# A bibliometric analysis of osteoporosis research trends in Southeast Asia: A 50-year review

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#### ABSTRACT

**B** ackground and aims: The aging population in Asia is increasing exponentially, contributing to a rise in agerelated conditions such as osteoporosis. Osteoporosis reduces bone strength and increases bone fragility, leading to fracture and disability. A barrier to improving osteoporosis care is the lack of evidence and knowledge about this disease. Hence, it is essential to assess the research landscape of osteoporosis in Southeast Asia (SEA) and determine the factors associated with scientific productivity. This bibliometric analysis showed the research productivity and its correlation with socioeconomic indices in SEA. This study identified the research trends, gaps, and factors associated with scientific productivity in osteoporosis research in SEA.

*Methods:* Using the Scopus database, a comprehensive search on osteoporosis research between 1972 and 2022 was conducted. Published research articles on osteoporosis conducted in SEA or articles with at least one of the authors from SEA were included. Bibliometric indices and socioeconomic data were obtained and summarized in tabular form. Spearman's rank-order correlation was used to determine the relationship between socioeconomic and epidemiologic factors and scientific productivity. VOSviewer software was used to visualize collaboration and keywords.

\*Corresponding author Email Address: eppacheco@gmail.com; eppacheco@up.edu.ph Date received: 29 January 2025 Dates revised: 20 March 2025; 28 April 2025; 11 May 2025 Date accepted: 12 May 2025 DOI: https://doi.org/10.54645/2025181WTZ-46 *Results:* The analysis comprised 1175 papers in total. Thailand, Singapore, and Malaysia have the region's highest research productivity and impact. The focus of osteoporosis research in SEA was on screening/risk assessment, diagnosis, treatment, and its adverse effects. The gross domestic product, GDP per capita, research and development expenditures, number of physicians and researchers, and international collaboration were correlated with increased osteoporosis research productivity. However, there was a negative correlation between SEA country's osteoporosis prevalence and disability-adjusted life years (DALY) attributed to low bone mineral density (BMD) with research impact and research productivity, respectively.

*Conclusions:* This study showed the general landscape, outputs, and productivity in osteoporosis research in SEA. Each SEA country should promote international research partnerships and increase research support to increase productivity and quality and fill knowledge gaps on osteoporosis in the region.

#### INTRODUCTION

Worldwide, life expectancy increases due to improvements in health, which comes along with an aging population. In Asia, the population of those aged over 50 years is expected to increase exponentially until the year 2050 (The Asia Pacific Regional Audit, 2013), contributing to a rise in age-related diseases, including osteoporosis. Osteoporosis is a disease characterized by decreased bone mass and microarchitectural deterioration,

#### KEYWORDS

Bibliometric analysis, Osteoporosis, Scientometrics, Southeast Asia

decreased bone strength, and increased bone fragility and fracture risk (NIH Consensus Development Panel on Osteoporosis Prevention and Therapy, 2001). The World Health Organization defined osteoporosis based on a bone mineral density (BMD) T-score of less than -2.5 standard deviation (Kanis JA on behalf of the World Health Organization Scientific Group, 2007). According to the International Osteoporosis Foundation, 1 in 5 men and 1 in 3 women over 50 will have an osteoporotic fracture. The prevalence of osteoporosis in Southeast Asian countries ranges from 9.3% in Singapore to 53% in Indonesia (Chen et al., 2020; Lim et al., 2005; Mithal et al., 2014; Pongchaiyakul et al., 2008). At the same time, projections showed that by 2050, more than half of the cases of hip fractures worldwide will occur in Asia (The Asia Pacific Regional Audit, 2013), leading to limitations in mobility, early retirement from work, and reduced ability to participate in society (Johnell and Kanis, 2006), making it an economic burden which is predicted to exceed one-third of gross domestic product per capita (Mohd-Tahir and Li, 2017).

One of the most significant barriers to osteoporosis care is the need for more knowledge and understanding about the disease. More investment is needed in large-scale research or registries for osteoporosis or fracture worldwide, especially in developing countries such as Malaysia, Thailand, and Vietnam. Allocating support to research is necessary for the development of science and technology, and social and economic development (Meo et al., 2013). Hence, it is essential to assess the research landscape of osteoporosis in the SEA region and determine the factors associated with scientific productivity. These factors can be identified by bibliometric analysis, a research method that identifies the distribution patterns of articles and assesses the scientific outputs of authors, journals, countries, and institutions. The data from this analysis may guide future research planning, program development, and allocation of resources for osteoporosis and fracture prevention (Kokol et al., 2021; Li and Zhao, 2015; Tantengco et al., 2021).

This study determined the annual trends in research publications, top contributors of knowledge, international collaborations, and socioeconomic factors correlated to scientific productivity in osteoporosis research in Southeast Asia (SEA) in the past 50 years, from 1972 to 2022. The results of this study can be used to generate research priorities and can provide potential ways to improve scientific productivity in osteoporosis research in SEA.

#### METHODOLOGY

#### **Study Selection**

We performed a literature search using the Scopus database, which is the largest research database. This study used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline to select articles to be included in the analysis, as shown in Figure 1. The following search terms were used: ("osteoporo\*" OR "osteoporosis" OR "low bone mass" OR "low bone density" OR "low bone mineral density" OR "low BMD"). The study was limited to published articles with at least one author from Southeast Asian (SEA) countries. Automated removal of duplicates was done in Microsoft Excel, followed by manual deduplication by checking the titles of the articles. Letters to the editor, notes, book chapters, commentaries, editorials, erratum, retracted papers, animal studies, and articles without a focus on osteoporosis were excluded. Only published articles in the English language were included. All electronic searches were performed on December 10, 2023. The search covered the timeframe from January 1972 until December 2022. The studies were screened based on title, author, affiliation, and abstracts, while full texts were further

reviewed for eligibility.



Figure 1: Screening of articles included in the bibliometric analysis

#### **Data Collection**

Information regarding the authors' name, publication year, title, name of the journal, affiliation, country, keywords, and *h*-index (this number represents the number of publications for which an author has been cited by other authors at least that same number of times) and total citations were extracted from the database. Data on the prevalence of osteoporosis in each country was obtained from the 2013 Asia-Pacific Regional Audit and different epidemiologic studies from SEA countries (The Asia Pacific Regional Audit, 2013). The 2019 Global Burden of Disease (GBD) database provided data on the disability-adjusted life years (DALYs) associated with low BMD and the agestandardized fracture prevalence attributable to falls (Institute for Health Metrics and Evaluation, 2021). The International Monetary Fund provided data on the overall population, gross domestic product (GDP), and GDP per capita (International Monetary Fund, 2020). However, the World Bank provided data on the population over 65, the physician-to-population ratio, the researcher-to-population ratio, and the research and development (R&D) expenditure (%GDP) (The World Bank, 2020). These were used to investigate the knowledge domain, development trends, and top contributors to knowledge about osteoporosis in SEA.

#### **Statistical Analysis**

Using Spearman's rank-order correlation, the relationship between socioeconomic and epidemiologic factors and scientific productivity and impact was examined. A p-value of less than 0.05 indicated statistical significance for the results. Version 22.01 of the Medcalc statistical program was utilized for the analysis. Using VOSviewer version 1.6.20 (van Eck and Waltman, 2010), the international collaboration network and keywords associated with osteoporosis research in the Southeast Asia region were shown. Co-authorship analysis with countries as the unit of analysis was conducted to determine the collaborations of different countries on osteoporosis research. Co-occurrence analysis with author keywords as the unit of analysis was conducted to determine the temporal trends of keywords used in osteoporosis research. Duplicate keywords and keywords with less than five citations were removed in the co-occurrence analysis.

#### RESULTS

#### **Publication by years**

There were 1,175 articles obtained from the Scopus database from 1972 to 2022. The first article was published in 1973, and annual publications did not increase until 2001 (Figure 2). The number of published studies on osteoporosis in SEA was the



Figure 2: Annual number of published osteoporosis research articles in Southeast Asia

#### **Publication by country**

Citation analysis and the number of publications by each SEA country on osteoporosis research are shown in Figure 3. Thailand had the highest number of publications (n = 407, 33%) in osteoporosis research, followed by Singapore (n = 291, 23.6%) and Malaysia (n = 278, 22.6%). On the other hand, Cambodia (n = 0), Laos (n = 0), Myanmar (n = 2, 0.2%), and Brunei (n = 4, 0.3%) had none to fewer than five publications. Among SEA countries, Singapore (total citations [TC] = 10,192, *h*-index = 50) had the highest number of citations, followed by Thailand (TC = 7,280, *h*-index = 40) and Malaysia (TC = 5,617,

*h*-index = 33). Compared to Thailand (n = 407, *h*-index = 40), Singapore (n = 291, *h*-index = 50) had more citations despite fewer publications. This is also the case between Vietnam (n = 56, *h*-index = 19) and Indonesia (n = 147, *h*-index = 16).

Rank	Country	Total Number of Publications	h-index	Total Citations		
1	THAILAND	407	40	7280		
2	SINGAPORE	291	50	10192		
3	MALAYSIA	278	33	5617		
4	INDONESIA	147	16	742		
5	VIETNAM	56	19	1226		
6	PHILIPPINES	47	15	580		
7	BRUNEI	4	2	28		
8	MYANMAR	2	2	41		
9.5	CAMBODIA	0	0	0		
9.5	LAOS	0	0	0		
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Figure 3: SEA countries ranked according to the total number of publications on osteoporosis with corresponding citation analysis

### Network visualization of country collaboration on osteoporosis research in SEA

Figure 4 shows the international research collaboration of each SEA country with other regions on osteoporosis. Thailand, Singapore, and Malaysia had more research collaborations than other SEA countries. Thailand had many papers in collaboration with Australia and the United States of America (USA). Singapore strongly collaborated with the USA, Germany, the United Kingdom, and Australia, while Malaysia collaborated with the United Kingdom and Australia. Vietnam and Indonesia were observed to collaborate strongly with Australia and Japan. There were weak collaborations among SEA countries.



Figure 4: Network visualization of international collaboration on osteoporosis research among Southeast Asian (SEA) countries. The size of each circle is directly proportional to the number of osteoporosis-related publications from that country. The width of the lines connecting countries reflects the frequency of co-authored publications between them. Colors represent clusters of countries that collaborate more frequently with each other, as identified by the VOSviewer clustering algorithm.

#### **Publication by institutions**

As shown in Figure 5, the most productive SEA institutions in osteoporosis research were universities and hospitals, of which the majority were from Thailand. The rest were from Singapore, Malaysia, and Indonesia. The Mahidol University in Thailand had the highest number of publications (n = 192), followed by Ramathibodi Hospital in Thailand (n = 94) and the National University of Singapore (n = 85). Analysis of total citations and h-index showed that Singapore General Hospital received the most citations at 3816; however, Mahidol University had the highest *h*-index at 31.



Figure 5: SEA institutions with the most production of research on osteoporosis

#### **Publication by journals**

Out of 153 journals that published osteoporosis research from SEA, Figure 6 shows the top ten. The Journal of the Medical Association of Thailand published the most articles (n = 105); however, Osteoporosis International obtained the highest total citations and *h*-index (TC = 3,014, *h*-index = 29). On the other hand, the Journal of Bone and Mineral Research (TC= 1119) and Journal of Clinical Densitometry (TC= 851) had the second and third highest total citations, respectively, despite publishing fewer journal articles.



Figure 6: Top journals that published osteoporosis research in SEA

#### **Publication by authors**

160 authors on osteoporosis research in SEA were included in this study and ranked by the number of published papers. The top 10 most productive authors are presented in Figure 7. Thailand had the most significant number of authors in the top ten, followed by Malaysia. Rajatanavin, R. from Theptarin Hospital, Thailand, had the highest number of publications (n = 45) and total citations (TC = 1,605), followed by Ongphiphadhanakul, B. (n= 44, TC= 1000) from Ramathibodi Hospital in Thailand and Nguyen, T.V. (n= 39, TC= 1385) from the University of Technology Sydney in Australia. On the other hand, Nguyen, T.V. had the highest h-index of 20.



Figure 7: Leading authors in SEA in osteoporosis research

#### **Keyword visualization**

Figure 8 shows a visualization map generated for keywords on osteoporosis research in SEA using VOSviewer (Version 1.6.20). The graphs showed the research hotspots in osteoporosis research in SEA from 2012 to 2018. The most frequently mentioned keywords were "osteoporosis", "bone "bone density", "osteopenia", mineral density", and "menopause". From 2009 to 2014, important keywords were related to diagnosis, treatment, and "risk factors," which included "bone mineral density," "menopause," "vitamin D," and "bisphosphonates." On the other hand, in 2014 to 2018 important keywords were "fragility fracture", related to "screening" and risk assessment such as "frax", "finite element analysis" and "DXA" also included were "knowledge" and "attitude", and "osteopenia" and "osteoporosis".



Figure 8: Network visualization of keywords related to osteoporosis research in Southeast Asia (SEA). The size of each circle is directly proportional to the number of articles using the keyword. The width of the lines connecting the circles reflects how often the connected keywords co-occur in the publications and is directly proportional to its frequency of co-occurrence with other keywords. The color gradient represents the average year of publication: keywords in purple are from older studies, while those in yellow are from more recent ones.

## Correlation of socioeconomic and epidemiologic characteristics with osteoporosis research productivity in Southeast Asia

No significant correlation existed between the population per country, age 65 and above, and age-standardized fracture prevalence due to falls with any bibliometric indices analyzed in this study. Osteoporosis prevalence ( $\rho_{total citations} = -0.943$ ;  $\rho_{h-index} = -0.943$ ) and DALY attributed to BMD for both sexes ( $\rho_{total}$  publications = -0.644) had a significant negative correlation with research impact and research productivity, respectively. On the other hand, GDP ( $\rho_{total publications} = 0.881$ ;  $\rho_{total citations} = 0.845$ ;  $\rho_{h-index} = 0.845$ ;  $\rho_{$ 

 $index = 0.835), GDP \ per \ capita \ (\rho_{total \ publications} = 0.729; \ \rho_{total \ citations} = 0.657; \ \rho_{h-index} = 0.707), \ R\&D \ expenditures \ (\rho_{total \ publications} = 0.933; \ \rho_{total \ citations} = 0.957; \ \rho_{h-index} = 0.969), \ number \ of \ researchers \ (\rho_{total \ publications} = 0.918; \ \rho_{total \ citations} = 0.918; \ \rho_{h-index} = 0.939), \ physicians-to-population \ ratio \ (\rho_{total \ publications} = 0.702; \ \rho_{total \ citations} = 0.726; \ \rho_{h-index} = 0.747), \ and \ international \ collaborations \ (\rho_{total \ publications} = 0.912; \ \rho_{total \ citations} = 0.922; \ \rho_{h-index} = 0.919) \ had \ significantly \ positive \ and \ high \ correlations \ with \ scientific \ productivity, \ total \ citations, \ and \ h-index \ for \ osteoporosis \ research \ in \ SEA \ (Supplementary \ Table \ 1; \ Table \ 1).$ 

Table 1: Different socioeconomic and epidemiologic characteristics correlated with scientific productivity in osteoporosis research in Southeast Asia.

Country-specific characteristics	<b>Bibliometric indices</b>	Spearman's Rho Coefficient (ρ)	p-value
	Total publications	0.255	0.4765
Population	Total citations	0.231	0.5208
	h-index	0.201	0.5772
	Total publications	0.468	0.1720
Population, age 65 and above	Total citations	0.432	0.2130
	h-index	0.402	0.2490
	Total publications	0.881	0.0007
Gross domestic product (GDP)	Total citations	0.845	0.0021
	h-index	0.835	0.0026
	Total publications	0.729	0.0166
(U) per capita	Total citations	0.657	0.0392

	h-index	0.707	0.0221
	Total publications	0.933	0.0001
Research & development expenditure (%GDP)	Total citations	0.957	0.0001
	h-index	0.969	0.0001
	Total publications	0.918	0.0002
Researchers to population (per mil people)	Total citations	0.918	0.0002
	h-index	0.939	0.0001
	Total publications	0.702	0.0238
Physician to population (per 1000 people)	Total citations	0.726	0.0174
	h-index	0.747	0.013
	Total publications	-0.771	0.072
Osteoporosis prevalence (%)	Total citations	-0.943	0.005
	h-index	-0.943	0.005
	Total publications	-0.350	0.3210
Age-standardized fracture prevalence (%)	Total citations	-0.246	0.4930
	h-index	-0.267	0.4560
	Total publications	-0.644	0.044
Disability-adjusted life years (DALYs) – Both sexes	Total citations	-0.571	0.084
Dour serves	h-index	-0.579	0.079
	Total publications	0.912	0.0002
International Collaborations	Total citations	0.922	0.0002
	h-index	0.919	0.0002

#### DISCUSSION

This study analyzed the trend of osteoporosis research output in SEA for the last 50 years. We have identified the research productivity and impact of countries, institutions, journals, and authors on osteoporosis research. We have also presented the region's most cited research articles, frequently used keywords, and the strength of research collaborations. 1,175 publications were identified in this study. The scientific output related to osteoporosis in SEA increased from 1972 until 2022, producing more than 50 publications annually starting in 2016. Globally, research productivity has been increasing over the past years, which might be due to the rise in productivity, the inclination towards evidence-based medicine, and probably the "publish or perish" phenomenon (Kokol et al., 2021). There was a slow growth in osteoporosis research in Asia until 2012, when publications showed a steady upward trend (Xie et al., 2020).

Thailand, Singapore, and Malaysia are the most productive countries with the highest h-index and total citations in osteoporosis research. Globally, researchers and institutions from the USA and Europe contributed most to the highly cited articles (Brüggmann et al., 2016; Gao et al., 2020). These nations' researchers tend to have strong collaborative ties with other highly productive countries (Brüggmann et al., 2016), showing that international collaboration in scientific research is important in producing more substantial scientific outcomes (Hou et al., 2021). As presented in our study, the three most productive countries in SEA, especially Singapore, demonstrated strong collaboration with these Western countries. Further analysis showed a positive correlation between international collaboration and research output. However, there needs to be stronger collaboration among SEA nations, in contrast to a previous analysis, in which countries with similar economic development, cultural background, membership in the same intergovernmental organizations, and scientific

capabilities have closer research collaboration (Hou et al., 2021). SEA countries should be more involved in collaborative networks to share resources and knowledge and create meaningful research on osteoporosis.

We also found a significant positive correlation between GDP. GDP per capita, R&D expenditure, number of researchers, and physicians to the population with scientific productivity and the impact of osteoporosis research in SEA. Previous bibliometric analyses of different research in SEA also showed a positive correlation between R&D expenditure and the number of publications and total citations. At the same time, they have contradicting results regarding other socioeconomic characteristics and bibliometric indices (Ilagan-Vega et al., 2022; Sanchez et al., 2023; Tantengco et al., 2021). In our study, countries with the highest number of publications, total citations, and h-index - Singapore, Thailand, and Malaysia, have the highest %GDP for research, and have a substantial number of physicians and researchers among SEA countries. On the other hand, Laos, Cambodia, and Myanmar have the lowest GDP per capita, R&D expenditure, and number of physicians and researchers in the region, which reflects their research output. A study by Zhang et al. (2012) also demonstrated a significant relationship between the expenditure of a country on research and development, not only to its research productivity and impact but ultimately to sustained economic growth. Investment in education and research creates innovations and enhances a nation's science and technology (Zhang, 2012).

Worldwide, Osteoporosis International, The New England Journal of Medicine, and Journal of Bone and Mineral Research are the leading journals in osteoporosis research, and all are medical journals and peer-reviewed (Brüggmann et al., 2016; Gao et al., 2020; Suzan et al., 2021; Zhou et al., 2019). Many of the leading journals in osteoporosis are specialized journals in the field, catering to specific audiences. Hence, these journals tend to greatly impact osteoporosis research globally. According to our data, SEA, a local journal – the Journal of Medical Association of Thailand, had the most publications, while two of the leading journals in the region are from Singapore; the availability of these local scientific indexed journals might contribute to the high number of published osteoporosis research in both countries. As mentioned in a study, a positive correlation exists between the number of scientific indexed journals in a country and its research outcome (Meo et al., 2013). Therefore, the improvement of these local journals is significant to the region, as they may produce more relevant research to the population, addressing region-specific issues.

Most highly cited articles on osteoporosis in SEA are from Singapore and international collaborations outside the region. Over half of the original articles (n= 13) produce primary data on osteoporosis from SEA countries. The oldest articles were from 2001, one was about hip fracture incidence in four Asian countries (Lau et al., 2001), while the other study formulated a simple assessment tool for postmenopausal Asian women to identify their risk of osteoporosis (Koh et al., 2001). These topics are still relevant, but have already been updated by other researchers. On the other hand, the newest articles from 2020 to 2021 are about the pathogenesis of glucocorticoid-induced osteoporosis (Chotiyarnwong and McCloskey, 2020) and the global prevalence of osteoporosis, respectively. There are conflicting data regarding the relationship between total citations and the age of the articles; some attributed few citations to new articles (Suzan et al., 2021), while some needed to demonstrate a significant correlation between the two (Gao et al., 2020). As demonstrated, older articles may have already accumulated a lot of citations due to the time they have been published. More current articles, especially those on the global disease burden, epidemiological information, and treatment and diagnostic guidelines, can also get many citations. This is because most studies cite them in their introduction and discussion parts to contextualize and substantiate their results.

Based on the network visualization of keywords linked to osteoporosis research in SEA, articles on osteoporosis mostly focus on prevention, diagnosis, treatment, and follow-up (Temel et al., 2022), but there has also been an increasing interest in fragility fractures among the scientific community for years (Vuillemin et al., 2021). Aside from the treatment of osteoporosis, research hotspots also include its adverse effects, such as atypical femoral fractures and osteonecrosis of the jaw (Zhou et al., 2019). In our study, the more prominent keywords in the earlier years were related to diagnosis, treatment, and risk factors, while later years tended to focus more on risk assessment, screening, fragility fracture, and knowledge. It is noteworthy that the keyword "men" was also mentioned in earlier studies, despite limited publications compared with studies on women, reflecting the insufficient attention on osteoporosis in men. This observation was also noted in bibliometric analysis by Wu et al. (2021), in which from 1998 to 2014, there was an increase in male osteoporosis research (Wu et al., 2021). However, over the years, there seems to be a downtrend in publication (Dong et al., 2022). Although overall, the production of osteoporosis research in SEA has been noted to increase throughout the years, there is still a scarcity of data on the prevalence of osteoporosis for each country in the region. We need to implement an up-to-date and wider collection of data on prevalence and focus on the development of ethnic-specific normative data, diagnostic and treatment strategies that are more relevant to the population, and sociodemographic status. Moreover, future areas of research include the epidemiology of fragility fractures among patients with osteoporosis, the use and validation of the FRAX® tool to evaluate fracture risk, and the use of computed tomography-based finite element analysis to

predict bone strength among osteoporosis patients.

Despite the burden of osteoporosis or low BMD, osteoporosis was not included in the GBD study 2019. The prevalence of low BMD globally has decreased over the past 30 years; however, low- to middle-income countries still have higher incidence and mortality rates than high-income countries (Dong et al., 2022). In a study by Panahi et al. (2023), they identified that African women had the highest summary exposure value (SEV) of low BMD, followed by Southeast Asian women in 2019. They also investigated the DALY attributed to low BMD, in which, globally, there was an increase in both sexes, and overall, the highest DALYs were observed in the Southeast Asia region (Panahi et al., 2023). Moreover, quality of life, access to health services, genetics, sex hormones, nutrition, physical activity, and lifestyle factors may affect BMD, explaining the differences between regions (Panahi et al., 2023). However, in our study, we found a negative correlation between DALY attributed to low BMD in both sexes and osteoporosis research productivity, which may reflect the gap in knowledge and awareness within the region, contributing to increasing disability due to low BMD.

Lastly, we also found a negative correlation between the prevalence of osteoporosis and the research impact. The implication of this is countries with higher prevalence and burden of osteoporosis lack research studies. This can be due to the need for published studies and the underreporting of cases. This data supports the need to increase the production of quality osteoporosis research in SEA to address the high burden of osteoporosis in some SEA countries. More research is needed to improve the region's care, prevention, and osteoporosis treatment.

This was the first study that investigated the performance of SEA countries on osteoporosis research. The data included was only from the Scopus database, which may have missed relevant journal articles from other databases. Furthermore, our study was also limited to English journals, which might lead to an underestimation of data that did not account for osteoporosis publications in native languages. The analysis of citations also included self-citations. Despite these limitations, the study provided an extensive analysis of the research performance, trends, gaps, and future areas for osteoporosis research in SEA.

#### CONCLUSION

Our study showed that research on osteoporosis is a growing topic of interest in SEA. Singapore, Thailand, and Malaysia were the key drivers in osteoporosis research in the region. Thailand was the most productive, while Singapore produced the most impactful research. GDP, GDP per capita, expenditure on R&D, number of physicians, and research to population are positively correlated with research productivity and impact. The study demonstrated the significant disparity in osteoporosis-related scientific output between countries with higher and lower socioeconomic capabilities. Therefore, research partnerships within and beyond SEA should be strengthened, especially in countries with lower resource allocation. Furthermore, funding and a strong research environment should be promoted to increase the productivity and quality of research on osteoporosis in the region, especially in universities and university-affiliated institutions.

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#### CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

#### CONTRIBUTIONS OF INDIVIDUAL AUTHORS

Sarah Jane B. Samalca: Conceptualization, Methodology, Software, Investigation, Data Curation, Writing-Original Draft.

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#### SUPPLEMENTAL INFORMATION

Supplementar	/ Table 1	• Countr	v-specific	characteristics	of	Southeast	Asian	countries
oupplemental		. Oounu	y-specific	Characteristics	UI.	ooumeasi	Asian	countines.

Countries	Population (in millions)	Population age 65 and above	GDP (in billions USD)	GDP per capita (units)	% GDP for Research	Age- standardized DALY (attributed to low BMD)	Prevalence of Osteoporosis (%)	Age- standardized fracture prevalence (%)	Physicians (per 1,000 people)	Researchers in R&D (per million people)
Brunei	0.44	27,708	16.68	37,850.98	0.28	109.16	NA	0.43	1.9	285
Cambodia	15.99	973,517	28.82	1,801.87	0.12	181.69	NA	0.45	0.2	31
Indonesia	274.86	18,891,582	1318.81	4,798.12	0.28	103.71	53 <sup>a</sup>	0.39	0.7	400
Laos	7.48	335,419	15.30	2,046.86	0.04	83.16	NA	0.44	0.3	16
Malaysia	32.65	2,546,223	407.03	12,465.61	0.95	75.45	24.10 <sup>b</sup>	0.44	2.2	726
Myanmar	53.89	3,692,668	66.16	1,227.70	0.15	138.15	NA	0.44	0.8	19
Philippines	111.57	6,282,669	404.28	3,623.59	0.32	66.71	45.9ª	0.44	0.8	172
Singapore	5.64	852,166	466.79	82,807.65	2.16	73.50	9.30°	0.41	2.4	7225
Thailand	70.08	10,906,792	495.42	7,069.59	1.33	66.17	19.8 <sup>d</sup>	0.44	0.9	2024
Vietnam	99.46	8,951,655	406.45	4,086.52	0.43	146.01	30 <sup>a</sup>	0.46	0.8	779

<sup>a</sup>Mithal, A., Bansal, B., Kyer, S. C., & Ebeling, P. (2014). The Asia-Pacific Regional Audit-Epidemiology, costs, and burden of osteoporosis in India 2013: A report of International Osteoporosis Foundation. Indian Journal of Endocrinology and Metabolism, 18(4), 449–454. https://doi.org/10.4103/2230-8210.137485

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