Perspectives

Developmental Gerontology and Active Population Aging in China

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ABSTRACT

Population aging is an irreversible process in the development of modern society, which brings challenges to comprehensive modernized social governance. Population aging is a "dualistic" development issue that not only leads to aging of the labor force structure but also creates new demographic dividends. This study describes the core thoughts of developmental gerontology (DG), which provides new insight into the relationship between active aging and comprehensive governance for modernized society. The development of DG will provide a feasible and sustainable path to integrate and coordinate the relationship between population aging, society, and economy.

Population aging is an irreversible trend in demographic transition and the development process of the global population and modern society. According to World Population Prospects 2022, the proportion of the population aged 60 years and older has exceeded 10% in the 21st century and will increase rapidly in the future. By the middle of this century, 70% of older adults will be concentrated in developing areas (*1*). China has the largest population of older adults in the world, and the proportion of older adults aged above 60 years old increased from 13.32% in 2010 to 18.73% in 2020 (*2*). The rapid speed and large scale of aging population pose severe challenges to social development. Thus, the task of renewing the relationship between population aging and modernized social governance is urgent and challenging.

THE DUALITY OF POPULATION AGING

Human Aging Omics (HAO), a theory of aging, argues that the aging process in lifecourse is highly related to the systematic identification, manifestation, and quantification of all sets of health conditions as well as the complex relationships with internal biomolecules and the external environment throughout the life course (*3*). Although internal biomolecules interact with the external environment over the life course, unhealthy risks continue to increase (*3*), and the aging process does not have a single timeline. It is the process of gradual expansion of health diversity. Therefore, the period of aging is not a cumulation of aging, illness, disability, and dependency but, rather, a process of highly differentiating health status. This awareness of "healthy diversity" provides opportunities for the development and achievement of active aging.

Population aging is not simply a "unitary" social burden problem but a "dualistic" development issue. Although the intensification of population aging inevitably leads to aging of the labor force structure and further increases the cost of China's labor force, this adversity can be eliminated to some extent. With the improvement and development of living quality and technology, the overall health of older adults has greatly improved and life expectancy with disabilities has been compressed. It is fully demonstrated that most of older adults, defined by calendar age, are no longer dependents but persons with great potential to participate in socioeconomic activities and create new demographic dividends. In that case, the definition of older adults should be transformed from the calendar age definition to the perspective of "active aging," which is based on health development.

ACTIVELY AGING THROUGHOUT THE LIFE COURSE TO CONSTRUCT DEVELOPMENTAL GERONTOLOGY

Developmental gerontology (DG) is a new interdisciplinary branch of natural and social science that focuses on the relationship between the aging process, population aging patterns and comprehensive modernized social governance. It defines "aging" from the perspectives of technological, social, and economic

development. It breaks through the traditional definition of aging — the biological process of human aging. DG aims to fully explore the potential of humans in the process of aging and release new demographic dividends for older adults.

HAO is one of the foundations of DG, and its cores include dynamic measurement and continuous evaluation of health, disease, aging, disability, and mortality through the life course. It is a useful tool to effectively identify the cumulation of exposures from birth to the end of life. For a long time, the methods of life science have been used to distinguish the differences in calendar age, biological age, and social age. As previous studies with animal experiments have shown, an association between aging and dynamic changes in deoxyribonucleic acid (DNA) methylation was found (*4*). DNA methylation was used to measure the age of human cells, referred to as the biological age, which was shown to be correlated with breast cancer risk (*5*). Moreover, the potential reasons for differentiation in trajectories of human physiological function through the life course were detected in previous studies. For example, evidence has demonstrated that the level of cognition in childhood determines the ceiling of the adult cognition level, its starting point of decline (*6*), and that the level of risk exposure in early life has a strong impact on mental and cognitive health in adulthood, which further explains the interactions of health status in the corresponding period of "gestational age-aging process-old age" (*7*–*8*). Optimistically, the development of life science and technology, as well as medical innovation, was expected to lead to the gradual maturation of technologies in the fields of storage, repair and regeneration of cells, etc. However, the important role of artificial intelligence (AI) technology in compensating and expanding human physiological functions cannot be ignored. All these factors contribute to the increase in population health reserves in the "life bank" and provide opportunities for expanding the length and width of life. Undoubtedly, these are important conjunctions for developmental gerontology to combine thoughts of natural science, social science and economic science (*5*).

According to DG, it is important to not only treat the relationship between population aging and comprehensive modernized social governance from the perspectives of aging, disease, disability, etc. but also combine the rules of population development and the characteristics of socioeconomic development. The positive and dynamic perspective and population structure stratified thinking are essential to re-examine issues of population aging and the development of older adults' human capital. In addition, the keys to realizing active and healthy aging with expanded dividends are 1) to scientifically and rationally develop older adults' human capital on the basis of the achievement of both social significance and life significance in later life and 2) to rethink the relationships of the chain of population structure, social development and population aging on account of the contexts of social development, the population aging process, systematic demographic change, historical change, and changes in fertility, family structure and mobility.

Based on the rules of human life development, DG provides new insight into the relationship between active aging and comprehensive modernized social governance. It analyzes the feasibility of developing human capital of older adults and believes that the health dividends for older adults will bring new vitality to social and economic development. Older adults not only accumulate a large amount of intellectual capital and social wealth but also contribute to social and cultural development, family cohesion strengthening and social harmony. As such, they have great potential in re-employment, continuing education, social management, volunteering, and scientific and technological innovation. Thus, with the improvement of health conditions, an increasing number of healthy older adults will become the potential labor force, increase the overall reserves of the labor force, and expand effective labor resources (*9*). The improvement of the health condition of older adults means the extension of the demographic dividend. By fully developing the potential abilities of older adults in the active phase and the population health dividend in older age, China can obtain the new demographic dividend once again, which provides a new impetus for social and economic development.

Furthermore, DG explores the relationship between population aging, the changes in macroeconomic structure, and the growth of the regional economy based on system analysis, which is under the background of the changes in consumption structure from the development of human capital in later life. DG regards older adults as not only an important productive and support force for comprehensive modernized social governance but also the driving forces for industrial restructuring and increasing total factor productivity. Population aging will promote the upgrading of the consumption structure and drive

enterprises to replace the labor force with capital and technology, further upgrading and rationalizing China's industrial structure. As the quality of the labor force increases, technology advances, infrastructure improves, the total factor productivity of society rises significantly, and the disadvantages brought about by increasing labor costs under population aging gets compensated to some extent (*10*). These factors provide a good opportunity for China to complete the transformation of its industrial structure, respond actively to population aging and improve comprehensive modernized social governance.

THOUGHTS ON PROMOTING ACTIVE POPULATION AGING FROM THE PERSPECTIVE OF DG

The key to active population aging is to realize that older adults are an important, productive support and driving force for social and economic development. It is also the key to treating aging, diseases, and disabilities throughout the life course and for society. It is fair to say that giving full play to the health values of older adults, actively developing their potential human capital and maximizing the health dividends from older adults, have almost become the only feasible way to integrate and coordinate the development of population aging and society and economy in a sustainable way to some extent. Below are some thoughts about how to adopt DG in promoting active population aging:

Increasing the Health Reserves and Developing the Health Dividends of Older Adults

First, it is important to fully understand the significance of the health dividends of older adults in the comprehensive governance of modernized society. DG advances that the negative impact of population aging on economic growth can be mitigated or even eliminated under consideration for population health factors (*9*). The combined impact of the health dividends of older adults and the labor force health dividends on the national savings rate can be expressed as follows:

$$s = 1 - \frac{c_L}{y} - \frac{c_R}{y}\frac{R - \beta R}{\alpha L + \beta R} \quad (1)$$

where s denotes the national savings rate, L denotes the number of workers, and y denotes the output level per capita of the workforce. c_L denotes the per capita consumption level, c_R denotes the per capita consumption level for the elderly population, R denotes the number of the elderly population, and β is assumed to be the proportion of the elderly population among the healthy elderly population.

Furthermore, from the perspective of labor productivity, the per capita output level of the labor force is influenced by the health level of the labor force, so the actual labor productivity can be expressed as follows:

$$y = y(\beta_L L + \beta_R R) \quad (2)$$

where β_L denotes the health coefficient of the labor force, and β_R denotes the health coefficient of older adults. Thus, in terms of economic growth, health improvement can generate health dividends for older adults.

Equation (*2*) shows that with the increasing number of older adults in China, health promotion through technological development and social support is one of the important ways to explore the "health dividend of older age" and respond actively to population aging.

Second, the investment in the development of health science and technology and the establishment of health support systems should be increased. During the process of population aging, it is important to identify and control health risks exposed to gestational age-aging process- old age to minimize the occurrence of diseases and disabilities from birth to old age during life and prevent the accumulation and outbreaks of disease, disability and even death in older age. This is also important for improving the health condition, productivity and efficiency of the labor force and extending the labor health dividend to achieve economic growth.

Third, it is important to strengthen the systems and mechanisms to promote population health at all levels of governance. To actively respond to population aging, the use of the following is essential: 1) multidimensional health-related indicators to measure the development conditions of a region or a unit; 2) a life course approach to promote active aging and construction of suitable systems to promoting the health of children, the labor force and older adults.

Accelerating the Construction of Aged-friendly Cities and Society

First, it is necessary to promote the construction of an age-friendly society by building a healthy environment, renovating a supportive environment,

and establishing an age-friendly basic, sociocultural, and social supporting environment. Meanwhile, a sound system providing health services for older adults led by the government, integrated into and supported by society, should be formed to encourage older adults to create a supportive and inclusive social environment. In addition, providing rich and diverse opportunities for older adults to actively participate in various social affairs can help to realize self-achievement, provide elderly a sense of competence and promote active aging.

Establishing the View of Active Aging in Active Participation, Contribution and Sharing of Society by Older Adults

DG highlights that older adults are the precious wealth and resources of society and the social labor forces that cannot be ignored. With a comprehensive definition of old age, a sound and effective system should be established to improve the participation, contribution and sharing of society by older adults to form a new pattern of modern governance of the aging society. First, the permanent mechanism for developing the human capital of older adults should be established. It is beneficial to give a full role to the market economy, gradually establish a competitive and orderly labor market system for older adults, fully mobilize the enthusiasm of elderly workers to re-employment, promote ways for flexible employment for older adults, activate the stock of human capital, and further improve the efficiency and level of social production. Second, it is important to actively develop the aging industry and cultivate new economic growth drivers for an aging society. Older adults in China have huge consumption potential. Thus, efforts should be made to overcome the current conflict between overcapacity and unmeet diverse demands of older adults, actively adjust the social industrial structure to adapt to population aging and promote the upgrading and transformation of the industrial structure. Driven by the health and demand of older adults, the proportion of the elderly health industry in the entire economy should be increased. In-depth application of the new generation information technology such as fifth generation technology (5G), AI, and big data in the field of population aging and health should be explored to cultivate new driving forces for social economic development.

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