Impact of Musculoskeletal Disorders on Healthy Life Expectancy in Japan

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Original research article

Impact of musculoskeletal disorders on healthy life expectancy in Japan

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ABSTRACT

Background: Musculoskeletal disorders are the key cause of morbidity in elderly people. However, the exact clinical reasons for musculoskeletal disorders related to healthy life expectancy remain elusive. Hence, we aimed to estimate gains in healthy life expectancy from the elimination of musculoskeletal diseases and injuries by using recent national health statistics data in Japan.

Methods: The present data were used from the population, life tables, and the number of deaths in Japan in 2016. Data regarding the activity and disease status of persons living at home were obtained from the 2016 Comprehensive Survey of Living Conditions. We selected eight disorders including musculoskeletal diseases and injuries from the above data: rheumatoid arthritis, arthrosis, low back pain, osteoporosis, fracture, malignant neoplasms, ischemic heart disease, and cerebrovascular diseases. After eliminating each disorder, we calculated the prevalence of limitations in the activities of daily living (ADL) in the population after excluding outpatients with the disorder and ADL limitations, inpatients with the disorder in hospitals and clinics, and people with the disorder who reside in long-term elderly care facilities. The prevalence of non-ADL limitations in the population was calculated after excluding outpatients with the disorder and non-ADL limitations.

Results: Musculoskeletal diseases and injuries generally decreased expected years at birth with activity limitations. In particular, eliminating low back pain and arthrosis decreased expected years at birth with activity limitation to the greatest extent in selected diseases and injuries (male: 0.9 years, female: 1.5 years). However, eliminating malignant neoplasms increased the expected years at birth with activity limitation (male: 1.3 years, female: 1.2 years). In addition, a combination of arthrosis and low back pain led to a moderate decrease in expected years with both ADL (male: 0.7 years, female: 1.1 years) and non-ADL limitations (male: 0.3 years, female: 0.4 years). In

contrast, the elimination of malignant neoplasms increased the expected years with both ADL (male: 0.5 years, female: 0.3 years) and non-ADL limitations (male: 0.8 years, female: 0.9 years). **Conclusions**: These findings provide clinical evidence that low back pain and arthrosis are the key conditions that can be addressed to prolong healthy life expectancy.

Keywords: disability-free life expectancy; healthy life expectancy; life expectancy; activities of daily living; health statistics

INTRODUCTION

The world is seeing a rapid increase in the aging population compared to years past. Worldwide, 22% (2 billion) of the population is expected to be over 60 years of age by 2050 up from 12% (900 million) in 2015. More than 80% of older people will be living in low- and middle-income countries in 2050. Changes in the proportion of the population older than 60 years have been adopted by many countries in the past few decades[1]. Based on the estimation by the World Health Organization (WHO), 40% of people over 60 years of age experience musculoskeletal disorders, and 80% had low back pain at some point in their lives[1, 2]. Musculoskeletal disorders are the key cause of morbidity in elderly people[3]. The musculoskeletal system regulates the ability to move, and overcoming musculoskeletal disorders may extend healthy life expectancy[4].

Healthy life expectancy is an intuitive and meaningful measure of population health and represents a long and healthy life lived, expressed as a percentage of overall life expectancy[5, 6]. Japan was the top country with the world's longest healthy life expectancy and life expectancy for both sexes in 2013. The increasing trends and significant changes were still being demonstrated in Japan from 1990 through 2013, relating to healthy life expectancy[7]. The gap between life expectancy and healthy life expectancy in older age create a considerable economic and social burden[1]. The voluminous report indicated that musculoskeletal disorders have a noticeable impinge on healthy life expectancy. However, the exact estimate gains in healthy life expectancy by eliminating musculoskeletal diseases and injuries remain elusive. Disability-free life expectancy after eliminating injuries and diseases was proposed as an indicator of disease burden. We have previously calculated gains in life expectancy and healthy life expectancy by using the Japanese National Health Statistics data and eliminating selected diseases and injuries[8]. This study aims to estimate gains in healthy life expectancy by eliminating musculoskeletal diseases

and injuries using the recent national health statistics data in Japan, a country with the fastest growing population in the world.

METHODS

Data

The present data were obtained from the population, life tables, and the number of deaths in Japan in 2016[9, 10]. The activity status and disease status data of persons living at home were obtained from the 2016 Comprehensive Survey of Living Conditions[11]. All data were collected using self-administered questionnaires distributed to 710 000 people in randomly selected households nationwide. The data of patients who were admitted to hospitals and clinics were obtained from the Patient Surveys in 2014 and 2017, which included information on 5 000 000 randomly selected patients throughout Japan[12]. Data of 110 000 elderly individuals admitted to healthcare and welfare facilities for long-term care ("residents of long-term elder care facilities" hereafter) were obtained from the 2016 Survey of Institutions and Establishments for Long-term Care[13]. Data from all three surveys were used with the approval of the Ministry of Health, Labour and Welfare of Japan, and the Ministry of Internal Affairs and Communications.

Activity limitation

For persons who are living at home, activity status was determined based on their replies to the survey questions: "Is your current daily life affected by health problems?" and "How is it affected?"[11]. Participants who responded "yes" proceeded to the second question. There were various responses to the second question, including limitations in "activities of daily living (ADL) (rising, dressing/undressing, eating, bathing, etc.)," "going out," "work, housework, or schoolwork," "physical exercise (including sports)," and "other." Responses were classified into

three levels of activity: (i) ADL limitation, (ii) non-ADL limitation, and (iii) no activity limitation. Persons who are in hospitals and clinics as inpatients and residents of long-term elderly care facilities were considered to have ADL limitation.

Disease status

We selected eight disorders: rheumatoid arthritis (International Classification of Diseases, 10th Revision [ICD-10] code: M05–M06), arthrosis (M15-M19), low back pain (M40-43, M45-49, M50-51, M53.0, M54.3-M54.5), osteoporosis (M80-M82), fracture (S02, S12, S22, S32, S42, S52, S62, S72, S82, S92, T02, T08, T10, T12, T14.2), malignant neoplasms (C00–C97), ischemic heart disease (I20–I25), and cerebrovascular disease (I60–I69). For persons living at home, disease status was assessed using responses to the following questions: "Are you currently seeking care at a hospital, clinic, or facility of traditional Japanese massage, acupuncture, moxibustion, or judo-orthopedics for diseases or injuries?" and "What are your diseases or injuries?"[11]. Persons who replied "Yes" proceeded to the next question, which has three options: "any of the 8 disorders (39 diseases and injuries categorized under the 8 disorders),” "other disorders," and "unknown." Persons who responded to have any of the eight disorders were classified as outpatients. For persons who are in hospitals and clinics as inpatients and residents of long-term elderly care facilities, their primary medical condition was used to determine the presence or absence of the eight disorders[12, 13]. The primary cause of death was analyzed[12, 13].

Calculation of gains in years with and without activity limitation expected from elimination of disorders

Anticipated years of life with and without activity limitation that would be gained from eliminating each of the above eight disorders in Japan as of 2016 were calculated. As with our previous report[8], gains were calculated as the difference in the number of years with versus without the

disease, based on a previous study by Colvez et al. [14].

By using the data regarding the number of deaths and life tables without disease elimination, we constructed a life table that eliminated deaths caused by disease. We expressed the probability of survival in age group x with the disease eliminated (p_x^e) based on the probability of disease elimination (p_x), the number of deaths (D_x) from all diseases and injuries, and the number of deaths from the disease (D_x^e), as follows:

$$\ln(p_x^e) = (1 - D_x^e/D_x)\ln(p_x)$$

Here, ln is a natural logarithm function, and the age groups are 0 to 4, 5 to 9,…, 80 to 84, and 85 years or older. According to Chiang's life table method[15], we calculated the number of survivors (l_x^e) and the stationary population (L_x^e) from the values of p_x^e.

The 2016 sex- and age-specific prevalence of ADL and non-ADL limitations were calculated after eliminating a given disorder. After eliminating a disorder, the prevalence of ADL limitation in the population was calculated after excluding outpatients with the disorder and ADL limitations, inpatients with the disorder in hospitals and clinics, and individuals with the disorder residing in long-term elderly care facilities. After eliminating a disorder, the prevalence of non-ADL limitation in the population was calculated after excluding outpatients with the disorder and non-ADL limitations. The prevalence of inpatients in 2016 was estimated from those in 2014 and 2017 using linear interpolation, and the prevalence in 2016 was based on the abovementioned data. According to the Sullivan method[16], years of life in age group x (e_x^e) expected after eliminating a disease are divided into those with or without activity limitation, as follows:

$$e_x^e = \Sigma\pi_y^e L_y^e/l_x^e + \Sigma(1 - \pi_y^e)L_y^e/l_x^e$$

Here, Σ represents the sum from age group x to the oldest age group in the age group of y. π_y^e is the age-specific prevalence of activity limitation after eliminating the disorder. The years with

activity limitation expected after eliminating a disorder were divided into those due to ADL limitations and those due to non-ADL limitations.

RESULTS

The death rate, prevalence, and proportion of selected disorders by age group in males and females are shown in Tables 1 and 2, respectively. While rheumatoid arthritis, arthrosis, low back pain, osteoporosis, fracture, and arthrosis and low back pain were associated with low death rates, malignant neoplasms, ischemic heart disease, and cerebrovascular diseases were associated with high death rates. Arthrosis and low back pain affected large proportions of outpatients in both the 0 to 64 years and the 65 years or older age groups. Meanwhile, cerebrovascular diseases affected many residents of long-term elderly care facilities and inpatients among those aged 65 years or older. Among outpatients, fracture affected the lowest proportion of those with no limitation of activities and the highest proportion of those with an ADL limitation.

Baseline years and gains at birth, with and without activity limitation expected after eliminating the selected disorders, are shown in Table 3. Life expectancy at birth was 81.0 years in males and 87.1 years in females. The number of expected years without and with activity limitation was 71.4 and 9.6 years in males and 73.7 and 13.5 years in females, respectively. There were small gains in life expectancy from elimination of rheumatoid arthritis, arthrosis, low back pain, osteoporosis, fracture, arthrosis, and low back pain (0.0–0.1 years) and large gains from eliminating cerebrovascular diseases, ischemic heart disease, and malignant neoplasms (0.4–3.7). Elimination of rheumatoid arthritis, osteoporosis, and fracture slightly increased the expected years without activity limitation (0.1–0.4) and slightly decreased years with activity limitation (0.1–0.4 years). Elimination of arthrosis, low back pain, and arthrosis and low back pain moderately

163 increased expected years without activity limitation (0.3–1.5 years) and decreased years with
164 activity limitation (0.3–1.5 years). The elimination of malignant neoplasms greatly increased the
165 expected years, both without and with activity limitation (1.7–2.4 and 1.2–1.3 years, respectively).
166 Elimination of ischemic heart disease and cerebrovascular diseases increased the expected years
167 without activity limitation (0.3–0.8 years); however, there were only minimal changes in years
168 with activity limitation after eliminating these diseases (≤0.2 years).

169 At birth, the expected years with non-ADL and ADL limitations were 5.2 and 4.5 years in
170 men and 6.5 and 6.9 years in women, respectively. Elimination of rheumatoid arthritis, arthrosis,
171 low back pain, osteoporosis, and fracture decreased expected years with ADL limitations (0.0–0.8
172 years) and non-ADL limitations (0.0–0.3 years). A combination of arthrosis and low back pain
173 showed a moderate decrease in expected years with both ADL limitations (0.7–1.1 years) and non-
174 ADL limitations (0.3–0.4). In contrast, the elimination of malignant neoplasms increased the
175 expected years with both ADL limitations (0.3–0.5) and non-ADL limitations (0.8–0.9 years).
176 Finally, the elimination of ischemic heart disease and cerebrovascular diseases led to a small
177 change in expected years with ADL limitations (0.1 years) and non-ADL limitations (0.0–0.1
178 years).

179

180 DISCUSSION

181 The present study demonstrated the degree of gains in healthy life expectancy following
182 elimination of musculoskeletal diseases and injuries, using recent national health statistics data in
183 Japan. Our results indicate that musculoskeletal diseases and injuries generally decreased expected
184 years at birth with activity limitations. In particular, low back pain and/or arthrosis decreased

185 expected years at birth with activity limitations to the greatest extent. These findings provide
186 clinical evidence that eliminating low back pain and arthrosis are the key factors for the elongation
187 of healthy life expectancy.

188 A plethora of clinical research indicates that arthrosis of the knee and hip, and low back
189 pain significantly affect medical, economic, and social status. An interesting study showed that on
190 average, patients with chronic low back pain have life expectancy shortened by 7%, and healthy
191 participants chose a 10% shorter life expectancy to avoid chronic low back pain[17]. A clinical
192 study reported that the personal and societal impact of low back pain is very high in patients who
193 have sought multidisciplinary spine care[4]. In particular, the quality of life and workability are
194 low and health care costs are twice as high as those of patients seeking primary low back pain
195 care[4]. Another study showed a remarkable reduction in the life expectancy of patients with
196 arthrosis and low back pain in the Canadian population[18] and that these patients mainly
197 independently managed the associated limitations these conditions can cause[18, 19]. Adequate
198 clinical research indicates that the increasing prevalence of arthrosis and low back pain in the aging
199 population is the major contributing factor that significantly affects medical, economic, and social
200 status[20, 21]. Interestingly, there are also reports that despite subsidized health care and medical
201 benefits, the impact of arthrosis of the knee and hip on individuals and the society has received
202 significant attention globally, particularly with respect to social consequences and health economic
203 implications that increase community awareness on this important condition[20, 21]. In the present
204 study, recent Japanese health statistics data showed that arthrosis and low back pain were
205 associated with low death rates and affected large proportions of outpatients in all age groups. In
206 addition, we observed that eliminating low back pain and/or arthrosis decreased expected years at
207 birth with activity limitation to the greatest extent in context of selected diseases and injuries.

208 Meanwhile, eliminating malignant neoplasms increased both life expectancy at birth and expected
209 years at birth without activity limitation. However, it also increased the expected years at birth
210 with activity limitation, which might be clinically unethical. These findings indicate that managing
211 back pain and/or arthrosis is very important for decreasing activity limitation. Consistent with our
212 findings, odds ratios and population attributable fractions associated with various diseases/injuries
213 with activity limitations indicated that orthopedic diseases as well as ophthalmic and psychiatric
214 diseases significantly affect activity limitation[22].

215 In 2007, the Japanese Orthopaedic Association (JOA) proposed a locomotive syndrome
216 (locomo) term to increase awareness and gain traction in the community and to educate the
217 population at risk as a means of extending the gains made so far and its management strategies[23–
218 25]. Population aging is associated with a high risk of locomotive syndrome. For example, the
219 Japanese population's average life expectancy is 81.0 years for men and 87.1 years for women.
220 On the other hand, the average healthy life expectancy is only 71.4 years for men and 73.7 years
221 for women, showing a wide gap between life expectancy and healthy life expectancy. Therefore,
222 extended disability-free life expectancy is the only hope of the general population. In this context,
223 increasing public awareness and gaining knowledge of the condition and management strategies
224 of locomotive syndrome and healthy life expectancy is essential, which is the primary goal of the
225 JOA[23–26]. In line with the above studies, our present study provides clinical evidence that
226 locomotive syndrome, which is associated with musculoskeletal diseases and injuries, affects
227 healthy life expectancy, and has medical, economic, and social implications.

228 This study has several limitations. First, although there are various musculoskeletal
229 diseases/injuries and their classification, this study examined only five musculoskeletal
230 diseases/injuries as we were limited to diseases that were included in the Comprehensive Survey

231 of Living Conditions. However, the five selected disorders are among the most important
232 musculoskeletal diseases/injuries. In addition, malignant neoplasms, ischemic heart disease, and
233 cerebrovascular disease, which are the major causes of death in Japan, were added as the target
234 diseases for comparison in the present study. Second, ICD-10 codes were assigned to each disease
235 according to the disease classification of the Patient Surveys in the present study, but it is difficult
236 to assign them identically. Third, the disease information in the Patient Surveys and the Survey of
237 Institutions and Establishments for Long-term Care were based on the diagnosis of the doctor and
238 the nursing specialists, respectively. However, because the disease information in the
239 Comprehensive Survey of Living Conditions was self-reported by the patient, the accuracy may
240 have been limited. Fourth, the underlying causes of death used in national health statistics do not
241 account for the indirect effects of the disease on mortality. In addition, the primary disease in
242 national health statistics does not take into account the effect of secondary diseases. Therefore, the
243 impact of musculoskeletal diseases/injuries on healthy life expectancy in this study may be
244 underestimated. Lastly, the calculation method used in the present study has been adopted in
245 previous studies[8, 11], but it is based on the assumption that "the age-specific prevalence of
246 disability in the stationary population is equivalent to that observed in the real population."
247 Nevertheless, this study clearly demonstrated that elimination of musculoskeletal diseases and
248 injuries decreased the expected years at birth with activity limitation.

249 **CONCLUSIONS**

250 In conclusion, the present study provides evidence that gains in years with and without
251 activity limitation are expected from eliminating selected diseases in Japan. Our results indicate
252 that low back pain and/or arthrosis moderately affect healthy life expectancy, while they do not
253 affect life expectancy among the Japanese population. These findings provide clinical evidence

254 that low back pain and arthrosis are the key conditions that may be addressed to elongate healthy
255 life expectancy.
256

257 **ABBREVIATIONS**

258 ADL, activities of daily living; WHO, world health organization; JOA, Japanese orthopaedic
259 association.

260 **DECLARATIONS**

261 **Ethics approval and consent to participate:** Data from all three surveys were used with the
262 approval of the Ministry of Health, Labour and Welfare of Japan, and the Ministry of Internal
263 Affairs and Communications.

264 **Consent for publication:** Not applicable

265 **Availability of data and materials:** The datasets used and/or analysed during the current study
266 are available from the corresponding author on reasonable request.

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275 Critically revising the article: Morita, Yamada, Kanaji, Nakamura, Matsumoto. Reviewed

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