Risk Management and Healthcare Policy

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Evolution of Low Bone Mineral Density Impact on Older Adults in the Western Pacific: Socio-Demographic and Health Workforce Perspectives (1990–2021)

Chuanqiang Dai[1], Nan Wang[1], Youshu Zhang[1], Guifang Wu[2], Yao Zhang[1], Yao Dong[1]

[1]Department of Orthopedics, Ziyang Central Hospital, Ziyang, Sichuan, 641300, People's Republic of China; [2]Department of Nursing, Ziyang Central Hospital, Ziyang, Sichuan, 641300, People's Republic of China

Correspondence: Chuanqiang Dai, Email daiqq159sc@163.com

Risk Management and Healthcare Policy downloaded from https://www.dovepress.com/
For personal use only.

Background: The Western Pacific Region is experiencing accelerated population aging, and diseases related to Low Bone Mineral Density (LBMD) have become a major public health challenge for the elderly population. Therefore, this study aims to assess the trends in the diseases burden of LBMD among the population aged 60 and above in the Western Pacific Region from 1990 to 2021, as well as its relationship with the human resources for health (HRH).

Methods: Disability-Adjusted Life Years (DALYs) and deaths data from Global Burden of Disease Study (GBD) 2021 and HRH data from GBD 2019 were used. The trends in the burden were evaluated through percentage changes and the Estimated Annual Percentage Change. Decomposition analysis was employed to assess the contributing factors of the burden. The Spearman rank correlation coefficient was used to quantify the correlations between the burden indicators, the Socio-demographic Index (SDI), and HRH.

Results: From 1990 to 2021, the diseases burden of LBMD increased in most countries and regions in the Western Pacific Region. From the perspective of gender stratification, the disease burden of females is generally higher than that of males. From the perspective of age stratification, the age-standardized rates of DALYs and deaths both increase with increasing age. There is a statistically significant negative correlation between deaths and SDI ($p<0.05$). More importantly, there has been a statistically significant negative correlation between deaths and Nursing and Midwifery from 1990 to 2021 ($p<0.05$).

Conclusion: The disease burden of LBMD in the Western Pacific Region remains a major public health issue. Strengthening the construction of HRH is conducive to reducing the burden related to LBMD.

Plain Language Summary: Due to accelerated aging, low bone mineral density (LBMD) is a growing public health challenge in the Western Pacific. This study (1990–2021) found rising LBMD burden, especially in China and among women, correlating with healthcare workforce shortages. Strengthening nursing/midwifery resources could help mitigate this burden, supporting healthier aging.

Keywords: low bone mineral density, human resources for health, Western Pacific Region, aging, Global Burden of Disease Study 2021, disease burden

Introduction

Low Bone Mineral Density (LBMD), which includes low bone mass and osteoporosis, is a condition characterized by a reduction in bone mass caused by increased bone resorption, weakened bone formation, or both.[1] LBMD is defined as a risk factor that may lead to various fracture outcomes, such as hip and vertebral fractures.[2] The World Health Organization defines osteopenia as a BMD T-score between −1.0 and −2.5, and osteoporosis as a T-score of ≤ −2.5, based on the standard deviation score of BMD related to peak bone mass in healthy young people.[3] Studies have shown

Received: 10 July 2025
Accepted: 16 October 2025
Published: 21 November 2025

© 2025 Dai et al. This work is published and licensed by Dove Medical Press Limited. The full terms of this license are available at https://www.dovepress.com/terms.php and incorporate the Creative Commons Attribution – Non Commercial (unported, v4.0) License (http://creativecommons.org/licenses/by-nc/4.0/). By accessing the work you hereby accept the Terms. Non-commercial uses of the work are permitted without any further permission from Dove Medical Press Limited, provided the work is properly attributed. For permission for commercial use of this work, please see paragraphs 4.2 and 5 of our Terms (https://www.dovepress.com/terms.php).

that for every one standard deviation decrease in femoral neck BMD, the risk of fracture increases by two to threetimes,[4] and this may subsequently be accompanied by severe long-term consequences. Hip fractures are associated with a mortality rate of approximately 20% within one year after injury, and survivors may have potential sequelae such as chronic pain, impaired function, and loss of independence.[5] It is estimated that the global prevalence of osteopenia and osteoporosis is 40.40% and 19.75% respectively.[6] The number of global deaths and Disability-Adjusted Life Years (DALYs) caused by LBMD reaches 463,010 and 16.6 million respectively, affecting more than 200 million people worldwide, and these figures are expected to continue to grow in the future.[7,8] On the other hand, osteoporosis is an age-related disease. Aging causes an imbalance in bone remodeling and bone loss,[9] which means that the aging of population and the extension of life expectancy are also exacerbating the burden imposed by LBMD. Therefore, it is essential to understand the current epidemiological patterns and burden, which will help to alleviate the disease burden related to LBMD.

With the acceleration of the population aging in the Western Pacific Region, this region is experiencing a remarkable transformation in its population structure. Currently, more than 260 million elderly people aged 65 and above live in this region, and this number is expected to continue to increase.[10] Aging not only brings about changes in lifestyle and health needs but also significantly increases the burden of age-related chronic diseases.[11] As a disease closely related to age, LBMD has an incidence that increases significantly with age. Especially among the elderly population, the risk of fractures and the resulting disability burden are more severe.[8,12] On the other hand, with the acceleration of population aging in the Western Pacific Region, the health needs of the elderly population are growing increasingly, which poses higher requirements for the healthcare systems and human resources for health (HRH). HRH are crucial for universal health coverage. Health workers play important roles in disease prevention, screening, diagnosis, and treatment, as well as the health management of the elderly.[13] Therefore, an in-depth exploration of the impact of LBMD on the health of the aging population in the Western Pacific Region, and a study of the relationship between HRH and the disease burden related to LBMD, are of great significance for reducing the disease burden of this group and formulating effective public health policies and intervention measures.

Although existing studies have examined the trends in the LBMD-related burden among the elderly population globally and in some regions,[12,14] there are still significant gaps in our understanding of the disease burden attributable to LBMD in the Western Pacific Region. In particular, the association between HRH and the LBMD burden has not been fully explored. Therefore, based on the Global Burden of Disease database, this study conducts a comprehensive and up-to-date assessment of the disease burden attributable to LBMD among the aging population aged 60 and above in the Western Pacific Region from 1990 to 2021. It also focused on analyzing the correlation between this burden and HRH, aiming to fill the gap in this area and provide a scientific basis for formulating targeted public health policies and interventions in the region.

Materials and Methods

Data Sources

This study utilized data from the Global Burden of Disease Study 2021 (GBD 2021) database, a comprehensive health database maintained by the Institute for Health Metrics and Evaluation. GBD 2021 is internationally recognized for its rigorous, peer-reviewed methodology and provides standardized estimates across a broad spectrum of health outcomes, with coverage of 204 countries and territories, 811 subnational locations, 371 diseases and injuries, and 88 modifiable risk factors over the time period 1990–2021. To address the study's research objectives, we systematically selected parameters from the GBD 2021 database across three core dimensions: Risk factor under GBD Estimate; DALYs and deaths under Measure; number and rate under Metric. Number represents the absolute count of DALYs and deaths in the population, while rate denotes the corresponding DALYs and deaths per 100,000 population. LBMD was chosen as the risk factor, and all-cause was selected under Cause. The population of interest was adults aged 60 years and above. The study focused on 31 countries or territories in the Western Pacific region, spanning from 1990 to 2021.[2,15–17] HRH data were obtained from the GBD 2019 Health Workforce Collaborators, covering the period from 1990 to 2019. The dataset included 22 categories of health workers, with density values representing workers per 10,000 population.[13] Since the

information provided by the database does not involve specific patient data, our team has obtained approval for exemption from ethical review from the Institutional Ethics Committee of Ziyang Central Hospital.

Disease and Risk Factor Definitions

According to the GBD 2021 framework, diseases and injuries are categorized into four main levels. Liver cancer is classified under the second level of neoplasms within the first level of non-communicable diseases. Low bone mineral density was defined with a theoretical minimum risk exposure level range of 1–1.3 g/cm2 in GBD 2021.[15,16]

Statistical Analysis

Estimated Annual Percentage Change (EAPC) Model: To depict long-term trends in the age-standardized rates (ASR) of disease burden, we calculated the EAPC by fitting a simple linear regression model of the natural logarithm of ASR against year. The slope of the regression line represents the EAPC, indicating the annual percentage change. The EAPC and its 95% confidence interval were derived from the regression coefficient and its standard error.

Decomposition Analysis: To investigate factors contributing to global disparities in disease burden, we employed decomposition analysis. This method allows for the disaggregation of overall health differences into contributions from various factors, such as population growth, population aging, and epidemiological changes.

Socio-demographic Index (SDI) Analysis: The SDI, developed by GBD researchers, is a composite indicator of development status closely related to health outcomes. We applied LOESS smoothing to visualize trends and conducted Spearman correlation tests to quantify the relationship between SDI and disease burden indicators.

HRH Correlation Analysis: LOESS smoothing was applied to visualize trends, and Spearman correlation tests were performed to quantify the relationship between HRH and disease burden indicators.

Results

The Disease Burden Related to LBMD Among the Population Aged 60 and Above in the Western Pacific Region

In 2021, among the 31 countries and regions in the Western Pacific region, due to China's large population base, the numbers of DALYs and deaths related to LBMD among the population aged 60 and above were the highest. From 1990 to 2021, the countries and regions with the largest percentage increases in the numbers of DALYs and deaths were the Northern Mariana Islands and Australia, reaching 285.11% and 344.82% respectively. It is also worth noting that the numbers of DALYs and deaths in Niue decreased compared to 1990. In 2021, the country with the highest age-standardized DALYs rate (ASDR) and age-standardized mortality rate (ASMR) was Cambodia. From 1990 to 2021, the ASDR and ASMR in 21 countries and regions decreased. The region with the largest decreases in ASDR and ASMR was Guam, and it also had the most significant downward trend. The EAPC values were −1.89 (95% CI: −2.86, −0.92) and −3.89 (95% CI: −5.1, −2.68) respectively. The countries and regions with the largest percentage increases were the Solomon Islands and Australia, and the countries and regions with the most significant upward trends were Kiribati and Australia. The EAPC values reached 1.16 (95% CI: 0.41, 1.9) and 2.06 (95% CI: 1.78 to 2.33) respectively (Figure 1, Tables S1 and S2).

In 2021, from the perspective of gender stratification, the disease burden related to LBMD among women in the Western Pacific region was generally higher than that among men. Specifically, the numbers of DALYs in 28 countries and regions and the numbers of deaths in 22 countries and regions were higher for females than for males. The ASDRs in 25 countries and regions and the ASMRs in 19 countries and regions were also higher for females than for males. From 1990 to 2021, both in terms of the percentage change in numbers and the trend reflected by the EAPC values, the burden on women was heavier than that on men (Figure 2, Tables S1 and S2).

The Age-Specific Burden Related to LBMD Among the Population Aged 60 and Above in the Western Pacific Region

In 2021, the ASDRs and ASMRs in all countries and regions of the Western Pacific increased with the rise of age (Tables S3 and S4). From 1990 to 2021, the percentage changes in numbers, the percentage changes in ASDR, and the estimated

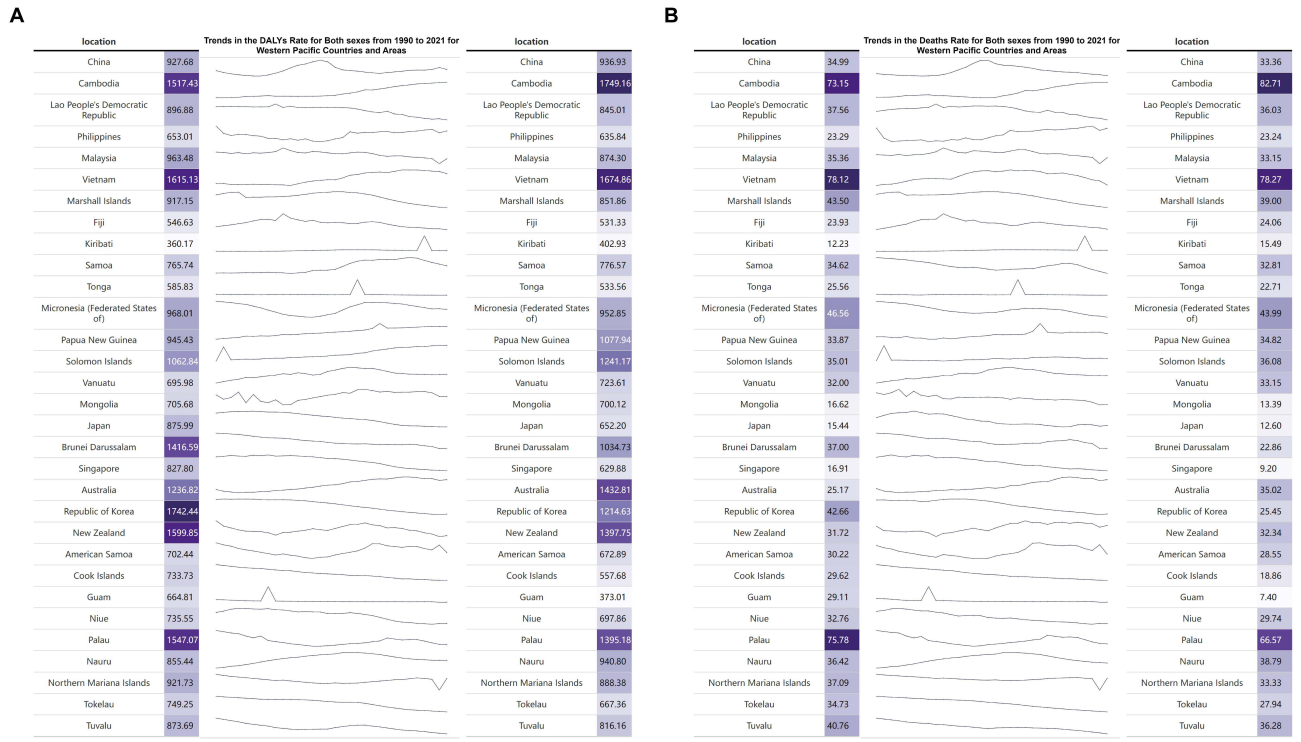

Figure 1 Temporal trends in age-standardized rates of DALYs and mortality associated with low bone mineral density in the Western Pacific region, 1990–2021, for the combined population aged 60 years and older. (**A**) Progression of age-standardized DALY rates from 1990 to 2021. (**B**) Progression of age-standardized mortality rates from 1990 to 2021.

EAPC values in the burden of LBMD in most countries and regions increased with the rise of age. Only in a few regions did the percentage change of ASMR increase with the rise of age. However, overall, the values of the percentage changes in the higher age groups were higher (Figure 3, Tables S3 and S4).

Decomposition Analysis of the Disease Burden Related to LBMD Among the Population Aged 60 and Above in the Western Pacific Region

From 1990 to 2021, except for Niue, the disease burden related to LBMD in other countries and regions increased (Figure 4). Especially in China, as the most populous country, the burden growth was particularly prominent, followed by Japan and VietNam. According to the decomposition analysis, this growth was mainly driven by the population, followed by aging, while the epidemiological change mainly made a negative contribution (Table S5).

The Correlation Between the LBMD Burden of the Population Aged 60 and Above and the SDI in the Western Pacific Region

There was almost no correlation between the SDI and the ASDR in 1990, 2019, and 2021. However, Spearman's R changed from positive to negative (Figure 5A–C). In 1990, there was a weak negative correlation between the SDI and the ASMR, but there was no significant difference. By 2019 and 2021, the negative correlation between the SDI and the ASMR was still weak, but it gradually strengthened compared with that in 1990, and there was a significant difference ($p<0.05$) (Figure 5D–F).

The Correlation Between the HRH and the LBMD Burden of the Population Aged 60 and Above in the Western Pacific Region

There was only a weak positive correlation between the DALYs and environmental health officers in 2019, and there was almost no correlation between DALYs and other health workers. Except for the relationships between Nursing and

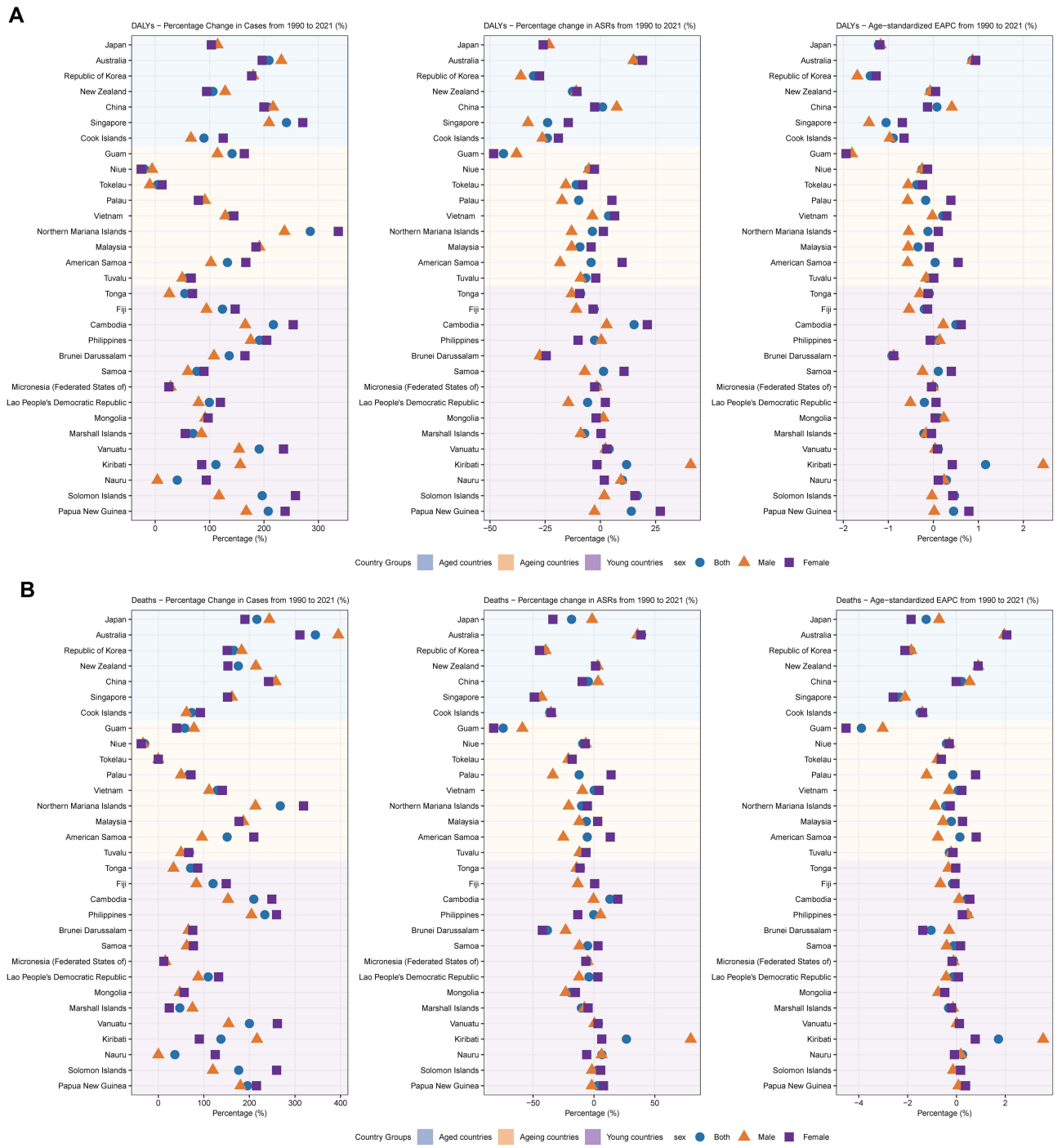

Figure 2 Comparative analysis of changes in burden metrics for low bone mineral density in the Western Pacific region, 1990–2021, stratified by sex for individuals aged 60 years and above. (**A**) DALYs: Percentage change in numbers, percentage change in age-standardized rates, and EAPC in age-standardized DALY rates. (**B**) Mortality: Percentage change in numbers, percentage change in age-standardized rates, and EAPC in age-standardized mortality rates.

Midwifery and radiographers in 2019, the correlation coefficients between DALYs and most health workers were positive (Figure 6A and C). Similar to DALYs, there was almost no correlation between the number of deaths and most health workers. Except for environmental health officers, the correlation coefficients between the number of deaths and most health workers were negative. In 2019, radiographers also exhibited a significant positive correlation with the number of deaths ($p<0.05$). Data from both 1990 and 2019 show a significant positive correlation between Nursing and Midwifery and the number of deaths ($p<0.05$) (Figure 6B and D).

https://doi.org/10.2147/RMHP.S552958

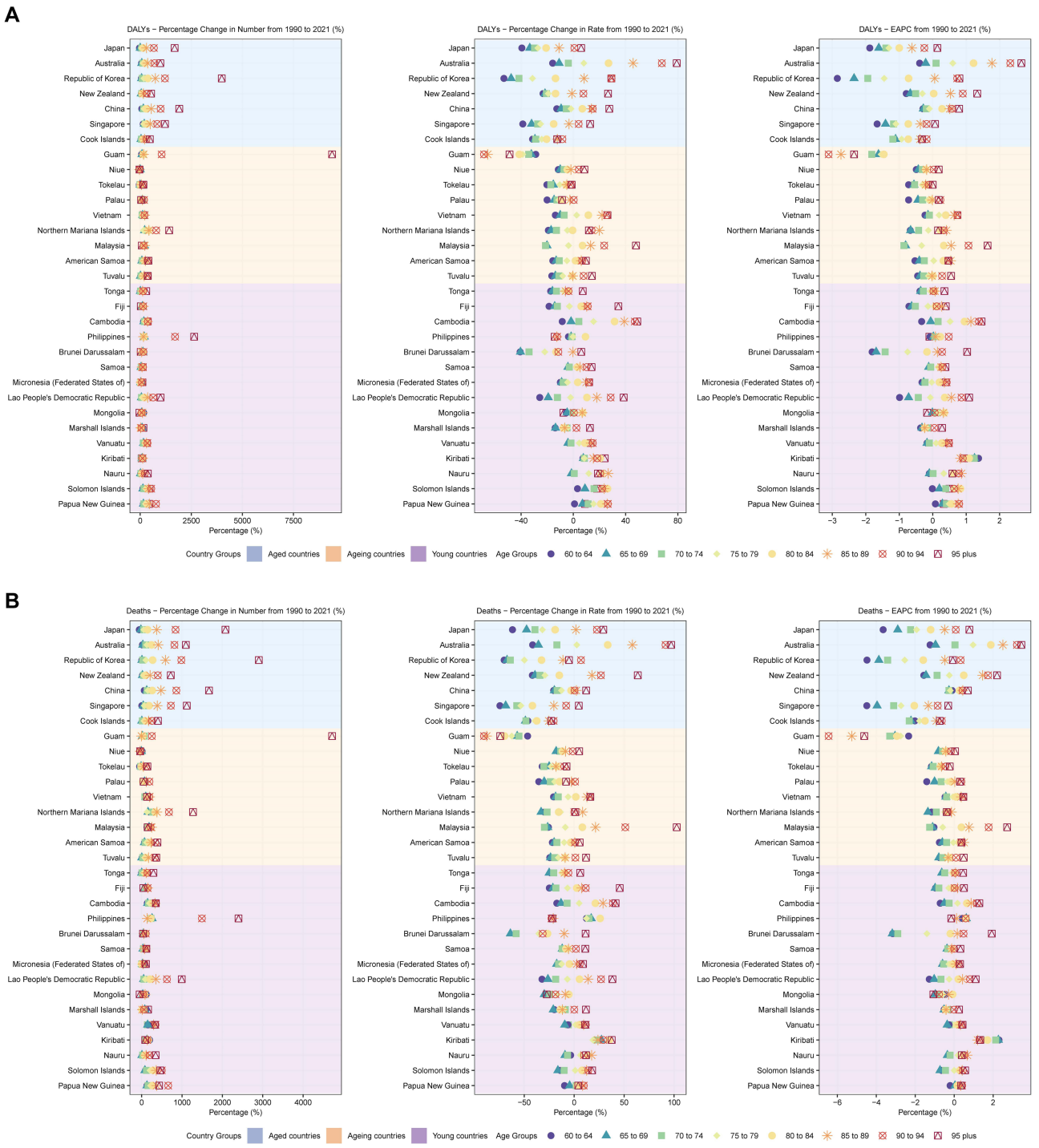

Figure 3 Age-specific burden analysis of low bone mineral density in the Western Pacific region, 1990–2021, for the combined sexes aged 60 years and older, presented in 5-year age intervals. (**A**) DALYs: Percentage change in numbers, percentage change in age-standardized rates, and EAPC in age-standardized DALY rates. (**B**) Mortality: Percentage change in numbers, percentage change in age-standardized rates, and EAPC in age-standardized mortality rates.

Discussion

This study systematically assessed the burden of diseases attributable to LBMD among individuals aged 60 and above in the Western Pacific Region from 1990 to 2021, and the potential relationship between disease burden and HRH from 1990 to 2019. The results indicate that from 1990 to 2021, the LBMD-related disease burden in the elderly population of the Western Pacific Region increased significantly, mainly driven by population growth. In most countries and regions,

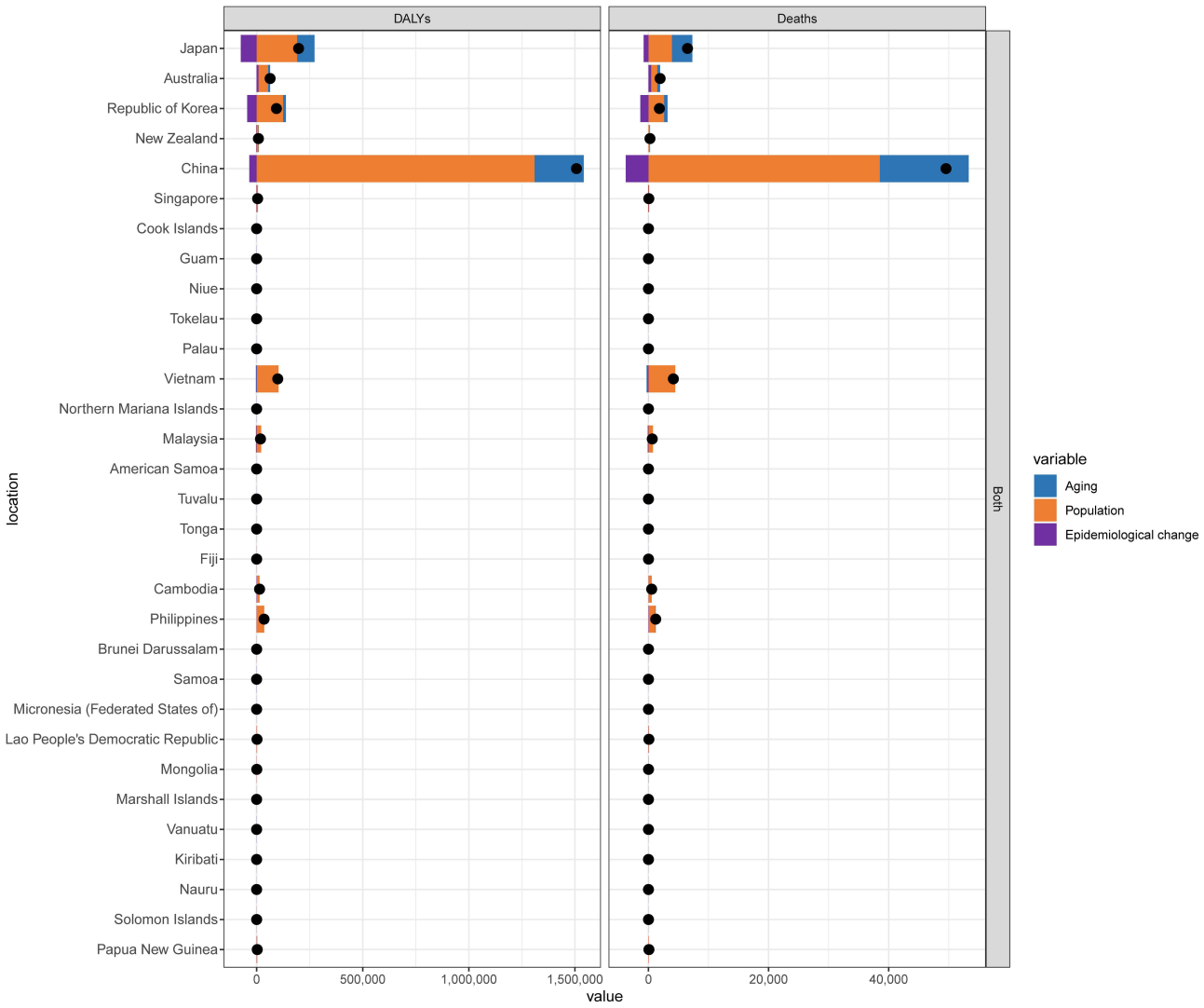

Figure 4 Decomposition of factors influencing changes in age-standardized DALY and mortality rates due to low bone mineral density in the Western Pacific region, 1990–2021, for the combined population aged 60 years and older.

both the ASDR and ASMR declined. In terms of age stratification, both ASDR and ASMR increased with age. Gender-wise, the LBMD burden was generally higher in women than in men. Socioeconomically, there was almost no correlation between the SDI and ASDR, but a weak negative correlation was observed between SDI and ASMR. Furthermore, both in 1990 and 2019, there was a negative correlation between Nursing and Midwifery and deaths, suggesting that they may have played a significant role in reducing the LBMD-related burden.

From 1990 to 2021, the burden of LBMD-related diseases increased in most countries and regions of the Western Pacific, while both ASDR and ASMR generally declined. The increase in absolute burden was primarily driven by population growth, while the decline in ASDR and ASMR may reflect improvements in global LBMD-related treatment and management.[18,19] Niue showed the only decrease in burden, which may be related to the migration of the local population to New Zealand and Australia in recent decades, and the smaller population size in Niue makes the data more prone to fluctuations.[20,21] It is worth noting the burden increase caused by population aging. Evidence has shown that age is a risk factor for osteoporosis 6. Consistent with other studies,[14] both ASDR and ASMR increased with age. Additionally, our results show that in most countries and regions, the percentage change in DALYs and deaths, as well as the EAPC, increased with age, reflecting the growing LBMD-related disease burden and the higher disease risk in older populations. This may be related to frailty in the elderly, the presence of various chronic diseases, and increased

https://doi.org/10.2147/RMHP.S552958

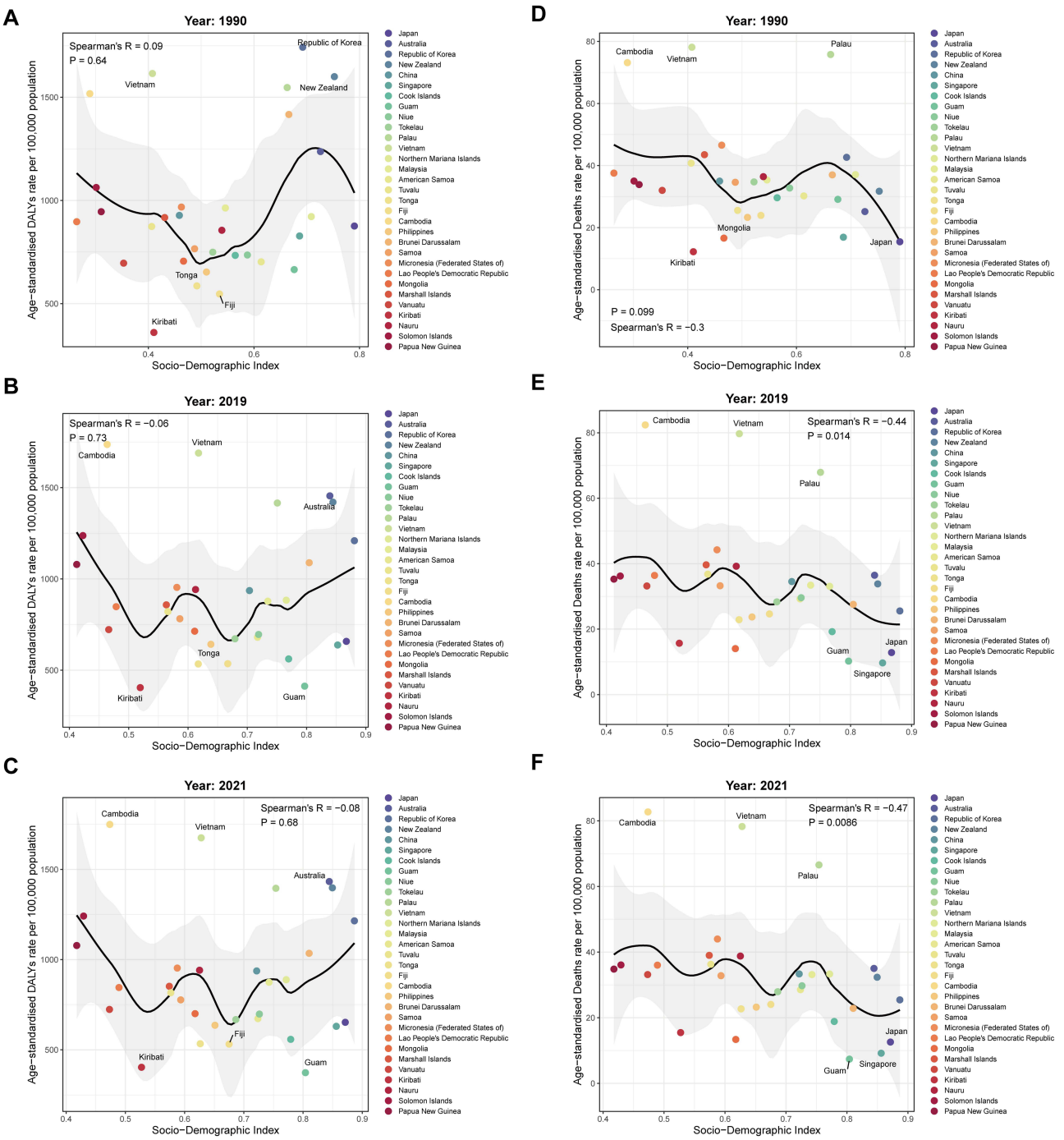

Figure 5 Socio-demographic correlates of low bone mineral density burden in the Western Pacific region for the combined population aged 60 years and above. (**A**–**C**) Relationship between age-standardized DALY rates and SDI in 1990, 2019, and 2021. (**D**–**F**) Association between age-standardized mortality rates and SDI in 1990, 2019, and 2021.

fracture susceptibility due to LBMD.[22–24] Elderly fractures often result in severe clinical outcomes, including disability and death.[5] These findings highlight the need for greater investment in the health of older populations and stronger public health policies, particularly early screening and interventions for osteoporosis, which may help slow this trend. In addition to population growth and aging, widespread non-communicable disease risk factors may have further exacerbated the disease burden, such as physical inactivity, dietary habits, smoking, alcohol use, and environmental pollution.[25–27] Controlling these risk factors is also essential for achieving Universal Health Coverage.

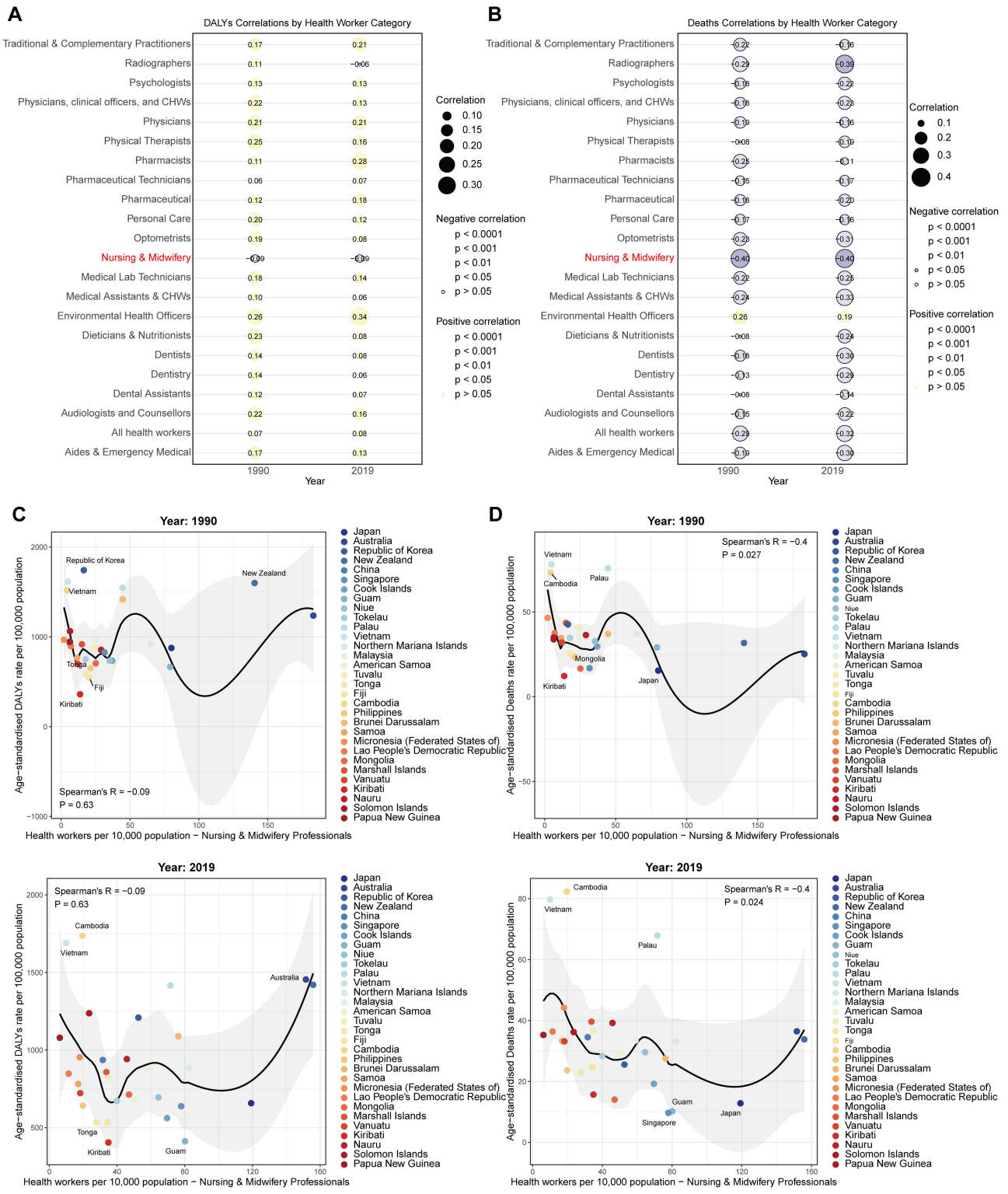

Figure 6 HRH correlates of low bone mineral density burden in the Western Pacific region for the combined population aged 60 years and above. (**A**) Multidimensional analysis of age-standardized DALY rates and HRH indicators, 1990 vs 2019. (**B**) Multidimensional analysis of age-standardized mortality rates and HRH indicators, 1990 vs 2019. (**C**) Focused analysis of age-standardized DALY rates and key HRH indicators (Nursing & Midwifery Professionals) in 1990 and 2019, highlighting extreme burden countries. (**D**) Focused analysis of age-standardized mortality rates and key HRH indicators (Nursing & Midwifery Professionals) in 1990 and 2019, highlighting extreme burden countries.

https://doi.org/10.2147/RMHP.S552958

Consistent with previous studies,[28] the burden of LBMD is generally higher in women than in men, which is mainly caused by estrogen deficiency in women after menopause. After menopause, women experience accelerated bone loss, and their bone area is usually smaller than that of men, making them more prone to osteoporotic fractures[29,30] approximately 50% of women experience at least one fracture after menopause.[31] However, it is worth noting that some studies have pointed out that the disability rate and mortality rate related to osteoporotic fractures in men are higher than those in women.[32] This means that when formulating relevant public health policies, in addition to fully considering the special physiological characteristics and disease susceptibility of women, the health problems it brings to the male population should not be ignored. However, osteoporosis often lacks typical symptoms in the early stage, resulting in only a small number of patients receiving timely treatment.[33] Studies have indicated that an elevated testosterone/estradiol ratio is negatively correlated with decreased bone mineral density and can increase the risk of osteoporotic fractures. Incorporating such hormonal indicators into clinical assessments is expected to improve the ability for early identification and risk stratification of osteoporotic fractures.[34] Although numerous guidelines and studies have focused on the screening and treatment of osteoporosis in women, only 7–25% of women who undergo screening are recommended to receive further intervention.[31] This reflects a potential mismatch between actual medical resources and the prevention and treatment needs of LBMD-related diseases in women, particularly in low- and middle-income countries.[13] The negative correlation between the SDI index and ASDR as well as ASMR confirms the shortage of medical resources in low-income countries. High-income countries and regions typically have more sufficient medical resources and health security;[13] especially with national development and the improvement of healthcare systems, issues such as fractures and osteoporosis among the elderly population have been better controlled through disease prevention, early diagnosis, and effective treatment.

Over the past few decades, the HRH in the Western Pacific Region has seen a slight improvement, but it remains severely insufficient—approximately 54.8% of countries and regions in this region still fail to meet the HRH needs for universal health coverage.[17] From the results of our analysis on the burden of LBMD-related diseases and HRH, there is no significant association between the burden of LBMD-related diseases and most HRH. This finding stands in contrast to the current situation where this disease has become a major public health challenge for the elderly population in the Western Pacific Region, suggesting that a close linkage mechanism has not yet been established between the current allocation of HRH in this region and the needs for disease prevention and control. On one hand, LBMD-related diseases fall into the category of chronic diseases in the elderly. However, the aggregated data on HRH fails to capture specific roles such as “geriatric specialists” and “orthopedic surgeons”, which weakens the direct correlation with the burden of LBMD-related diseases. Meanwhile, the Western Pacific Region is in a phase of accelerated population aging, and the burden of LBMD-related diseases is strongly correlated with age—the growth rate of HRH may not keep pace with the increasing disease burden brought about by aging. Even if the total number of HRH is sufficient, its impact on disease management will be greatly reduced if HRH is not effectively allocated to the fields of elderly care and primary healthcare. On the other hand, the severe consequences of LBMD (such as fractures) often occur years later. Many health systems focus more on acute, event-driven treatments (performing surgery after a fracture occurs) rather than long-term, preventive management (early screening, medication, and lifestyle interventions to prevent fractures).[35] HRH may be allocated more to addressing acute events rather than to prevention, which also explains why the increase in HRH has not led to a significant reduction in disease burden.

The HRH and DALYs are mainly in a positive correlation, which may reflect the demand-oriented allocation of resources. In particular, countries and regions with a high disease burden will passively increase investment in HRH to meet the demand.[36] At the same time, this also reflects the improvement of diagnosis and screening capabilities from another perspective—when more LBMD patients are diagnosed, the data on DALYs will show a higher estimated value. The negative correlation between HRH and deaths directly demonstrates the key role of HRH in saving lives and reducing mortality. In particular, the significant negative correlation between Nursing and Midwifery personnel and the number of deaths indicates that they are a key force in reducing the mortality rate of LBMD patients. Nursing and Midwifery personnel are usually involved in disease prevention, treatment, and health education; an increase in the number of such personnel may have led to better medical care and reduced disease burden.[37] However, since the core function of Nursing and Midwifery is not geriatric LBMD health management, the

statistically significant association between this type of HRH and LBMD mortality burden remains a weak correlation. Nevertheless, this correlation has persisted from 1990 to 2021, indicating that it is genuine and long-term stable, making it one of the few identifiable potential influencing factors directly related to HRH in the prevention and control of LBMD-related deaths. It provides a clear HRH targets for the prevention and control of LBMD mortality, avoiding blindness in policy-making. Moreover, studies have pointed out that strengthening the Nursing and Midwifery workforce can directly benefit the elderly population, and in particular, enhancing specialized care for the elderly helps improve their adverse health outcomes,[38] which reflects the value of care-driven outcome intervention.

Since 2016, countries around the world have increased their assistance for HRH development, but the availability of HRH remains limited and has not yet effectively alleviated the global shortage of health workers; the impact of the COVID-19 pandemic has further exacerbated this challenge.[39] Although the shortage and allocation issues of HRH have existed for a long time, countries have actively responded at different levels. For example, in Healthy China 2030, China has proposed to strengthen the cultivation and training of health professionals and improve the medical service system to advance universal health coverage.[40] In response to changes in medical needs brought about by an aging society, Japan has implemented a series of healthcare system reforms, providing valuable experience for other countries in addressing similar demographic and epidemiological transitions.[41] Overall, to address the shortage and optimize the allocation of HRH, it is necessary not only to continuously increase resource investment but also to focus on systematic strategic planning and structural optimization, so as to maximize the effectiveness of limited human resources in addressing disease burden.

This study also has certain limitations. Firstly, this study is based on the GBD database, and its accuracy depends on the data quality of this database. Secondly, this study mainly focuses on macro factors such as population aging and HRH. However, during the process of changes in the burden of LBMD, it may also be affected by other factors such as socioeconomic conditions, cultural factors, and lifestyle. Thirdly, the data on HRH only go up to 2019 and cannot reflect the relationship between HRH and the disease burden after the COVID-19 pandemic. Lastly, although the relationship between the density of HRH and the disease burden has been explored, in reality, both the quantity and quality of HRH are equally important. The lack of quality may lead to an underestimation of the actual demand.

Conclusion

In conclusion, this study for the first time reveals the changing trends of the disease burden related to LBMD among the aging population aged 60 and above in the Western Pacific Region, as well as its relationship with HRH. From 1990 to 2021, the burden of LBMD-related diseases among the elderly population in this region increased significantly, which also exerts great pressure on the healthcare system. The significant correlations between Nursing and Midwifery and disease burden reflect the "potential value of intervention", providing a clear HRH targets for LBMD management, highlighting the importance of HRH in addressing the growing burden of LBMD. Optimizing the allocation of HRH and strengthening the development of the health workforce are effective strategies to cope with population aging and the burden of LBMD-related diseases.

Abbreviations

LBMD, Low Bone Mineral Density; HRH, human resources for health; DALYs, Disability-Adjusted Life Years; GBD, Global Burden of Disease Study; SDI, Socio-demographic Index; EAPC, Estimated Annual Percentage Change; ASR, age-standardized rates; ASDR, age-standardized DALYs rate; ASMR, age-standardized mortality rate.

Data Sharing Statement

Data from this study are publicly available through the GBD 2021 (https://ghdx.healthdata.org/gbd-2021) and the GBD 2019 (https://ghdx.healthdata.org/gbd-2019), providing comprehensive databases for disease burden and health resource data, respectively.

Acknowledgments

We thank the Global Burden of Disease collaborators for providing health data, and researchers from human resources for health studies. We also acknowledge insights on Western Pacific population aging from authors of "Burden of cardiovascular disease in the Western Pacific".

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This study was supported by 2024 National Health Commission Medical Management Institute Medical Quality (Evidence Based) Management Research Project (No. YLZLXZ24G044) to Chuanqiang Dai.

Disclosure

The authors declare no competing interests in this work.

References

1. Panahi N, Saeedi Moghaddam S, Fahimfar N, et al. Trend in global burden attributable to low bone mineral density in different WHO regions: 2000 and beyond, results from the global burden of disease (GBD) study 2019. *Endocr Connect*. 2023;12(10):e230160. doi:10.1530/EC-23-0160
2. GBD 2021 Risk Factors Collaborators. Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990-2021: a systematic analysis for the global burden of disease study 2021. *Lancet*. 2024;403(10440):2162–2203. doi:10.1016/S0140-6736(24)00933-4.
3. Kanis JA, Kanis JA. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: synopsis of a WHO report. WHO study group. *Osteoporos Int*. 1994;4(6):368–381. doi:10.1007/BF01622200
4. Johnell O, Kanis JA, Oden A, et al. Predictive value of BMD for Hip and other fractures. *J Bone Miner Res*. 2005;20(7):1185–1194. doi:10.1359/JBMR.050304
5. Johnston CB, Dagar M. Osteoporosis in older adults. *Med Clin North Am*. 2020;104(5):873–884. doi:10.1016/j.mcna.2020.06.004
6. Xiao PL, Cui AY, Hsu CJ, et al. Global, regional prevalence, and risk factors of osteoporosis according to the World Health Organization diagnostic criteria: a systematic review and meta-analysis. *Osteoporos Int*. 2022;33(10):2137–2153. doi:10.1007/s00198-022-06454-3
7. Li J, Jia H, Liu Z, Xu K. Global, regional and national trends in the burden of low bone mineral density from 1990 to 2030: a Bayesian age-period-cohort modeling study. *Bone*. 2024;189:117253. doi:10.1016/j.bone.2024.117253
8. Dong Y, Kang H, Peng R, et al. Global, regional, and national burden of low bone mineral density from 1990 to 2019: results from the global burden of disease study 2019. *Front Endocrinol*. 2022;13:870905. doi:10.3389/fendo.2022.870905
9. Föger-Samwald U, Kerschan-Schindl K, Butylina M, Pietschmann P. Age related osteoporosis: targeting cellular senescence. *Int J Mol Sci*. 2022;23(5):2701. doi:10.3390/ijms23052701
10. World population ageing 2019: highlights New York City United Nations, department of economic and social affairs, population division; 2019. Available from: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights. Accessed February 15, 2025..)
11. Hu FB. Diet strategies for promoting healthy aging and longevity: an epidemiological perspective. *J Intern Med*. 2024;295(4):508–531. doi:10.1111/joim.13728
12. Fu Y, Ba L, Lü N, et al. Burden of falls attributable to low bone mineral density among people aged 60 years and over in China from 1990 to 2019. *Front Public Health*. 2023;11:1204497. doi:10.3389/fpubh.2023.1204497
13. Haakenstad A, Irvine CMS, Knight M; GBD 2019 Human Resources for Health Collaborators. Measuring the availability of human resources for health and its relationship to universal health coverage for 204 countries and territories from 1990 to 2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2022;399(10341):2129–2154. doi:10.1016/S0140-6736(22)00532-3
14. Wang J, Luo S, Wang F, Canavese F, Li L. Global burden of injury due to low bone mineral density in adults aged 55 years and older, 1990 to 2021: a population-based study. *Bone*. 2025;193:117418. doi:10.1016/j.bone.2025.117418
15. GBD 2021 Diseases and Injuries Collaborators. Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet*. 2024;403(10440):2133–2161. doi:10.1016/S0140-6736(24)00757-8.
16. GBD 2021 Causes of Death Collaborators. Global burden of 288 causes of death and life expectancy decomposition in 204 countries and territories and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet*. 2024;403(10440):2100–2132. doi:10.1016/S0140-6736(24)00367-2.

17. Wang H, Yu X, Guo J, et al. Burden of cardiovascular disease among the Western Pacific region and its association with human resources for health, 1990-2021: a systematic analysis of the global burden of disease study 2021. *Lancet Reg Health West Pac*. 2024;51:101195. doi:10.1016/j.lanwpc.2024.101195
18. Rentzeperi E, Pegiou S, Tsakiridis I, et al. Diagnosis and management of osteoporosis: a comprehensive review of guidelines. *Obstet Gynecol Surv*. 2023;78(11):657–681. doi:10.1097/OGX.0000000000001181
19. Aibar-Almazán A, Voltes-Martínez A, Castellote-Caballero Y, Afanador-Restrepo DF, Carcelén-Fraile MDC, López-Ruiz E. Current status of the diagnosis and management of osteoporosis. *Int J Mol Sci*. 2022;23(16):9465. doi:10.3390/ijms23169465
20. Togiamua E, Eruthayam C, Lau K. Matalili-Aga Gahua: development of the matalili framework as a holistic model for the well-being of the Niue people. *Asia Pac J Public Health*. 2025;37(1):134–142. doi:10.1177/10105395241292146
21. Government of Niue health strategic plan 2011 - 2021. Available from: https://extranet.who.int/nutrition/gina/sites/default/filesstore/NIU%202011%20Health%20Strategic%20Plan.pdf. Accessed November 14, 2025.
22. Dent E, Hanlon P, Sim M, et al. Recent developments in frailty identification, management, risk factors and prevention: a narrative review of leading journals in geriatrics and gerontology. *Ageing Res Rev*. 2023;91:102082. doi:10.1016/j.arr.2023.102082
23. Bell SA, Horowitz J, Iwashyna TJ. Health outcomes after disaster for older adults with chronic disease: a systematic review. *Gerontologist*. 2020;60(7):e535–e547. doi:10.1093/geront/gnz123
24. Shen Y, Huang X, Wu J, et al. The global burden of osteoporosis, low bone mass, and its related fracture in 204 countries and territories, 1990-2019. *Front Endocrinol*. 2022;13:882241. doi:10.3389/fendo.2022.882241
25. Sun X, Yon DK, Nguyen TT, et al. Dietary and other lifestyle factors and their influence on non-communicable diseases in the Western Pacific region. *Lancet Reg Health West Pac*. 2023;43:100842. doi:10.1016/j.lanwpc.2023.100842
26. Katzmarzyk PT, Friedenreich C, Shiroma EJ, Lee IM. Physical inactivity and non-communicable disease burden in low-income, middle-income and high-income countries. *Br J Sports Med*. 2022;56(2):101–106. doi:10.1136/bjsports-2020-103640
27. Münzel T, Hahad O, Sørensen M, et al. Environmental risk factors and cardiovascular diseases: a comprehensive expert review. *Cardiovasc Res*. 2022;118(14):2880–2902. doi:10.1093/cvr/cvab316
28. Patwardhan V, Gil GF, Arrieta A, et al. Differences across the lifespan between females and males in the top 20 causes of disease burden globally: a systematic analysis of the Global Burden of Disease Study 2021. *Lancet Public Health*. 2024;9(5):e282–e294. doi:10.1016/S2468-2667(24)00053-7
29. Zhang YY, Xie N, Sun XD, et al. Insights and implications of sexual dimorphism in osteoporosis. *Bone Res*. 2024;12(1):8. doi:10.1038/s41413-023-00306-4
30. Riggs BL, Melton Iii LJ 3rd, Robb RA, et al. Population-based study of age and sex differences in bone volumetric density, size, geometry, and structure at different skeletal sites. *J Bone Miner Res*. 2004;19(12):1945–1954. doi:10.1359/JBMR.040916
31. Reid IR. A broader strategy for osteoporosis interventions. *Nat Rev Endocrinol*. 2020;16(6):333–339. doi:10.1038/s41574-020-0339-7
32. Vilaca T, Eastell R, Schini M. Osteoporosis in men. *Lancet Diabetes Endocrinol*. 2022;10(4):273–283. doi:10.1016/S2213-8587(22)00012-2
33. LeBoff MS, Greenspan SL, Insogna KL, et al. The clinician's guide to prevention and treatment of osteoporosis. *Osteoporos Int*. 2022;33(10):2049–2102. doi:10.1007/s00198-021-05900-y
34. Tian X, Zhang B. The association between sex hormones and bone mineral density in US females. *Sci Rep*. 2025;15(1):5546. doi:10.1038/s41598-025-89985-z
35. Le HV, Van BW, Shahzad H, et al. Fracture liaison service-a multidisciplinary approach to osteoporosis management. *Osteoporos Int*. 2024;35(10):1719–1727. doi:10.1007/s00198-024-07181-7
36. McIsaac M, Buchan J, Abu-Agla A, Kawar R, Campbell J. Global strategy on human resources for health: workforce 2030-a five-year check-in. *Hum Resour Health*. 2024;22(1):68. doi:10.1186/s12960-024-00940-x
37. Mai H, Mc Evoy L, Wilson C, et al. Frailty and risk of subsequent fracture among older adults presenting to hospital with a minimal trauma fracture. *Osteoporos Int*. 2023;34(2):399–404. doi:10.1007/s00198-022-06630-5
38. Rezaei-Shahsavarloo Z, Atashzadeh-Shoorideh F, Gobbens RJJ, Gobbens RJJ, Ebadi A, Ghaedamini Harouni G. The impact of interventions on management of frailty in hospitalized frail older adults: a systematic review and meta-analysis. *BMC Geriatr*. 2020;20(1):526. doi:10.1186/s12877-020-01935-8
39. Micah AE, Solorio J, Stutzman H, Zhao Y, Tsakalos G, Dieleman JL. Development assistance for human resources for health, 1990-2020. *Hum Resour Health*. 2022;20(1):51. doi:10.1186/s12960-022-00744-x
40. Healthy China 2030. 2016. Available from: https://www.gov.cn/zhengce/2016-10/25/content_5124174.htm. Accessed February 17, 2025..)
41. Honda M, Inoue N, Liverani M, Nagai M. Lessons learned from the history of postgraduate medical training in Japan: from disease-centred care to patient-centred care in an aging society. *Hum Resour Health*. 2022;20(1):54. doi:10.1186/s12960-022-00752-x

Risk Management and Healthcare Policy

Dovepress
Taylor & Francis Group

Publish your work in this journal

Risk Management and Healthcare Policy is an international, peer-reviewed, open access journal focusing on all aspects of public health, policy, and preventative measures to promote good health and improve morbidity and mortality in the population. The journal welcomes submitted papers covering original research, basic science, clinical & epidemiological studies, reviews and evaluations, guidelines, expert opinion and commentary, case reports and extended reports. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit http://www.dovepress.com/testimonials.php to read real quotes from published authors.

Submit your manuscript here: https://www.dovepress.com/risk-management-and-healthcare-policy-journal