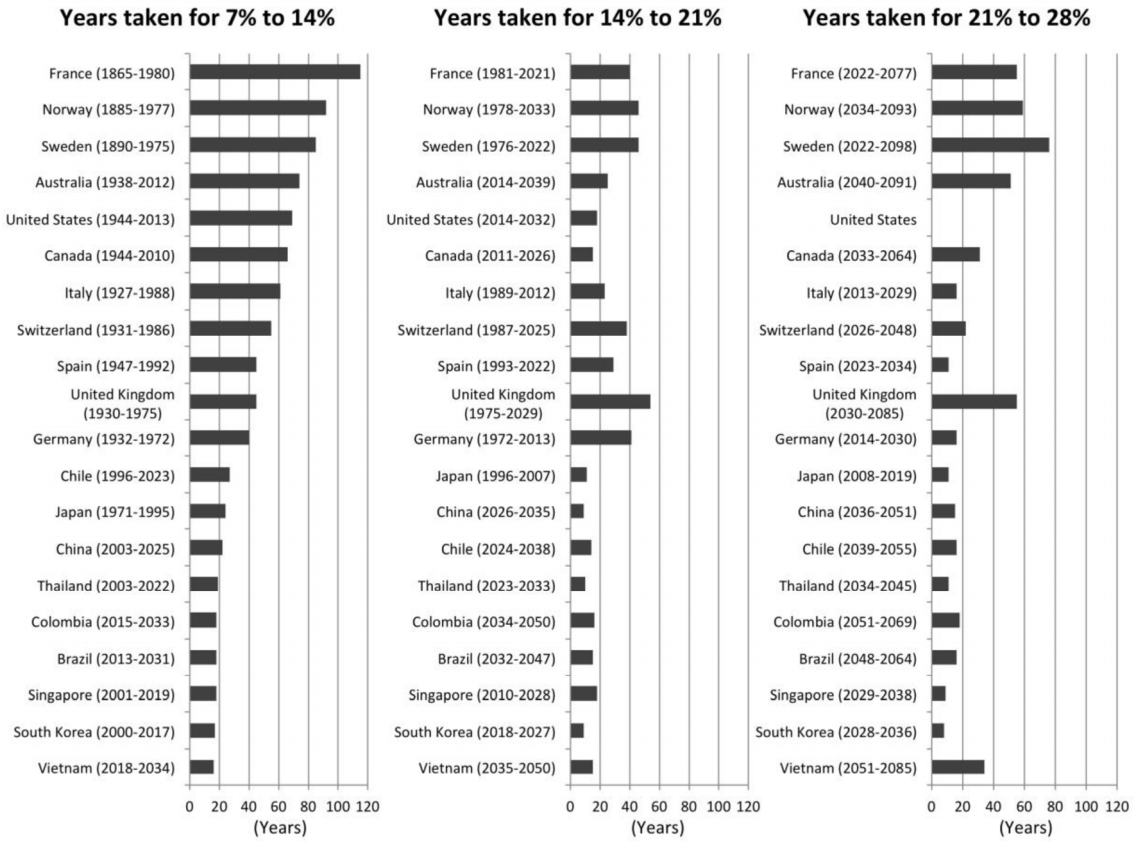

Figure 5. Number of years taken or predicted to take for three aging transitions in selected countries. Note: Created from the Organisation for Economic Co-Operation and Development (OECD) and UN demographic database. Years in parentheses are the periods during which each aging transition occurred or is predicted to occur.

The second and third aging transitions are predicted to happen within a much shorter amount of time in developed countries. The second transition, from 14–21 percent, is expected to happen in less than 60 years for Europe, less than 20 years for Canada and the United States and in around 10–15 years for Asia and South American countries. All countries listed in Figure 5 will complete the second aging transition by 2050. Although the third aging transition may take a longer time for some European countries, it is also expected to occur as rapidly as the second transition in the majority of countries (Figure 5). Currently, only Japan, Germany and Italy have reached the second aging transition,

and among these three countries, Japan is the most rapidly aging country, as it will reach the third transition by 2019. In general, the number of years taken or predicted to take for these three aging transitions are expected to be lower as these countries move to later transitions in the future.

As Figure 5 illustrates, population aging will be greatly accelerated in the coming decades and have profound impacts both in developed and developing countries. This phenomenal acceleration of population aging would particularly be a peril for developing countries, as they have to face the emerging demands for medical treatment, long-term care and financial support for aging societies before they fully benefit from their economic development ([39], pp. 30–47; [40,41]; [42], pp. 86–95). Responses to population aging and related social challenges must be developed according to the speed of population aging in developing countries.

4. Population Aging at Three Different Levels

As numerous profound impacts of population aging are anticipated, it is important to structurally analyze the expected challenges at different levels. This point is also supported by Bloom *et al.* (2011) [43], as they propose adaptation strategies to population aging at three different levels: (i) societal; (ii) organizational; and (iii) individual levels. Employing a set of analytical levels will greatly help, particularly developing countries, to foresee possible challenges. In this paper, the authors propose using (i) national; (ii) communal; and (iii) individual levels to delineate the emerging population aging challenges.

4.1. Population Aging Challenges at the National Level

At the national level, in developed countries, population aging is often framed as an imminent issue for social welfare systems, which are based on the balance between the older population who receives services and the younger population who supports the system's operation ([12,44]; [45], pp. 9–28; [46,47]). In 2010, there were four persons of working population age (age 15–64) to support one older person (aged 65-plus) in developed countries; however, this ratio is predicted to decline to three working age persons to one older person by 2025 [7]. This change in the balance between the older population and the younger population is caused by the rapid increase of the older-old population (aged 80-plus) in the coming decades [2]. Since public insurance for medical and geriatric services is covered almost universally in developed countries [48] and the older-old persons have a higher risk of suffering from chronic diseases and developing disabilities [49,50], there will be considerable pressure on welfare budgetary schemes. For example, Japan, the most aged country in the world where the aged 65-plus population accounts for 25.1 percent of the population, the share of social security expenditure of the country's total national income increased from 5.8 percent in 1970 to 29.6 percent in 2010. In actual terms, 70.5 trillion yen (equivalent to 579.5 billion US dollars) was spent on elderly care, which is equivalent to 68.1 percent of total social security expenditure. This figure was the largest ever, yet continual increases are expected [51].

In the context of developing countries, where social welfare schemes are not yet well established, the main challenge is to adequately respond to the escalating medical and other needs of the elderly. Among these countries, the impact of aging will be felt most drastically in China, as the country has the largest aging population, which is 160 million aged 60-plus people [52]. Considering the country's

shortage of nursing centers, the difficulty in constructing care facilities fast enough to catch up with the growing aging population and the relatively expensive medical costs for low and middle-income people in China, it will be important to train geriatric care workers, to prepare a policy to cover uninsured and underinsured elderly and to build a strategy to cope with the expected increase of elderly with disabilities [53,54]. Although there is a considerable difference in terms of the speed and scale of aging transitions in each country, the development of socioeconomic systems to provide economic security for the growing older population will be a shared concern among developing countries [22].

4.2. Population Aging at the Communal Level

The definition of the communal level needs to be flexible, since this level includes all units of society between the national and the individual levels. In a practical sense, the communal level includes all administrative units below the national government, such as provincial and municipal areas, and those smaller units of social groups, such as neighborhood communities or voluntary groups of residents. In addition, the focus of the communal level is not limited to the well-being of the elderly. The core challenge at this level is about securing adequate living conditions for all generations and maintaining the livelihood of societies while facing population aging challenges.

As for developed countries, topics discussed at the communal level in earlier literature have varied across urban and rural areas. The issues of shrinking cities and abandonment of facilities, such as complex housing, are discussed in relation to the living environment of elderly residents in urban areas [55,56]. Recent urban, community-based initiatives, such as Groundwork in the United Kingdom [57,58] or Machizukuri (participatory planning process) in Japan [59], are exemplary communal initiatives that aim to create social ties by enhancing citizens' participation in city and neighborhood planning [60]. These bottom-up and autonomous approaches in community design enable the community members to address the demands of older residents. These local initiatives encourage residents' collective actions to build an inclusive society for all generations in urban communities.

In rural areas, the proportion of the older population tends to be higher than in urban areas, often as a result of youth migration to cities [23]. Such out-migration of rural young population is increasingly common in developed countries, and older residents are often left behind in rural towns [61–64]. In the case of Japan, the United Kingdom and Ireland, rural residents are experiencing critical declines in access to basic services, such as grocery stores, post office services and gas stations, due to gradual withdrawal of service providers from remote areas [65–70]. Closures of basic services primarily affect local living conditions, particularly of elderly households, and decrease chances for interaction among community members, which often becomes a driver of social isolation for older residents.

In the case of developing countries, the types of challenges at the communal level are more diverse and particular to social contexts. Although the literature is limited, Rittirong *et al.* (2014) [71] reported the importance of support by community organizations, such as Buddhist temples or local healthcare centers, in Thailand. They also pointed out that religion has an important role for the elderly in Thailand, as they participate in ceremonies at temples on holy days every month and interact with other participants. Cases of community care are also reported in Taiwan where neighborhood-based communities in cities may be critical in providing geriatric care for the urban elderly [72]. As social welfare schemes for the elderly are either not available or may not be fully established, structural responses at the communal

level will be a key approach for community-based care for elderly residents. In addition, the notion of sustainable development will be particularly useful in analyzing diverse and unpredictable population aging challenges in developing countries. The application of the sustainable development concept allows a holistic view to investigate hidden challenges, as it explores the economic, environmental and social dimensions of the target system [73].

4.3. Population Aging at the Individual Level

Aging is a life course process of individuals. During this process, every person experiences gradual changes in physical and psychological conditions. The main challenge of population aging at this level is how to ensure the fulfillment of living conditions for older individuals.

Regardless of the differences between developed and developing countries, older people tend to be at higher risk on various occasions in their day-to-day lives. Earlier studies suggest that older people have higher health risks and a greater possibility of being victims of severe climate events, such as heat waves [74–76] and hurricanes [77,78]; especially those with chronic diseases are more vulnerable to these events. In addition, older people are also exposed to greater risks by being trapped in a state of social exclusion or relative poverty [79–81].

In terms of the psychological conditions of older people, loneliness and social isolation are two important concepts that enable better understanding of the state of older people in a society. To begin with, loneliness is a subjective notion and describes the state of individuals experiencing the loss or absence of an intimate or needed relationship [80,82], yet it does not necessarily imply the state of an individual being alone *per se*. Drennan *et al.* (2008) [83] concludes that people with a higher degree of loneliness tend to be: (i) males at the low income level; (ii) those who infrequently communicate with their children or other family members; and (iii) often those who provide home care for their spouse or relatives. In contrast, social isolation is an objective notion that describes the actual degree of connectedness to other individuals or social groups. The condition of being socially isolated is explained as "the objective state of having minimal contact with other people" [84]. Poor physical health, low morale and experiencing difficulties in communication and mobility are considered as the causes of social isolation [85]. As individuals go through different stages of life, they experience various patterns of losing social relationships that they have built. For example, retirement is a representative occasion of losing connections that can increase one's vulnerability not only in financial terms, but also in social relationships. Deaths of partners, friends and family members are also symbolic moments that may become a trigger for a greater degree of social isolation.

Along with general life events, gender appears as the second trigger for social isolation. Older women often receive a double jeopardy that positions them first as "elderly" and second as "woman". In fact, older women tend to be subjected to discrimination in employment, access to daily needs, ownership of property and even participation in leisure activities [86,87]. Such inequalities in older woman tend to appear in a rural setting more so due to the required travel distance to services; recent price increases in energy and food are placing additional pressure on household budgets, and such situations are generally more difficult to manage for older female residents [66,88]. In addition, in developing countries, older women tend to have lower educational levels and economic independence; hence, they tend to be economically dependent on either their husbands or relatives [89,90].

One major challenge regarding loneliness and social isolation of older people exists in the social perception towards older people. General perceptions of the elderly often have negative connotations, and they set a strong assumption that "older people are inevitably dependent and a burden on society" [91]. Such stereotypes classify the older population as welfare beneficiaries and underestimate their contributions to society. In reality, older residents, especially those in their pre-retirement, are often found as major contributors in caregiving and volunteering and also as active entrepreneurs in local communities [92–94]. In a society with higher proportions of the elderly, it will be critical to build an inclusive atmosphere not only for older residents, but also for all generations, recognizing older residents as active members of society and actively working to prevent loneliness and social isolation.

5. Topics for Future Research

5.1. Population Aging and Sustainable Development

As discussed in the previous sections, population aging is increasingly becoming a global phenomenon, and various challenges are predicted across the national, communal and individual levels. Particularly in developing countries, where both physical infrastructure and social systems are rapidly evolving, what will be the unique challenges related to aging? More specifically, along with the challenge in establishing social security systems and ensuring further economic growth at the national level, what should be the focus of studies on population aging at the communal and individual levels in the social and cultural contexts of developing countries? To answer these questions, discussing population aging in line with the concept of sustainable development, which incorporates intergenerational equity, environmental concerns and social equality dimensions while pursuing economic development [95–97], would be very helpful, as it provides a holistic view to address different dimensions of the aging phenomenon.

To start with, the current development scheme of developing countries does not necessarily address the demands of the elderly. This is clearly pointed out by Shetty (2012) [98] who argues that there has been "a massive disconnect between the Millennium Development Goals (MDGs) and aging". Highlighting the looming threat of aging in the coming decades, some international organizations are calling for global attention to include population aging on the sustainable development agenda [99,100]; however, aging is not included in post-MDG discussions. This may be because of the still very young population of developing countries. Shetty (2012) [98] pointed out that many developing countries have made their efforts in dealing with diseases in youth and middle-aged people intensively, which has led them to achieve longer life expectancies. However, such prioritization of the younger population has caused a situation that many developing countries are unprepared to meet the needs of the emerging elderly population [98]. Developing countries need to incorporate aging in their development agendas, and strategic responses at all levels are required. Moreover, it is critically important to implement such responses today, as any measures addressing demographic issues require a long time to observe their effects fully [101].

Secondly, these responses to population aging should not be limited to policy level discussions on such topics, such as the sustainability of social security systems; aging in every dimension of society must be addressed. This is particularly the case for developing countries where the impacts of

environmental issues are more acute and the general living conditions of elderly residents are more affected by rapid social changes [102]. Although there is a great degree of heterogeneity among developing countries, a few studies reported unsafe living conditions for the elderly. Although the higher chance of older residents to be crime victims is not confined to developing countries, Veras (2009) [103] documented that elderly Brazilians have to live with the fear of violence, which reflects the high crime rate of the country. Somrongthong *et al.* (2014) [104] report possible dangers related to housing environments in rural Thailand, such as "lighting and unsafe wires". Accordingly, social infrastructure, such as public facilities, transportation and public housing, needs to be designed to be accessible for all generations, including older residents.

Thirdly, population aging needs to be examined in relation to other development challenges, because aging populations will be a predominant condition in most countries in the coming decades. For example, urbanization is another universal phenomenon; by 2030, more than 60 percent of the global population will be living in cities, and about 25 percent of them will be aged 60-plus [105]. The combination of population aging and urbanization is considered as a major demographic challenge of this century [106]. Despite the abundant studies on population aging and urbanization, respectively, not much research has examined these two challenges together. A review paper by Phillipson (2004) [107] listed: (i) elucidating the urban context; (ii) examining the impact of globalization on definitions and perceptions of place; and (iii) urban ethnography to comprehend the experience of aging within cities, as agendas for urban aging research. Regarding the urban context, Smith (2009) [108] identified three factors that prevent older residents from aging well, which are: (i) neighborhood problems, such as overcrowding, noise and air pollution; (ii) living environment problems; and (iii) perceived city environment, such as fear of crime and access to high-quality services. Particularly, living environment problems include practical fears in the daily lives of older people, such as "negotiating hilly and/or uneven terrain, and worries about being able to sit down whilst out shopping" [109], and access to public toilets in the city centers [106]. These earlier studies are limited to the case of developed countries.

As for developing countries, one such challenge related to urbanization pertains to the types of urban residences. A large-scale migration from rural areas to cities has been taking place due to rapid urbanization, and significant numbers of these migrants first settle in residential areas with low-income level households or informal settlements in an urban area. Some of them eventually move to other parts of the city, whereas the others continue to live in the same areas and become permanent residents. As those permanent residents become aged, their experiences in an urban settlement would differ greatly from those of older residents in developed countries. Furthermore, urbanization often holds diverse environmental challenges in such areas, as water quality, air pollution and waste management. As urbanization with all its complexities is expected to expand rapidly in developing countries, further studies are required to examine how environmental challenges affect older people and the local responses needed.

5.2. Community-Function Decline in Rural Areas: Emerging Topic from the Experience of Japan

The other expected challenge related to population aging in developing countries is rural declines induced by the recent rapid urbanization trend. This is because urbanization is largely driven by the

migration of young populations, which affects the "age distribution in both sending and receiving areas" [110].

In developed countries, rural areas are hollowing out due to the continual out-migration of young populations, and rural areas are experiencing diverse declines not only in their demographics, but also in local economies, living environments and social vitality [61,111]. Among those countries that are experiencing such rural declines, Japan's experience is particularly drastic.

In Japan, a large-scale migration of young population to major cities occurred between the late 1950s and the early 1970s during a period of rapid economic growth [112]. Figure 6 illustrates the changing flow of in-migration of three major city areas in Japan. The peak time for this large-scale migration was the period of 1955–1960, when about 588,000 people moved to these three metropolitan areas. Although the size is much smaller, the migration trend to the Tokyo area is still present today, with around 65,000 people migrating there in 2010 (Figure 6).

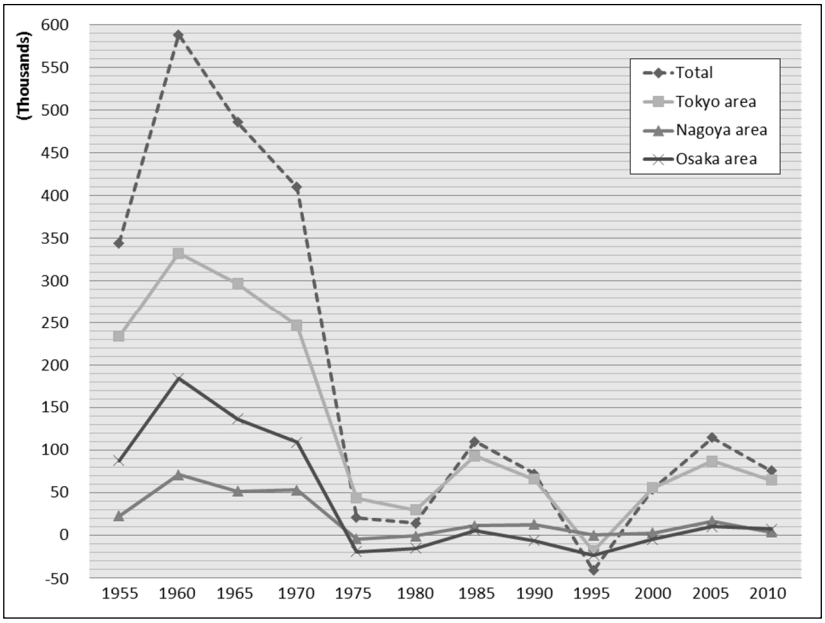

Figure 6. In-migration of three major city areas in Japan from 1955–2010. Note: Created from the report on Internal Migration in Japan by the Ministry of Internal Affairs and Communications. Counted numbers show only Japanese nationality. Area definitions are as follows: the Tokyo area includes Chiba, Kanagawa, Tokyo and Saitama prefectures; the Nagoya area includes Aichi, Gifu and Mie prefectures; the Osaka area includes Hyogo, Kyoto, Nara and Osaka prefectures.

Between two National Censuses of 2005 and 2010, 38 out of the country's 47 prefectures experienced negative population growth [113]. Especially, five prefectures with the greatest degree of depopulation (Aomori, Akita, Iwate, Yamagata, Kochi) experienced a four–five percent population decline annually during this five-year period. As of 2013, the share of older people (aged 65-plus) in these five prefectures was between 27 and 32 percent, while the national average was at 25.1 percent. Among them, Akita had the highest share of older people at 31.6 percent. Rural Japan is one of the areas in the world where the most rapid population aging has happened; therefore, its experience can

provide significant insights for rural areas of developing countries where similar patterns of rural decline are predicted due to the rapid urbanization experience.

One clear impact of population aging can be found in the declining community vitality in rural areas. Though it is a relatively new concept and does not have a universal definition, community vitality is seen as "the ability of a community to sustain itself into the future as well as provide opportunities for its residents to pursue their own life goals and the ability of residents to experience positive life outcomes" [114]. This concept is close to the notion of 'community-function' developed by Japanese scholars in rural studies. In rural Japan, residents form neighborhood-based social relationships for the activities that are essential for maintaining their livelihood and local environment. These collective actions are recognized as a set of functions, called "community-function" (originally "*shurakukino*" in Japanese), that each rural community has ([115], pp. 73–76; [116–120]). Although there is no established set of indicators for its measurement, earlier studies suggest that the collective actions of residents are critical for sustaining community-function. For example, collective actions of residents in farming and forestry, maintenance of living environments and local events, such as seasonal festivals and traditional performing arts, are considered as key activities to determine the quality of community-function.

Community-function is a useful notion for understanding the self-managing capacity of a rural community, and its decline implies the weakening of community vitality. As a result of continued outflow of young people and the aging of residents, rural communities are experiencing drastic declines in community-function, and further declines are seen as possible threats to the sustainability of rural communities [121].

Rural studies in Japan examined the actual changes that residents experience during the declining process of community-function. They claim residents face a wide range of challenges in their living conditions in such aspects as transportation and access to basic services [69,122], management of vacant houses and community facilities [56,123,124] and abandonment of farmlands and communal forests due to aging of farmers and lack of successors [125,126].

The succession of traditional knowledge is another concern during the rural decline process, as it has been the main body of knowledge about the interaction between nature and society based on the regular observation of the local environment, which looks at patterns of natural cycles including crises [127,128]. Traditional knowledge is also linked to local beliefs and understanding of place that are critical to the identity formation of local people. The case of rural Japan illustrates a severe situation regarding traditional knowledge transfer over generations as older residents practically cannot transfer their knowledge to younger generations since there are fewer young people in their communities. Additionally, even if some young people remain in rural communities, many of them are not engaged with farming, which is a key intermediary between nature and society. This situation makes learning specific types of traditional knowledge, which they can only acquire through direct observations and experiences with nature, much more difficult.

The main challenge for rural decline is to find a sustainable approach to reinvigorating the declining community-function and to create new functions to respond to emerging challenges. Fulfillment of declining functions may be achieved by merging a number of rural communities to keep the critical mass for maintaining the minimum size and quality of community-function. This initial phase of response aims at securing the living conditions of rural residents. Yet, at the same time, it would be critical for rural communities to be open to the external infusion of knowledge. New knowledge from outside may

revitalize the traditional knowledge to preserve declining community-function or add novel functions addressing new local challenges. In fact, the demands of residents are likely to change, as there is a higher share of older residents in a community. Further case studies are required to identify the role of traditional and new knowledge during the process of population aging in rural communities.

Considering the larger scale of urbanization and population aging, a faster pace of rural decline is expected in developing countries. For example, Gautam (2008) [129] reported the living conditions of elderly residents in Nepal, noting that they are largely left alone in rural villages and feel helplessness, loneliness and frustration even though they receive financial support from their out-migrated children who are making their own livings in cities. Flahety *et al.* (2007) [54] also claim that the recent trend of rural-to-urban migration may interfere with the traditional networks of children to provide care for the elderly, as they are physically distant from their home. Although the same degree of population aging as Japan may not be observed, studies on rural decline, especially in terms of community-function and traditional knowledge, will be critical for developing countries.

6. Conclusions

This paper reviewed the population aging trends in world and regional demography. The world demography is rapidly shifting to an era of population aging. This point has been confirmed by the increasing share and actual size of the aged 60-plus populations, both in developed and developing regions. Although Europe will remain the most aged region in terms of the share of older people, population projections suggest that population aging will be intensified in Asia, Latin America and Africa in terms of the total number of elderly. The declining fertility rate and the increasing life expectancies both at birth and at older ages are identified as the demographic causes for the population aging trend in the world. The acceleration of population aging in the selected countries was also reviewed in terms of three aging transitions. Although Europe and Northern American will go through these transitions over relatively longer periods of time than Asian and Latin American countries, the second and the third transitions are predicted to occur rapidly in all countries. In general, the number of years taken or predicted to take for these transitions is decreasing as countries move to later transitions in the future.

Three levels—(i) the national; (ii) the communal; and (iii) the individual levels—are applied to structurally analyze the expected challenges related to population aging both in developed and developing countries. At the national level, the increasing financial pressure to sustain current systems due to the increasing proportion of older people is a major concern, especially in developed countries. As for developing countries, where welfare schemes are not fully established, the main challenge will be to meet the medical and other needs of the growing older population. The case of China highlights a shortage of care facilities and geriatric care workers. Though the size and speed of population aging differ among developing countries, the development of socioeconomic systems to ensure economic security for the elderly will be a common challenge. At the communal level, challenges both in urban and rural areas are discussed for developed countries. In urban areas, challenges are linked to the physical changes of cities, such as shrinking cities or abandonment of facilities, whereas the challenges in rural areas are more directly related to residents' living conditions, such as the accessibility of basic services. As for developing countries, the types of challenges at the communal level are expected

to be more diverse and particular to social contexts. The case of Thailand suggests that community organizations, such as Buddhist temples and local healthcare centers, play an important role in enhancing the well-being of the elderly. Another case of community care in Taiwan also suggested the importance of healthcare services at this level. At the individual level, the concepts of loneliness and social isolation are reviewed. Possible approaches are linked to initiatives at the communal level, which aim at increasing the social participation of older people. Gender dimensions are also briefly mentioned as an additional trigger for social isolation. In the case of developing countries, gender appears to be a more distinctive issue in educational attainment levels and economic dependency.

Finally, two topics are suggested for future research on population aging. The first topic is about the need to link population aging challenges with sustainable development. With the knowledge that the size of the older population will increase drastically in developing regions, population aging should be discussed in the context of other development challenges. Urbanization is raised as a possible topic that has a significant linkage to population aging. As more than 60 percent of the global population will live in cities by 2030, it is urgent to address sustainable development issues of elderly residents in urban settlements, particularly in developing countries. In fact, WHO (2007) [106] suggests the combination of aging and urbanization is a major demographic challenge of this century.

The second topic is about rural declines caused by the extensive out-migration of the young population as part of a recent rapid urbanization trend. Japan's experience of rural decline is presented to illustrate possible challenges in rural aging communities. The problems of rural decline both in terms of tangible aspects, such as access to basic services, management of local properties and public transportation, and intangible aspects, such as succession of traditional knowledge among generations, are introduced. Furthermore, the concept of community-function from Japanese rural studies is introduced as a useful notion for understanding the self-managing capacity of rural communities. Considering the strong presence of urbanization and accelerating population aging, a similar pattern of rural decline may occur in rapidly-aging developing countries.

Given the anticipated impacts of population aging, the authors call for future studies on population aging in developing countries. One effective approach would be a series of comparative studies between the countries that have been experiencing rapid population aging, such as Japan, Korea and Singapore, and the other countries in which a rapid acceleration of population aging is expected in the coming decades. Analysis in these studies should be conducted across the national, communal and individual levels. Among them, the communal level should be emphasized, as local and autonomous initiatives will be a critical measure in responding to diverse development challenges. Further studies to create a body of knowledge on population aging in developing countries will help in placing population aging on the agenda of future sustainable development discussions.

Author Contributions

Shogo Kudo has been conducting research on population aging in rural areas of Japan over the past 5 years and has provided leadership for this study. Emmanuel Mutisya and Masafumi Nagao both served to improve the content as well as the structure of this paper.

Conflicts of Interest

The authors declare no conflict of interest.

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