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Study on Some Indicators of Healthy Life Expectancy in the Democratic People's Republic of Korea

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Abstract: Nowadays it is one of the important issues to work out and analyze how long people lead a healthy life in order to clearly understand the health status of population in our country and to take countermeasures for the improvement of their health. Compute the disability life expectancy and disability-free life expectancy (DFLE) in DPRK by sex, age group, urban and rural areas, and types of disability among several indicators which reflect the healthy life expectancy of the population. For the first time, the 2008 census in DPRK provided data on degree of impairments related to human activities. The disability life expectancy is derived from the method commonly used in life expectancy calculation and the DFLE is derived in continuous time and, because of data limitation, implemented using piecewise-constant disability prevalence. (Hereunder disability life expectancy will be expressed as life expectancy.) The life expectancy (LE) of men at birth is 65.6 years and that of women is 72.7 years in DPRK. The life expectancy is 70.5 years in urban areas and 67.6 years in rural areas. The LE at age 60 is 13.2 years for males and 19.1 years for females. The DFLE at age 60 is 8.1 years for males and 10.8 years for females. In DPRK, women live longer than men, on average, but spend more years of living with disability. People in urban areas live longer than those in rural areas and they spend more years of living, free of disability. Such calculation and analysis will contribute to the promotion of the public health effectively in the future.

Keyword: Life Expectancy, Health, Disability, Disability Free Life Expectancy

1. Introduction

Disability causes the decrease of human abilities to take an active part in socio-economic activities. Surveys and studies on the disabled population are of great significance in preventing disability, recovering their health and encouraging them to take an active part in social life and production. [1]

In the DPRK the state takes absolute responsibility for the disabled people and fully ensures their lives, thus introduce various policies in order to protect them. On June 18th, 2003 the Law on the Care for the Disabled was adopted in the DPRK. The law related to the protection of the disabled defines the disabled as the person who is unable to lead a normal life for a long time due to mental or physical disability and some kind of limited abilities. And in the Law it says that the state takes full responsibility for the disabled people's lives and protects them. [3-7] In 2007, the Population Centre of the DPRK organized a survey on the health status of the population and the 2008 Census carried out by CBS included questions to measure the disability status of the population. [8-11]

The 2008 Population Census collected, for the first time, data on disability i.e. limitations with activities of daily living using the International Classification of Functioning, Disability and Health (ICF). ICF is the framework used by the World Health Organization (WHO) for measuring health and disability status for both individual people and entire population. In the 2008 Census of DPRK, different types of disabilities were distinguished: disability with seeing, hearing, mobility and memory. In this paper, the data on disability status are used to compute indicators on health status at the nationwide level and in urban and rural areas as well as for males and females. The main indicators are disability life expectancy and the Disability-Free Life Expectancy (DFLE). [12-16]

2. A Note on Health Indicators

Health indicators fall into two general categories: health expectancy and health gaps. Health expectancy measures how long people can expect to live without certain diseases or limitations on their normal activities. It is a summary measure indicator of population health that combines the impact of mortality and morbidity. Such indicators are health-adjusted life expectancy (HALE) or health expectancy, disability-free life expectancy (DFLE) and active life expectancy (ALE). HALE is the main indicator of population health which measures how long people are likely to lead a healthy life. [17-19] Active life expectancy is an indicator which shows how good their functional status is, in terms of people's daily life activities. Other measures of functional disability exist.

Health gaps choose a norm or goal for the population (such as an average age at death of 75), and quantify the difference between the actual health of the population and the goal. Health gap measures determine the potential years of life lost due to premature deaths and years of life in worse than full health. The gap measures the difference between actual population health and some specified norm. The most commonly used health gap measure is the disability-adjusted life years (DALYs). [20] The Disability Adjusted Life Year is a quantitative indicator of burden of disease that reflects the total amount of healthy life lost, due to all causes, either from premature mortality or from some degree of disability during a period of time. Other measures are included in the disability-free life expectancy (DALE).

3. Data

The main data source is the 2008 population census. The Census was conducted between 1st and 15th October 2008 with a reference date of 1st October 2008. Data collection was done through house-to-house interviewing by enumerators using the census questionnaire.

The Census included the question "Did any member of this household die between 1 Oct. 2007 and 30 Sept. 2008?". For dead household members, the sex, date of birth and date of death were recorded. In addition to this the age at death in completed years was recorded. The place of residence (urban, rural) and province of the dead person at time of death was not recorded; it was taken as the place of residence of the household at the time of the Census. The census includes all individuals living in private households, institutional living quarters. The total population was 24 million 52 thousand. (Census report from CBS, 2009)

In this paper, the life expectancy is based on the number of deaths and civilian population recorded in the 2008 Census and published in the National Report of the 2008 Census.

People at the age of over 5 were asked whether they have (a) difficulty seeing, even if wearing glasses, (b) hearing, (c) walking or climbing stairs, or (d) remembering or concentrating. The respondent could select between four possible responses: no difficulty, some difficulty, a lot of difficulty and "cannot do at all" (Central Bureau of Statistics, 2008). The approach used to identify a disabled person was adopted from the International Classification of Functioning, Disability and Health (ICF).

The degree of a limitation was self-reported. Answers may be affected by cultural, educational and other differences in the interpretation of the questions and the evaluation of one's health status. All data are recorded on the degree of the self-reported impairments. A person is disabled if, at the time of the census, he or she is experiencing some type of long term or permanent impairment or handicap that affects his ability to function normally. Unless a person responded that he could do all the above mentioned body functions without difficulty, he/she is regarded as one with disability (report from Central Bureau of Statistics on 2008 Census in DPRK, 2009).

Table 1. *Age specific disability rate by sex on national level.*

Age	Total Disability Rate	Male Disability Rate	Female Disability Rate
5-9	0.0033	0.0035	0.0031
10-19	0.0059	0.0063	0.0055
20-29	0.0102	0.0112	0.0091
30-39	0.0183	0.0195	0.0171
40-49	0.0413	0.0395	0.0431
50-59	0.1232	0.1098	0.1355
60-69	0.2968	0.2814	0.3085
70-79	0.4986	0.4925	0.5013
80+	0.6723	0.8559	0.6440

The data are given by 10 year age intervals for people at the age of over 5. These rates were applied to a life-table population by 5-year age group, assuming the same disability rate in two consecutive age groups. Table 1 shows the prevalence of disabled persons with multiple impairments.

The 2008 Census is the major source of data on functional impairment. The Census provides other data on disability, in addition to the data described above. The Census records the activity status of persons aged 16 and over, excluding people who serve the army. The census asked each person what his or her usual activity was for the six months prior to the Census. The Census indicates that 80 percent of the males at the age of over 16 are working, compared to 62 percent of the females.

If a person is not engaged in economic activity (not working), his or her usual activity might be studying, doing household chores, or doing something else for reasons of incapacity or retirement. The proportion of incapacitated is 1.2 percent of the age 16+ population for males and 0.7 percent for females. It is a little higher in rural areas than in urban areas. The proportion varies with age. At age 50-59, it is 2.4 percent for males and 1.1 percent for females. Data is not given at the age of over 60(retirement age).

In 2007, the Population Centre conducted a survey among the elderly population to determine their health status. In that survey about 43% of the elderly answered that they were in "good health", while 33%, replied "normal" and the rest, in "poor health". More than half of the elderly (57 percent)

reported a disease. The most frequently occurred diseases were high-blood pressure which was the highest rate (17.8%), backache (15.2%), heart disease (12.1%), and arthritis (10.1%). (Korean Federation for Care of the Aged, 2012)

4. Method

The disability free life expectancy (DFLE) combines age-specific death rates and age-specific disability rates. The method of estimating DFLE was first proposed by Sullivan (1971) and is known as the Sullivan method. The Sullivan method is the most widely used method for the estimation of DFLE.

The World Health Organization (WHO) uses the Sullivan method to compute the healthy life expectancy (HALE), which is the health indicator used by WHO for post-2015 global health monitoring.

In what follows, we derive the DFLE in continuous time and then introduce assumptions imposed by the data availability.

First we compute the survival function and the years-lived function from mortality rates. Let $\mu(x)$ be the instantaneous rate of death at age x and assume that the rate is time-invariant. Under assumption of stationary, the survival function $l(x)$ also gives the age distribution of the population.

The probability that an individual is alive at age x is

$$l(x) = \exp\left[-\int_0^x \mu(t)dt\right] \quad (1)$$

The expected number of years lived between ages x and x+5 is the area under the survival function between ages x and y.

$${}_0L(x, x+5) = \int_x^{x+5} l(t)\,dt = \int_x^{x+5} exp\left[-\int_0^t \mu(\tau)d\tau\right]dt = l(x)\int_x^{x+5} exp\left[-\int_x^t \mu(\tau)d\tau\right]dt \quad (2)$$

Since the death rates are for 5-year age groups, we assume that death rates are piecewise constant, i.e. constant in age groups from x to x+5. In that case, the expected number of years lived between ages x and x+5 are:

$${}_0L(x, x+5) = l(x)\int_x^{x+5} exp\left[-m(x)\int_x^t d\tau\right]dt = l(x)\int_x^{x+5} exp\left[-(t-x)\ {}_5m(x)\right]dt \quad (3)$$

where ${}_5m(x)$ is the individual death rate during the age interval from exact age x to, but not including, exact age x+5.

The integral represents the number of years the individual may expect to live between x and x+5, on condition that he is alive at exact age x.

It is denoted by ${}_xL(x, x+5)$.

$${}_xL(x, x+5) = \frac{1-exp\left[-(x+5-x)\ {}_5m(x)\right]}{{}_5m(x)} = \frac{1-exp\left[5\ {}_5m(x)\right]}{{}_5m(x)} \quad (4)$$

The death rate ${}_5m(x)$ is an occurrence-exposure rate, which is the ratio of the probability of dying in the age interval from x to x+5 and the expected number of years lived during that interval.

$${}_5m(x) = \frac{\int_x^{x+5} l(t)\mu(t)dt}{\int_x^{x+5} l(t)dt} \quad (5)$$

The individual death rate in the interval x to x+5 is a weighted average of the instantaneous death rate $\mu(t)$ where t varies from x to x+5.

The weights are supplied by the survival function $l(t)$.

The individual death rate ${}_5m(x)$ is estimated from the 2008 Census data on numbers of deaths 12 months prior to the census and the population at the time of the census (1st October 2008). For deaths, the date of birth, the date of death and the age at death they are recorded in completed years.

The tabulated data show the number of deaths by age at the time of death. To be consistent with the data from census report, the death rate during age interval from x to x+5 is computed by dividing the number of deaths of persons aged x to x+4 in completed years by the population aged x to x+4 at the time of the census. It slightly overestimates the person-years lived by persons aged x to x+4 at time of the census 12 months prior to the census.

The age-specific death rate estimated from the 2008 Census data, ${}_5M(x)$, is set equal to the individual death rate (or life-table death rate) ${}_5m(x)$. Anomalous features of the age distribution of the population may result in ${}_5M(x)$ being not a very good estimator of ${}_5m(x)$.

Since the population of DPRK is close to a stationary population, we equate the individual or life-table death rate to the empirical death rate based on the 2008 Census data.

The life expectancy at age x is

$$e(x) = \frac{1}{l(x)}\int_x^{\omega} l(t)\,dt = \sum_{y=x}^{z-5} {}_xL(y, y+5) + {}_xL(z) \quad (6)$$

where ω is the highest age and z is the first age of the highest, open-ended age interval.

In the 2008 Census, a person is disabled if the person has a physical or mental condition that affects his or her ability to function normally. Consider two states: free of disability (state 1, say) and disability (state 2, say). At any age, a person alive is in either of these two states.

Let $\pi(x)$ denote the probability that a person of exact age x is disabled, e.g. the probability in state 2. The probability that a person is free of disability at age x is the probability of surviving to age x and the probability of being without disability, on condition that he su

$$h(x) = [1-\pi(x)]l(x) \quad (7)$$

In a multistate (2-state) perspective on disability status, $\pi(x)$ and $h(x)$ *are* state probabilities, $\pi(x)$ is a conditional probability and $h(x)$ is an unconditional probability. The disability free life expectancy at age x (DFLE(x)) is

$$DFLE(x) = \frac{1}{l(x)}\int_x^{\omega} h(t)dt = \frac{1}{l(x)}\int_x^{\omega}[1-\pi(t)]l(t)dt \quad (8)$$

In the 2008 Census, disability data are published by age group of 10 years, except for the first age group for which disability data are available (age group 5 - 9) and the highest, open ended age group (80+). To estimate the disability function $\pi(x)$ we assume that the function is piecewise constant. In other words, the probability of being disabled at a given age, on condition that he survives, is the same for all ages in that age interval. The probability is estimated by the proportion of persons in a given age interval that is disabled, which is the disability prevalence.

The estimation of the survival function from period mortality rates and the estimation of the disability function from cross-sectional disability show that DFLE can be calculated without deviation under the assumption of stationary population. Since the population in DPRK is close to a stationary population, the bias in the estimate is likely to be small, except for the bias introduced by using broad age groups of 10 years.

Let *D(x, x+n(x))* denote the prevalence of disability in age group from x to x+n(x), with n(x) the length of the age interval with x as the lowest age. n(x) depends on x. Its value is 10 years except for the lowest and highest age group.

The prevalence of disability is often denoted as disability rate. It is not an occurrence-exposure rate, but the proportion of people aged between x and x+n(x) who are disabled at a given point in time.

The expected number of years a person may live without disability between ages x and x+n(x) is:

$$_0LF(x,x+n(x)) = \frac{1}{l(x)}\int_x^{x+n(x)} h(t)dt = \frac{1}{l(x)}\int_x^{x+n(x)}[1-\pi(t)]l(t)dt \quad (9)$$

If the disability prevalence is the same for all ages between x and x+n(x), then the expected number of years without disability between x and x+n(x) may be written as:

$$_0LF(x,x+n(x)) = [1-D(x,x+n(x))]\ _0L(x,x+n(x)) \quad (10)$$

The disability-free life expectancy at age x is

$$DFLE(x) = \sum_{y=x}^{z}\ _xLF(x,x+n(x)) \quad (11)$$

A person who is disabled at age x is likely to spend more years with disability during the coming n years than a person who without any functional limitation at age x.

In this paper, we compute the life expectancy without disability at age 5 because the prevalence of disability below age 5 is not available.

5. Results

In this section, we present the results of our analysis. First, we present the life expectancy and the DFLE for the country. Next we present the life expectancy and the DFLE for urban and rural areas. In addition to this we present life expectancies at age 0, 5 and 60. The disability life expectancy is at age 5 and 60. The DFLE at age 0 cannot be computed because disability rates are not available for age 0.

5.1. Life Expectancy (LE) and Disability-Free Life Expectancy (DFLE) in DPRK

The official estimate of the LE at birth from 2008 census is 65.6 years for males (65.3 in our calculation) and 72.7 years for females (72.6 in our calculation). It is 69.3 for males and females combined (69.2 in our calculation). The gender gap LE at birth is 7.1 years at age 0.

The LE at age 5 is 62.2 for males and 69.4 for females (66.0 for males and females combined).

The DFLE at age 5 is 56.5 for males and 60.3 for females (58.5 for males and females combined). The difference between LE and DFLE is 5.7 years for males and 9.1years for females.

That difference reflects the expected number of years with disability. Data on disability from the observation in DPRK is similar to that from observations in most other countries: females live longer than malesbut spend also more years with disability. Males spend 9.1 percent of their expected lifetime with at least some difficulty in one of these 4; seeing, hearing, walking or remembering. Females spend 13.2 percent of their expected lifetime with at least some functional impairment. The difference in DLFE between males and females depends on difference in age-specific mortality and disability rates.

The disability rates for males and females vary considerably by age. Figure 1 shows the ratio of female disability rate to male disability rate, by age. The figure indicates that in age group 20-29, the disability rates of females is lower than males and it is 60 percent of the disability rate of males. At age 50-59, females are showing a higher prevalence of disability than males.

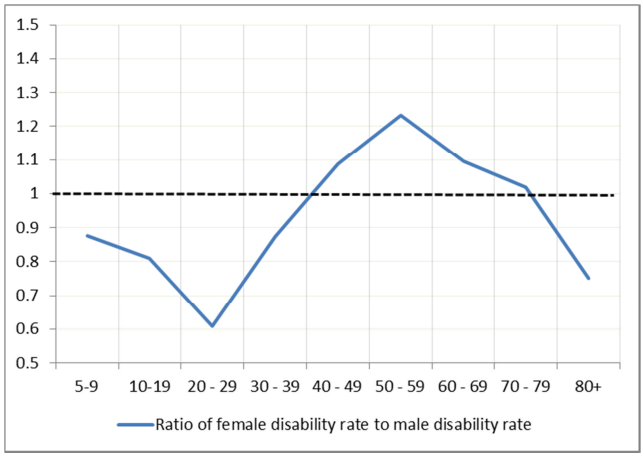

Figure 1. *Ratio of female disability rate to male disability rate.*

5.2. Life Expectancy and Disability-Free Life Expectancy in Urban and Rural Areas

People in urban areas live longer than people in rural areas.

At age 5, the difference is 2.6 years. The life expectancy at age 5 is 66.9 years in urban areas and 64.3 years in rural areas (Table 2). The difference between urban areas and rural areas in the life expectancy at age 5 is 2.4 years for males and 2.5 years for females. People in urban areas not only live longer, but they are also in better health. Disability rates are higher in rural areas than in urban areas. The higher disability rates in rural areas combined with a lower life expectancy result in almost the same number of years with disability in urban and rural areas.

The DFLE at aged 5was 59.4 years in urban and 56.9 years in rural areas, a difference of 2.5 years. Differences between urban and rural areas are small. Males in urban areas spend 8.9 percent of their expected lifetime with disability. Males in rural areas spend 9.5 percent of their expected lifetime with disability. The difference is smaller for women (12.9 percent in urban areas and 13.3 percent in rural areas).

Table 2. *Differences between LE and DFLE of the population group at age 5.*

Regions	Total			Male			Female		
	LE	DFLE	(LE-DFLE)	LE	DFLE	(LE-DFLE)	LE	DFLE	(LE-DFLE)
National level	66.0	58.5	7.5	62.2	56.5	5.7	69.4	60.3	9.1
Urban area	66.9	59.4	7.6	62.7	57.1	5.6	70.4	61.3	9.2
Rural area	64.3	56.9	7.4	60.3	54.6	5.7	67.9	58.9	9.1

The table shows that differences of LE and DFLE in urban and rural areas are very similar to the difference in national level.

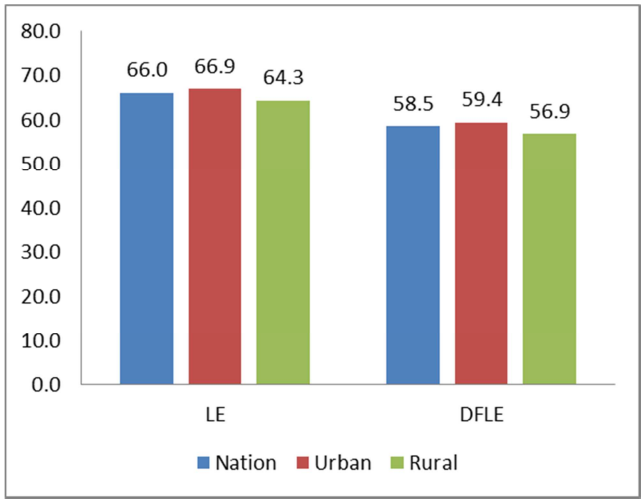

Figure 2. *LE and DFLE by nation and regions at age 5.*

Figure 2 shows that population in urban areas live almost 2.5 years longer than that in rural areas and they also lead a healthier life. This difference is related to the fact that there are more disabled people in rural areas than urban areas.

Table 3. *Disability rate in urban and rural areas.*

Regions	Number of population	Number of disabled	Disability rate
Urban	13161784	1023172	0.0777
Rural	8478036	743201	0.0877

The disability rate in urban areas is 7.77% and 8.77% in rural areas.

We can also look the difference pattern between male and female in urban and rural areas. In this case, the total difference pattern in urban and rural areas is a little different with the pattern by sex in same areas.

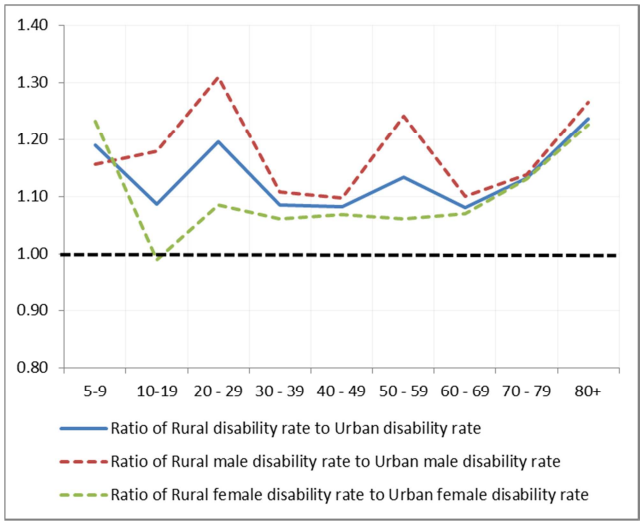

Figure 3. *Difference in Ratios of disability by sex in urban and rural areas.*

Figure 3 shows the difference in disability rates in rural and urban areas considering the ratio of disability rate in rural and urban areas by age and sex. The difference is higher for males than for females, particularly in age group 20-29 and 50-59.

5.3. DFLE According to Types of Disability

The impairments with the highest prevalence in DPRK are difficulty in seeing (even with glasses) and difficulty in walking. 32 percent of men with impairment and 28 percent of women with impairment were reported to have difficulty in seeing. Also 30 percent of men with impairment and 31 percent of women with impairment were reported to have difficulty in either walking or going upstairs. Figure 4 shows

the percentage of disabled men and women according to the types of disability.

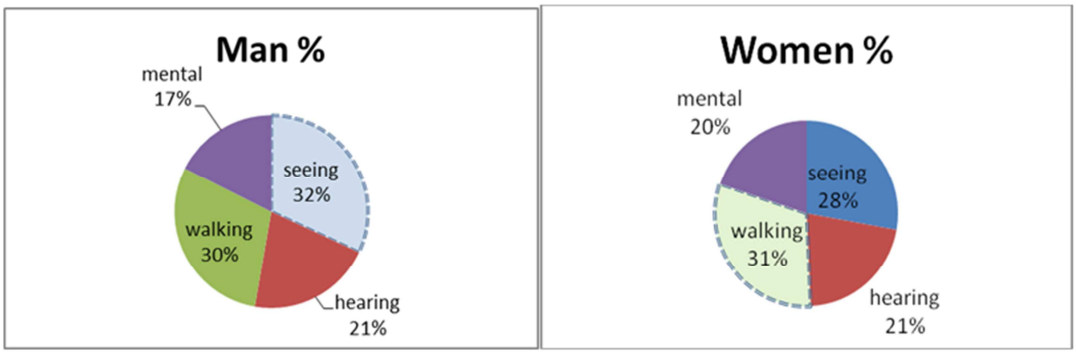

Figure 4. *Percentage of men and women disabled.*

The disability rates according to types of disability were used to compute the DFLE according to types of disability.

The DFLE at age 5 by types of disability is the DFLE when only one impairment is considered and other impairments are omitted from the analysis. For instance, if difficulties in walking or going upstairs are the only impairment considered, then the life expectancy without walking disability is 63.7 years and the expected number of years with disability is 2.3 years (Table 4).

Table 4. *Difference in LE and DFLE at age 5, by types of disability and sex.*

Classification	Total		Male		Female	
	LE	Difference	LE	Difference	LE	Difference
Nation LE	66.0		62.2		69.4	
DFLE/seeing	63.9	2.1	60.4	1.8	67.0	2.4
DFLE/hearing	64.4	1.7	61.0	1.2	67.4	2.0
DFLE/walking	63.7	2.3	60.6	1.6	66.6	2.8
DFLE/mental	64.6	1.5	61.2	1.0	67.6	1.9

In this table, the "Difference" part of the table shows the difference between LE of country and disability type specific DFLE in three categories (Total, Male, Female), respectively.

5.4. Life Expectancy and Disability-Free Life Expectancy at Age 60+

Life expectancy analysis of this age group is important in the light of the situation that the country's population is ageing and the demand for countering this problem becomes more and more urgent. According to the results of the analysis the LE at age 60 is 16.6 years; 9.7 years are free of disability and 6.9 years are with disability. (Table 5)

Women live longer but spend more years with disability than men. Women also spend a higher proportion of the remaining lifetime with some type of disability (43.5 percent versus 38.6 percent).

Table 5. *LE at age 60 and DFLE at age 60 by sex.*

Indicators	Nations		
	Total	Male	Female
LE at aged 60	16.6	13.2	19.1
DFLE at aged 60	9.7	8.1	10.8
Difference	6.9	5.1	8.3

In DPRK, LE at age 60 is 16.6 years; 13.2 years for male, and 19.1 years for female. And DFLE at age 60 is 9.7 years; 8.1 years for male, and 10.8 years for female. Therefore, the difference between LE and DFLE is 6.9 years; 5.1 years for males, and 8.3 years for females. Persons aged 60 live for about 7 years with disability.

Table 6. *LE and DFLE at age 60 in urban and rural areas, by sex.*

Indicators	Urban			Rural		
	Total	Male	Female	Total	Male	Female
LE at aged 60	17.2	13.7	19.8	15.6	12.5	18.2
DFLE at aged 60	10.4	8.6	11.6	8.8	7.5	9.9
Difference	6.9	5.0	8.2	6.9	5.1	8.3

Table 6 shows the LE and DFLE in urban and rural areas. The differences between urban and rural areas are small. This can be explained by the fact that there is a slight difference in living conditions and health care system between urban and rural areas.

The DPRK government has been introducing people-oriented policies to entirely take care of the older people's lives and health in conformity with the demands of the changing reality.

6. Conclusion

Based on data from the 2008 Population Census of the DPRK, a boy at age 5 may expect to live 62.2 years and spend 9.1 percent of the remaining lifetime with some type of impairment. A girl at age 5 may expect to live 69.4 years and spend 13.2 percent of the remaining lifetime with some type of disability. This means that men live 5.7 years with some

disability and as for women, 9.1 years. People in urban areas live longer than people in rural areas, but they spend almost the same number of years with some type of disability.

In order to fully display the advantages of our socialist system and implement people-oriented health care policies, it's of great importance to conduct surveys and do research on the health status of the population in the future.

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