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Osteoarthritis in Southeast and East Asia: A Review

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ABSTRACT OF THE THESIS

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Osteoarthritis (OA), a disease of the joint characterized by progressive cartilage degradation and chronic pain, is the most common form of arthritis and the leading contributor to disability. The prevalence of OA is increasing worldwide with global population aging [1]. The rise in OA prevalence is especially concerning for many Southeast and East Asian countries with unprecedentedly rapid population aging. This literature review aims to explore the OA prevalence and risk factors, and the OA lived experience in

Southeast and East Asia; as well as the OA situation in Vietnam and Japan. Knee and hand OA are highly prevalent in Southeast and East Asia, and are associated with diverse biological, behavioral, and social factors such as age, sex, body mass index, occupation and educational level, and sociocultural activities. The OA lived experience is highly variable and characterized by limited knowledge of OA and OA management; pain and disability impact on physical, sociocultural, and psychological health; and self-management of OA. Finally, comparison of the OA situation in Vietnam and Japan revealed more challenges for OA management in Vietnam. Learning from Japan, we recommend that Vietnam implement a long-term care insurance system to support OA patients with disability, in addition to promoting public awareness of OA and OA prevention and management. With increased aging population and burden of healthcare to the society, awareness of OA and the modifiable risk factors should happen at all levels including the public, health providers and policy makers.

1.   Introduction

Osteoarthritis (OA), the most common form of arthritis, is a chronic disease of the synovial joint that is characterized by progressive degradation of articular cartilage, leading to stiffness, pain, and impaired movement. OA commonly affects the joints in the knees, hip, shoulders, hands, feet, and spine; and is the leading contributor to disability. Additionally, OA prevalence increases with age. As an illustration, the global prevalence of knee OA was estimated to be 16% in persons aged ≥15 years and increased to 23% in adults aged ≥40 years [2]. Aside from pain management methods and, in severe cases, total joint replacement, there is currently no effective treatment for OA.

A debilitating disease, OA imposes serious health and socioeconomic consequences. On the individual level, OA-induced pain and functional limitations lead to reduced work performance and productivity, income loss, social isolation, psychological distress, thereby lowering the patients' quality of life [3], [4]. OA is also associated with increased risk of mortality, especially cardiovascular disease-related mortality [5]. In 2019, OA ranked 15th among the Level 3 causes for global Years Lost to Disability (YLDs), constituting 2.2% of total global YLDs. On the societal level, global OA-related healthcare and non-healthcare costs, including productivity loss, ranged from 0.25% to 0.5% of a country's gross domestic product (GDP) [6].

Risk factors for OA include both modifiable and nonmodifiable factors such as advanced age, female sex, obesity, diet, and mechanical injury [5]. Accordingly, OA is becoming more prevalent with fast population aging and increased obesity prevalence worldwide [1]. Since 1990, the global age-standardized prevalence and annual incidence rate of OA had increased to 3754.2/100,000 (9.3% increase) and 181.2/100,000 (8.2% increase) in 2017 [7]. The rise in OA prevalence is especially concerning for Asian countries, particularly Southeast and East Asian countries, with unprecedentedly rapid population aging that surpassed the aging rate in the rest of the world [8]. To prepare for the increased burden of OA in Southeast and East Asia, it is important to understand the current situation of OA in the regions, which are home to politically, economically, and culturally diverse countries.

The purpose of this review is to explore the manifestation of and response to OA in the Southeast and East Asian regions. Considering the results from existing literature, this review will identify and explore the following OA-related domains in Southeast and East Asia: 1) prevalence and risk factors of OA; 2) the OA patient's perspective on knowledge of OA, OA symptoms and impact on the lived experience, and OA management; and 3) case studies of OA management in the low- and middle-income country (LMIC) of Vietnam and the high-income country (HIC) of Japan, with additional focus on Vietnam and making policy recommendations for OA strategy in Vietnam.

2. Methods

All peer-reviewed and grey literature search was conducted from December 2020 through June 2021.

2.1. OA prevalence and associated factors

To identify country-specific OA prevalence and associated factors in the 21st century, a search was performed on the PubMed database using the keywords "osteoarthritis prevalence" and "osteoarthritis risk factors" combined with each Southeast and East Asian country's name. Studies was restricted to observational epidemiological studies of OA (both population-based studies and studies on the profiles of OA patients) written in English, published from the year 2000 to present, and conducted on a general population in one or more regions. Peer-reviewed articles were selected for in-depth review if they met the inclusion criteria, contained relevant information on OA prevalence and/or OA-associated factors. To ensure selected studies reflect the current or most recent situation of OA, for each country, only the three most recent studies on OA prevalence and four most recent studies on OA-associated factors were included in this literature review. Studies conducted on a specific subpopulation (such as a specific career), published before 2000, and/or less recent were excluded from the review.

2.2. The patient's perspective

To explore the lived experience of OA patients, a search was performed on the PubMed and Google Scholar databases using the keyword "osteoarthritis qualitative" with "asia" or country name. Studies were restricted to qualitative studies that were written in English, published from the year 2006 to present, and

explored the lived experiences and perceptions of OA patients through in-depth interviews and/or focus group discussions. To capture the common lived experiences and perceptions of OA patients, only studies with OA patients using conservative management strategies and not having had joint replacement surgeries were included. Studies with non-OA patients (such as caregivers and physicians) or OA patients with surgery were excluded from the review.

2.3. Case studies

To explore the current situation of OA in Vietnam and Japan, a search was conducted on the PubMed and Google Scholar databases, as well as the web-based Google search engine, for peer-reviewed articles and public information on policies, guidelines, and reports related to OA and written in English or Vietnamese. Search keywords included the keywords used for qualitative and epidemiological studies, plus the following keywords: "healthcare system", "aging", "osteoarthritis guidelines", "long term care", and "osteoarthritis" combined with "Japan" or "Vietnam", as well as the Vietnamese translation of these keywords. Peer-reviewed articles and grey literature were selected based on the relevance to the domains of general health system, OA prevalence, and OA strategies in these countries. Information posted on the public websites (such as the WHO and Vietnamese/Japanese Ministry of Health websites) was extracted for in-depth review of relevant information. Information from presentations at conferences and credible news media and was also included. English- and Vietnamese-language information was included in review. Information from social media and non-credible news media was excluded.
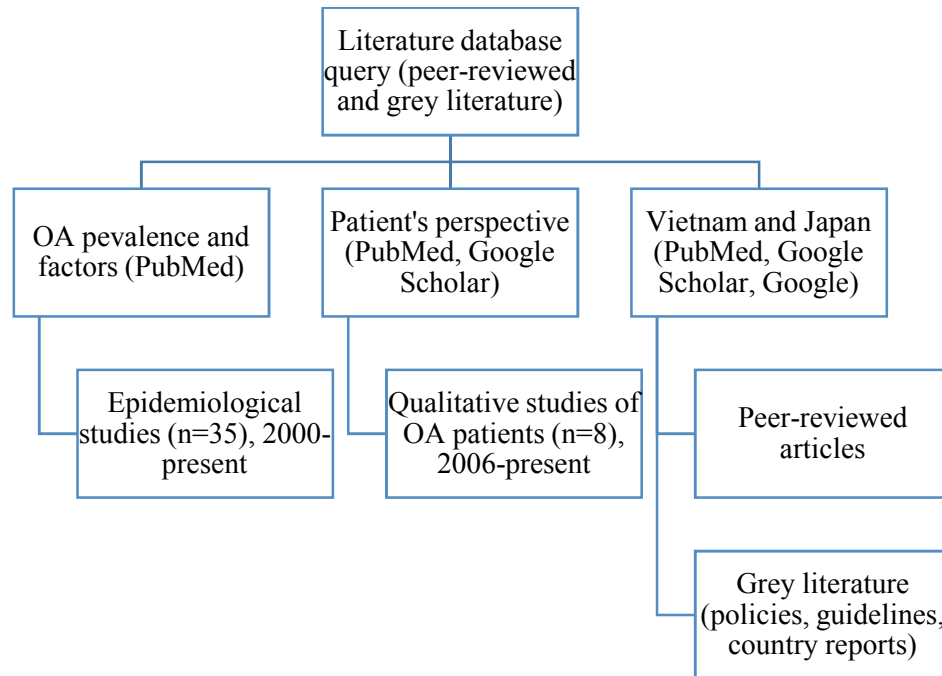
Figure 1: Flowchart of search strategy.

3. Results

3.1. OA prevalence and associated factors

Thirty-five epidemiological studies on the prevalence and associated risk factors of OA in Southeast and East Asian countries were included in this review [9]–[14], [14]–[30], [30]–[40]. These studies were published in the 21st century, ranging from 2002 to 2021, and included both population-based studies and studies of characteristics of OA patients with ties to the same health facilities; with cross-sectional, case-control, or cohort (prospective or retrospective) study designs. **Table 1** in Supplementary summarizes the study design, participant demographics, and findings related to OA prevalence and/or risk factors from the epidemiological studies included in this review. In these studies, OA was defined as radiographic or symptomatic OA. In radiographic assessment of OA, most studies employed the Kellgren-Lawrence scoring system in accordance with the WHO's recommendation for large OA epidemiological studies. The Kellgren-Lawrence scale classifies different levels of OA severity based on radiographic features such as joint space narrowing (indicating the extent of cartilage loss) and osteophyte formation.

The search for epidemiological prevalence of OA in the 21st century in each Southeast and East Asian country on the PubMed database, with restrictions mentioned in Methods, yielded few to no results for lower middle-income countries, many of them located in the Southeast Asian region. The more recent epidemiological studies on OA prevalence were also conducted in more high-income countries than LMIC in both Southeast and East Asian countries. Given the different OA assessment methods and sample demographics in studies included in this review, prevalence of OA will not be compared across countries.

In the Southeast Asian region, only the countries of Malaysia, Philippines, Thailand, and Vietnam had OA prevalence studies, published since 2000, on the PubMed database. Singapore and Brunei, the highest and second-to-highest income countries in the Southeast Asian region, had no reported OA prevalence on PubMed since 2000. In studies that included various joints affected by OA, OA in the knee was the most common form of diagnosed OA (accounting for around 60% of diagnosed OA cases), followed by OA in multiple joints, spine, hand, and hip (in decreasing order of prevalence) in the Philippines [13]; and OA in the hip in Vietnam [22]. In both countries, hip OA was the least frequent form of diagnosed OA, accounting for around 3% of diagnosed OA cases.

Most countries in the East Asian region, except for Hong Kong and Taiwan, had OA prevalence studies, published since 2000, on the PubMed database. Generally, as in the Southeast Asia, knee and hand OA were more prevalent than hip OA in the East Asian region, with knee OA being more prevalent and more researched on in multiple countries [25]–[28], [30]–[35], [37], [38], [40]. Furthermore, many studies report discordance in the prevalence of radiographic and symptomatic OA in the same population [15], [18], [20], [21], [30], [30], [32], [40].

Common OA-associated nonmodifiable and modifiable factors were identified in cross-sectional, case control, and longitudinal cohort studies conducted in various Southeast and East Asian countries. Knee OA was found to be associated with the biological factors of advanced age, the female sex, higher body mass index (BMI) or excess body weight, comorbidities (including obesity, hypertension, and gout), history

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of knee injury, and history of abortion; the behavioral factors of repetitive knee use (in standing, walking, stair-climbing, lifting, or kneeling), habitual floor activities (in the squatting, side-knee bending, and lotus positions); as well as the social factors of lower socioeconomic status – indicated by lower educational level, lower household income, or certain types of occupations (such as occupations in public services, sales, plant/machine operations; or not working or being housewife), and residence in rural or mountainous areas [9], [10], [12]–[14], [14]–[30], [30]–[41]. Additionally, in a multiethnic sample (n=1,226, mean age=69) in urban Malaysia, Mat et al. (2019) found a higher prevalence of self-reported knee pain and OA-related symptoms among older adults of the Malay ethnicity (44.6%) compared to the Indian (31.9%) and Chinese (23.5%) ethnicities [12]. In the same year, a nationwide cross-sectional study (n=2,302 with 61% women) in South Korea found a positive association between daily consumption of 7 or more cups of coffee and the prevalence of radiographic knee OA in men, as well as an observed exposure-response pattern in the level of coffee consumption and prevalence of knee OA in men, but not in women. Nevertheless, there was no association between the common daily consumption of 1-2 cups of coffee and the prevalence of knee OA [42]. Alcohol consumption [13], [34], [39], insufficient consumption of soy products [31], and lower consumption of green tea [34] were other dietary factors associated with knee OA.

Besides knee OA, few studies on other types of OA were included in this review. In these studies, hand OA was found to be associated with advanced age, the female sex, and high BMI; lumbar OA with advanced age, the female sex, work demands and posture, and lower socioeconomic status; hip OA with advanced age, the male sex, residence in coastal areas, and physical activity [26], [29], [30], [40]. Having rheumatoid arthritis or metabolic syndrome, as well as residence in areas with low urbanization, were also predictors for OA, according to studies conducted in Taiwan and in the Philippines [13], [36].

There were mixed findings on the association between OA and smoking. Multiple studies – conducted in China, Hong Kong, Indonesia, Malaysia, and Japan – have reported an inverse association between smoking and knee OA, suggesting the protective effect of smoking in OA development [10], [25], [29], [34]. Likewise, in a Chinese population-based (n=63,129 with 56% women) retrospective cohort study

(with a mean follow-up time of 14.5 years) in Singapore, smoking was inversely associated with the incidence of total knee replacement due to severe knee OA independently of body weight and sex. There was also a dose-response relationship between the increased duration/dosage of smoking and decreased risk of severe OA, but this relationship was attenuated by the increasing period of smoking cessation [14]. Conversely, a more recent study of the characteristics of knee OA patients in Indonesia (n=47 with 89% women) identified passive smoking as a risk factor for knee OA [10]. Another study of the clinical profile of primary OA patients (n=859 with 75% women) in the Philippines also denied the protective effect of smoking in OA despite observing a high prevalence of non-smokers (71%) in the OA patient population [13].

3.2. The patient's perspective

Eight qualitative studies included in this review investigated the lived experience, knowledge of OA, and OA management among middle-aged and older adults with OA living in Southeast and East Asian countries (particularly Hong Kong, Malaysia, Singapore, South Korea, and Taiwan) [41], [43]–[49]. The mean age of OA patients in these studies ranged from 49.6 years to 73.2 years, with the youngest mean age of 49.6 years characterizing a study on middle-aged adults with early OA in Taiwan [45]. Participants had diagnosed OA of various severity levels in the knee (in six studies) [11], [43]–[46], [49] or the hand (in two studies) [47], [48]. Additionally, most studies included both men and women, with women constituting the majority of participants [44], [45], [47]–[49]. A study in South Korea included only female participants [46].

Participants' socioeconomic status was reported in four studies with the indicator of educational level alone [44] or both educational level and occupation [47]–[49]. In particular, current participants' occupations (in addition to educational level) were reported in two hand OA studies in Singapore, with most participants being retired, followed by being employee (type of occupation unspecified) or housewife [47], [48]. Occupational history was reported only in a study on early knee OA in Taiwan, with most participants working as laborers in the past [45].

In qualitative studies included in this review, participants had not received joint replacement or arthroplasty [11], [43]–[49]. Additionally, in seven of the eight studies, participants had not received special OA treatment or intervention (such as experiential treatment or intervention) other than the standard treatment [11], [43]–[47], [49]. In a single study conducted in Singapore, participants (hand OA patients) had participated in a comprehensive education and self-management program [48]; thus, this study was excluded from our review of the patient's knowledge of OA. Focus group discussions and/or qualitative interviews were utilized to explore the experiences and perceptions of OA patients in all qualitative studies included in this review [11], [43]–[49].

In all studies, OA patients experienced joint pain and stiffness that caused functional limitations in daily living and sociocultural activities. The following domains predominated the lived experiences of OA patients: knowledge of OA, pain and functional disability, participation in sociocultural activities, psychological health, and pain management. These domains also constituted primary concerns among knee OA and hand OA patients across different ethnicities and countries [11], [43]–[49].

3.2.1. Knowledge of OA

The patients' knowledge of OA etiology, particularly knee OA, was explored in four studies in conducted Hong Kong (mean age=57.1; 13 women, 7 men), Malaysia (Kamsan et al.; mean age=73.2; 13 women, 3 men), (Ahmad et al.; mean age=67.1; 8 women, 4 men), and Taiwan (mean age=49.6; 14 women, 3 men) [11], [43]–[45]. Middle-aged and older adults with knee OA commonly attributed the condition to aging, wear and tear or degeneration of knee structures, and history of knee overuse or overloading (from occupational or non-occupational activities) [11], [43]–[45]. Of these factors, aging was most frequently associated with OA development. In Taiwan, OA patients' attribution of knee OA to aging was partly explained by the general name of OA in Taiwan being "degenerative arthritis". This general knowledge of OA as a sign of aging, however, created confusion for middle-aged adults with knee OA in Kao and Tsai's study (2014); consequently, these middle-aged participants attributed their condition to occupational demands or other health conditions such as high uric acid levels [45]. Other perceived causes of knee OA included excess body weight [43], [44], menopause, and rheumatism [43], previous injuries, and

inappropriate footwear [44]. While most participants in these studies could identify factors causing OA, few were familiar with the underlying biological mechanisms. In the few participants' descriptions of knee OA biology, a common theme was the loss of fluid or gel resulting in increased friction rubbing between the bones, which in turn caused pain. Wear and tear of the knee ligament and formation of bone spurs were also mentioned, but to a lesser extent [11], [44]. Overall, although common themes emerged, the patient's knowledge of OA, as well as the level of knowledge, varied across individuals in each of the studies [11], [43]–[45]. Concerningly, Kamsan et al. (2020) found insufficient level of OA knowledge among older adults with knee OA in an urban city of Malaysia, despite these patients having lived with OA for three or more years. A strong desire to learn more about the disease and disease management was also observed among participants in the same study [44]. Similarly, many middle-aged adults with knee OA in northern Taiwan reported little understanding of OA and its management due to lack of OA-related information and lack of access to OA-related information (as a result of insufficient information in doctor's consultations, lack of instructional tools for patients, not knowing how to find relevant information, and not having anyone to discuss OA with) [45].

3.2.2. Pain and disability; and impact on physical, social, and psychological health

Regardless of their self-knowledge of OA, OA patients inevitably experienced chronic pain and functional disability, as observed in four qualitative studies of the OA experience conducted in Hong Kong (mean age=57.1; 13 women, 7 men) [43], Malaysia (mean age=67.1; 8 women, 4 men) [11], Taiwan (mean age=49.6; 14 women, 3 men) [45], and Singapore (mean age=62.9; 23 women, 3 men) [47]. Both knee and hand OA patients described joint pain, stiffness, and swelling as intermittent symptoms whose intensities varied with time and certain factors [11], [43], [45], [47]. Additionally, in Chan and Chan's study of knee OA patients in Hong Kong, 80% of participants distinguished inflammatory from mechanical pain. While mechanical pain was described as sharp pain resulting from joint loading or movement, inflammatory pain was described as burning and longer-lasting flares triggered by various factors including weather changes [43]. Perceived aggravating factors for OA-related knee pain (mechanical or inflammatory pain) included knee movement following a period of inactivity; movements and postures such as squatting, climbing stairs,

and prolonged sitting, standing, or walking; sprain or feet misplacement; and weather changes [11], [43]. Similarly, perceived aggravating factors for OA-related hand pain included movements such as gripping or rinsing; cold and rainy weather; and foods such as seafood, salty biscuits, bean products, and foods that are considered "cool" in the Chinese culture [47]. Because many movements or postures worsen OA-induced pain, OA patients experienced functional limitations and disability as they avoided or became unable to perform certain movements. Consequently, both knee and hand OA patients reported difficulties in daily living activities such as self-care, driving, cooking, and doing housework. They also reported impaired work performance that resulted in changes in job or job duties, absence from work, job quitting and early retirement, and loss of income [43], [45], [47].

OA-induced physical limitations and disability also interfered with participation in social and cultural activities, according to six qualitative studies conducted in Hong Kong, Malaysia, Singapore, and Taiwan [11], [43]–[45], [47], [49]. For example, OA patients reported reduced participation in and avoidance of religious or traditional rituals due to challenges in kneeling and sitting cross-legged with knee OA [44], [49], and in getting up from kneeling with hand OA [47]. Additionally, OA disrupts the patients' family roles, as many people with knee or hand OA became unable to care for or go out with their young grandchildren, aging partner, or any family member [11], [43], [47]. Other social and recreational activities negatively affected by knee or hand OA included hanging out with others, playing with grandchildren, going out or travelling, shopping, doing exercise, using the computer, sewing, gardening, and arranging flowers [11], [43], [45], [47]. Moreover, social participation represented one of the most important domains for people with OA, with the perceived level of importance varying across individuals and across different ethnicities of OA patients. In Xie et al.'s multiethnic study (2012), for instance, OA impact on religious participation was considered important by a larger proportion of Malay participants compared to Indian and Chinese participants. Despite such variation, qualitative studies consistently found that OA significantly and negatively affected the patients' social health.

Interrelated with the physical and social impact was the psychological impact of OA, explored in the same six qualitative studies that investigated the social impact of OA [11], [43]–[45], [47], [49] plus a

study conducted in Singapore on patients-perceived important domains [48]. In most knee and hand OA patients, distress, apprehension, and negative feelings (such as feelings of frustration and helplessness) stemmed from various aspects, including the nature of the OA disease (such as the unpredictability of OA-related symptoms and disease progression, and the ineffectiveness of pain and symptom management methods), OA impact on the lived experiences of patients (such as functional limitations in physical and social activities, and loss of independence or increased dependency on others), and lack of social support (such as not having anyone to talk to about OA, and others being unaware of or underestimating the impact of OA). [11], [43]–[45], [47], [49]. OA patients were also concerned with physical deformities; the extent of concern with physical deformities appeared to be greater in hand OA patients (with 25 of 45 (55.6%) participants rating hand and finger appearance/self-image as an important domain) compared to knee OA patients in similar age group (with 14 of 41 (34.1%) participants of multiethnicities rating deformity as an important domain) [48], [49]. Moreover, in Thumboo et al.'s study, two participants expressed having had suicidal thoughts due to, directly or indirectly, having hand pain and disability [47]. On the other hand, many older adults coped with the emotional impact of OA by accepting the disease as a normal condition of aging; this self-acceptance helped restore patients' hope, optimism, and ability to enjoy life [11], [43], [44], [47]. Religious and social support from friends and family also helped patients cope with OA [47]. As is the case with knowledge of OA, the OA-related symptoms, perceived aggravating factors, and functional disability and its impact varied across individuals with OA and guided their management strategies.

3.2.3.   Management and coping strategies

Six qualitative studies conducted in Hong Kong [43], Malaysia [44], Singapore [47], South Korea [46], and Taiwan [45] provided an insight into the self-management of OA among middle-aged and older adults living with knee or hand OA. Chan and Chan (2011) found that patient's knowledge of coping strategies for OA came from health professionals including doctors physical therapists, from the Internet and media, and from other OA patients [43]. Kamsan et al. (2020) specifically found that personal beliefs and recommendation from family or peers contributed to the patient's use of alternative treatment for OA [44]. As most participants were aware of the irreversibility of OA, OA management centered on alleviating

symptoms (especially pain) and slowing disease progression by protecting the joints. Symptom management, particularly pain alleviation, among participants typically combined pharmacological with non-pharmacological methods, as well as western with traditional methods. Generally, in knee OA patients, pain management included rest periods; ice therapy; thermal treatment; showering or bathing in hot water, and swimming; massage with or without ointment/cream; posture modification; traditional remedies of salt, herbs, or oils; traditional/Chinese medicine; acupuncture; electrotherapy; and topical agents and over-the-counter medication [11], [43]–[46]. Some participants also reported that praying helped relieve pain while serving as an exercise to protect the knee flexibility [44]. Similarly, in hand OA, self-pain management included stretching hands; western medical treatment; and alternative treatment including massage, acupuncture and over-the-counter supplements [47]. Pain-relieving medications, or analgesics, commonly used or prescribed for OA were non-steroidal anti-inflammatory drugs (NSAIDs) [43], [44]. Participants with knee OA in Chan and Chan's study (2011) found NSAIDs highly effective in relieving inflammatory pain. However, these medications' side effects made them unfavorable for OA patients; intraarticular injections were also unfavorable for the same reason. For example, in Kao and Tsai's study (2014), middle-aged patients with early knee OA avoided frequent use of analgesics and intraarticular injections in fear of their long-term side effects on the kidney, stomach, or cartilage [45]. Similarly, older adults with knee OA in urban Malaysia preferred non-invasive and non-pharmacological management strategies to intraarticular injections, joint replacement, and prescribed analgesics. Some refused to take prescribed medications due to skepticism toward their side effects [44]. Treatment side effects and reliance on medications also constituted some of the major concerns for participants in Chan and Chan's study (2011).

In addition to pain management, delaying disease progression is a major aspect of OA management. To slow disease progression, OA patients tried to protect the joints and preserve joint functions, primarily with diverse non-pharmacological strategies. In knee OA, these strategies aimed to included physiotherapy and exercise to preserve the knee function; use of assistive devices such as knee bracing and walking aids to protect the knee; diet changes to lose weight and reduce loading on the knee; posture and activity modification, such as avoiding heavy lifting and exercise, to reduce loading on the knee [11], [43]–[46],

[49]. Hand OA patients also reported hand stretching and did exercises, use of assistive devices, and modification of tasks as coping strategies [47]. In addition to preventing OA deterioration, these coping strategies also helped to relieve joint pain, and their perceived efficacy varied across individuals. While most knee OA patients in Ahmad et al.'s study (2018) found physiotherapy to be effective in both delaying OA progression and reducing pain, some found physiotherapy effective only for delayed progression but not pain reduction [11]. In Thumboo et al.'s study (2017), one participant with hand OA described the occupational therapy service as expensive (charging even more than doctors) yet giving "useless and impractical advice" [47].

Barriers to OA care and management existed in multiple aspects, ranging from symptom recognition to access to treatment. Firstly, late health-seeking behavior was observed in 55% of participants with knee OA in Chan and Chan's study (2011). Although these participants had experienced OA symptoms for a long time, they only sought medical help when their social and daily living activities became impaired due to the irregular frequency of symptoms, the misunderstanding of symptoms as a natural part of aging, and the fear of facing the truth [43]. Secondly, several studies found insufficient knowledge of OA and coping strategies among OA patients, as previously described in the Results section 3.2.1.Knowledge of OA [44], [45]. Most participants with knee OA in Kamsan et al.'s study (2020) also wanted to learn more about non-pharmacological pain interventions as well as exercise and weight management [44]. Thirdly, OA care and management entailed lifestyle changes that were, by nature, not easy to implement. For instance, in a study by Park et al. (2020), Korean women with knee OA and one or more comorbidity (i.e. hypertension, diabetes, and/or dyslipidemia) had difficulty engaging in the recommended level of physical activity for many reasons, including joint pain and fatigue during exercise, worries about injuries, lack of motivation, limited time and resources (such as limited access to exercise facilities), and insufficient knowledge of the importance of physical activity in OA with comorbidity [46]. Two participants with knee OA in Ahmad et al.'s study (2018) also reported non-compliance with home exercise due to lack of motivation and equipment [11], and participants with knee OA in Kamsan et al.'s study reported insufficient knowledge of appropriate exercises to perform despite knowing the importance of exercise in preventing

or slowing OA deterioration [44]. Lastly, OA care and management methods are expensive. In Thumboo et al.'s study (2017), the unmet needs of hand OA patients included the high costs of supplements and assistive devices, and the high charges of health and alternative health services [47]. Consistently, Kamsan et al. (2020) observed that treatment cost, along with perceived treatment efficacy, influenced the patient's approach to coping with OA [44].

3.3. Case studies

3.3.1. Vietnam

3.3.1.1. Healthcare for older adults

Healthcare in Vietnam is characterized by a mixed public-private system, with the public system being the dominant form of health provider. The public health system is organized into the central-, provincial-, and district-level hospitals, and commune clinics. While general and preventive care services are provided at all levels of health facilities, many Vietnamese people bypass the commune clinics and lower-level health facilities to seek care from higher-level hospitals, leading to overburdening in higher-level hospitals and increased out-of-pocket expenses [50], [51]. This is due to the shortage of health workers and resources in lower-level health facilities. At the 11th ASEAN and Japan High Level Officials Meeting on Caring Societies, the Vietnamese Ministry of Health reported the uneven allocation of public health budget to higher-level health facilities and the underfunding of commune- and district-level facilities that weakens the primary care system [52].

There is currently no universal health coverage, but Vietnam is making significant progress toward universal health coverage through social health insurance, meeting many objectives outlined in the Master Plan for Universal Coverage. Nearly 96% of seniors aged 60+ had health insurance in 2018. It is projected that by the end of 2021, all senior citizens will have health insurance [53]. However, limitations in Vietnam's social health insurance results in reduced health seeking behavior and, among those seeking healthcare, catastrophic economic burden on the households [54], [55].

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The majority of older adults in Vietnam receive care from public providers. According to Le and Nguyen (2020), there is limited geriatric care and expertise in Vietnam's health system. The leading facility that provides specialized geriatric care is the National Geriatric Hospital (central level) in the capitol city of Hanoi. Provincial hospitals with geriatric departments (which comprise 20% of provincial hospitals in the country) are concentrated in densely populated provinces [54].

3.3.1.2. The OA situation in Vietnam

3.3.1.2.1. Prevalence and risk factors

Vietnam has a population size of over 95 million. There were nearly 13 million adults aged 60 or older in 2020 (constituting 12% of the total population), with nearly 2 million over the age of 80 [53], [56]. According to the HelpAge Global Network, Vietnam is among Asian countries with fast-aging population, and the number of older adults in the country is projected to be 29 million by 2050. Over 70% of older adults live in rural regions of the country [57][57].

The current number of people living with OA in Vietnam is not known, as few epidemiological studies have explored OA prevalence in Vietnam in recent years. Two cross-sectional studies conducted in a rural (2015) and urban (2014) region revealed the prevalence of diagnosed OA in older adults and radiographic knee OA in middle-aged and older adults and, respectively [22], [24]. Specifically, in a random sample 669 women and 476 men of aged 60+ in the rural district of FilaBavi, the prevalence of physician-diagnosed arthritis/OA, as reported by participants, was 35% (41% in women, 23% in men); the joint problems including OA were also the most frequently reported chronic disease among these elderly participants [24]. In another random sample of 488 women and 170 men aged 40+ in Ho Chi Minh City, the largest city of the country, the point prevalence of radiographic knee OA (indicated by radiographic grades of ≥2 on the Kellgren and Lawrence scale) was 34.2% (35.3% in women, 31.2% in men) [22]. Both studies showed that OA and radiographic knee OA affected more women than men. Finally, a less recent WHO-ILAR COPCORD (WHO- International League of Associations of Rheumatology Community Oriented Program for Control of Rheumatic Diseases) study, conducted in 2003 on an urban population (1,138 women, 981 men aged 16+), found that OA (diagnosed using the American College of

Rheumatology classification) was the most prevalent rheumatic disease with a 4.1% prevalence (4.7% in women, 3.3% in men). Knee OA accounted for 60% of the OA cases and occurred more frequently in women (78%) compared to men. Hip OA was less common, accounting for 3.4% of OA cases, and may be explained by the relatively low BMI among Vietnamese adults (BMI around 19.7 for both men and women). The disparities in knee and hip OA may also be explained by the habit of squatting being protective to the hips and detrimental to the knees [23]. Altogether, although these studies utilized different OA reporting methods, they provided evidence for an increase in OA prevalence over time in the urban Vietnamese population, with knee OA being the most common form of OA, especially in women. There appeared to be little difference in the OA prevalence between urban (2014) and rural (2015) regions, but this lack of significant difference was due to the use of different OA diagnostic methods in these studies.

In agreement with findings from other Southeast and East Asian countries, higher prevalence of knee OA was associated with the following biological factors: advanced age, higher BMI, self-reported knee pain [22], and the female sex [22]–[24]. Ho-Pham et al. observed a 56% increase in the risk of radiographic knee OA with every 5-year increase in age (prevalence ratio PR=1.56), a 14% increase in the risk of radiographic knee OA with every kg/cm^2 increase in BMI (PR=1.14). Self-reported symptoms of pain when squatting, bony enlargement of the knee, and crepitus were also predictive of radiographic knee OA (PR=3.1). Additionally, squatting was postulated as a behavioral risk factor for knee OA in the Vietnamese population [22].

Vietnam has undergone drastic demographic and economic transitions that contributed to the rise of OA risk factors. First, the country has entered the aging phase since 2011 and, according to the WHO, is one of the country with the fastest-aging population in the world [58]. Secondly, the country has experienced fast economic growth, industrialization, and urbanization that resulted in – among other lifestyle changes – increased westernization of diet (in addition to the high salt intake in the traditional Vietnamese diet), physical inactivity, and alcohol consumption [59]–[61]. The prevalence of active and passive smoking has reduced in response to the government efforts to reduce smoking, but the 5.3% reduction in smoking from 2010 to 2015 was lower than expected [59]; the smoking prevalence among men

in Vietnam also surpassed that in nine other Southeast/South Asian countries and was especially high among older men and men living in rural regions [61]. Altogether, these lifestyles changes not only increased the risk of OA, but also contributed to the increased prevalence of overweight/obesity (although the prevalence of obesity in Vietnam remains low compared to other countries), diabetes, and hyperlipidemia over time, in addition to the existing high prevalence of prehypertension and hypertension [59]–[61]. (Moreover, although the prevalence of prehypertension (42%) and hypertension (21%) among Vietnamese adults was high, only a small proportion of them were aware of their high blood pressure, especially in rural areas with higher prevalence of hypertension yet lower personal awareness of their status [59].) These conditions are well-known risk factors for OA. Overall, the country is seeing a rise in both nonmodifiable and modifiable risk factors for OA.

3.3.1.2.2.   OA care and management

The health system of Vietnam supports the integration of western and traditional medicine. The clinical guidelines for OA diagnosis and treatment, previously published in 2014 along with the Ministry of Health policy #361 (361/QĐ-BYT) and widely applied in non-oriental medicine health facilities, closely follows core international guidelines and recommendations, including the ACR criteria for OA diagnosis and the American College of Rheumatology/European League Against Rheumatism pharmacological (such as paracetamol and NSAIDs) and non-pharmacological management recommendations (such as weight loss and exercise) [62]. Concurrently, traditional medicinal herbs and care techniques continue to be used for OA management [23], [63], [64], and have proven to be effective, as is the case with a traditional multiherbal remedy recently demonstrated to provide anti-OA effect in the rat OA model [65]. At the 19th Annual Conference of the Ho Chi Minh City Rheumatology Association held in 2020, Dr. Nguyễn Thị Bay (PGS. TS.) reported on the use and effect of traditional medicine in OA management in and outside Vietnam and encouraged the integration of traditional medicine in OA strategies. Recognizing the role and progress of traditional medicine in Vietnamese healthcare, in 2020, the Ministry of Health published policy #5013 (5013/QĐ-BYT) that provided the first evidence-based guidelines on integrating the traditional and western medicine in diagnosing and treating 20 common diseases including knee OA. These knee OA treatment

guidelines include, in addition to the core western OA management recommendations, the use of traditional medicinal remedies and techniques such as acupuncture, massage and chiropractic, and catgut embedding therapy [66]. These guidelines are consistent with the management strategies commonly used by people with musculoskeletal pain. In the 2003 WHO-ILAR COPCORD study, 35% of participants with musculoskeletal complaints reported treatment with prescription, and nearly 41% reported treatment with massage, acupuncture, traditional medicines. Still, the remainder of the participants with musculoskeletal pain reported treatment with self-medication without prescription, with half of them using corticosteroids for pain relief without a formal diagnosis [23].

3.3.1.2.3. Challenges in OA care

Many challenges to effective OA care and strategy in Vietnam are also present in other chronic diseases, as they lie in the country's health system that is not fully prepared for a shift in the disease burden to noncommunicable diseases (NCDs). Another challenge lies in community awareness of OA.

First, as discussed previously, uneven distribution of health facilities has been one of the long-standing reasons for the fragmented healthcare system that compromises care for the elderly and for NCDs. Studies on the health system in rural Vietnam in 2012, 2014, and 2017 found limited capacity for noncommunicable disease (NCD) treatment services as well as limited access to NCD and long-term care services among older adults in rural regions [51], [67]. A more recent study (2018) also found that commune health centers in rural Vietnam, which are the first point of care for rural residents, have limited NCD prevention and treatment services and are underutilized [68]. The inaccessibility of care for NCD and for the elderly in rural regions creates constraints for OA patients and families living in rural Vietnam, where joint pain was one of the most frequently reported health challenges [69].

Secondly, OA care and treatment is expensive and can impose catastrophic health expenditure on households, as is the case with other chronic diseases. Mwangi et al. (2015) found higher healthcare expenditures (for both outpatient and inpatient) among older adults with diagnosed common chronic diseases including OA, compared to those without common chronic diseases. Specifically, care seeking at higher-level facilities, which is essential to healthcare for the elderly and NCDs, was associated with

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household catastrophic health expenditure [70]. This is because in Vietnam, health insurance plays a minimal role in household healthcare expenses for NCDs and for the elderly; most of these expenses are paid out-of-pocket [70], [71]. Social health insurance does not cover, among others, regular health check-ups and screening for certain chronic diseases, which are essential services for adults at risk of OA [67], [71]. The high treatment cost of OA can lead to reduced health-seeking behavior. In a cross-sectional study of chronic pain prevalence and management in 48 provinces (n=12,136 with 49% women), and joint pain was identified as the most prevalent chronic pain among older adults, and the average 6-month cost of chronic pain treatment was $200 per person, much higher than the poverty threshold of below $600/year, and likely contributed to late and inadequate pain management among people with chronic pain [72].

Thirdly, there are common misconceptions about musculoskeletal diseases in the Vietnamese community, according to Dr. Lê Anh Thư (PGS. TS) at the 19th Annual Conference of the Ho Chi Minh City Rheumatology Association. Some of these misconceptions were that musculoskeletal diseases only affect women and the elderly, only affect the joints, and can be treated with supplements or anti-inflammatory drugs alone [73]. These misconceptions can contribute to delayed health seeking for OA. In fact, in the study on chronic pain management among Vietnamese people, 25% of participants relied on self-medication rather than professional help for pain treatment [72].

Altogether, limitations of NCD services, financial burden, and awareness of disease presented barriers to OA care and management in Vietnam.

3.3.2.   A glimpse of the OA strategy in Japan

Japan is the third largest economy and home to the oldest population in the world. In 2018, over 35 million people in Japan were 65 years or older, constituting nearly 28% of the total population [74]. The prevalence of knee OA in Japan was estimated to be 40% based on population-based studies, with an incidence of 52 per 10,000 person-years [2].

Like Vietnam, Japan's healthcare system also encompasses public and private health systems, with the public system being the dominant form of health provider. The Japanese public health system is robust

and serves as a model for many countries' health systems. Public health facilities are organized into the national, prefectural, and municipal levels, all regulated and controlled by the government [75].

A prominent characteristic of Japan's public health system is universal health coverage. All residents of Japan have health insurance in the form of Employees' Health Insurance or national insurance [74]. Since 1961, the universal health insurance system has allowed Japan residents to receive comprehensive and quality care at relatively low costs, thereby promoting health equity in the country [74], [76]. However, certain aspects of Japan's health insurance system, including service-based reimbursement and free access to care at any level, have resulted in overutilization of health services and thus overburdening of the health system in Japan [74]–[76]. Another challenge in Japan's health system is the shortage of health workers and disparity of healthcare between the urban and rural regions [77], [78].

To meet the demands of a growing population of older adults and older adults with disabilities, Japan has implemented the Long-Term Care Insurance (LTCI) Act, kaigohoken, since 2000 [76], [79], [80]. Seniors aged 65 and above receive benefits from two distinct healthcare insurances: the LTCI and the medical care (MC) insurance. While the MC insurance covers medical treatment, the LTCI program covers home- and community-based care, including home services, visiting health professionals, and residential care [76], [79], [80]. The LTCI is thus beneficial for people with OA-induced functional limitations who need assistance with daily living activities in the home. Indeed, the Japanese government has identified joint diseases as one the leading needs for the care provided in the LTCI program in 2010, along with stroke, dementia, and old-age asthenia [81].

To specifically address OA treatment in Japan, the Japanese Orthopedic Association (JOA) developed the Japanese knee OA guidelines in 2011, adapting the Osteoarthritis Research Society International (OARSI) guidelines – which are commonly used in Western countries – to Japan-specific context. The 2011 Japanese guidelines provided both non-pharmacological and pharmacological management methods, and recommended lifestyle and exercise changes early in OA treatment, before prescription of medications. Deviating from the OARSI guidelines, the Japanese guidelines also omitted acetaminophen, opioids, and acupuncture because these treatments are not covered by the public health

insurance, as well as recommend intraarticular hyaluronic acid injections earlier than the OARSI guidelines in Europe or in the United States [82]. The Japanese OARSI guidelines, combined with the health insurance system, exemplify Japan's commitment to providing affordable and quality care and support for OA patients and older adults in general.

4. Discussion

4.1. OA prevalence and risk factors

There is a scarcity of epidemiological data on the prevalence of OA in many LMIC in the Southeast and East Asian countries. In epidemiological studies on OA prevalence, different OA diagnostic strategies gave different prevalence findings. This is consistent with the well-documented discordance between radiographic and symptomatic OA [83]. Despite differences in the OA diagnostic criteria employed in these studies, overall, knee and hand OA showed high prevalence than hip OA in Southeast and East Asian countries, with knee OA being the most common type of OA in multiple countries in the region. (Knee OA also constituted the majority of OA studies in this review.) Our findings are consistent with results from previous studies [2], [84] A scoping review on the prevalence, risk factors, and prevention of OA in Asia also found a higher prevalence of knee, hand, and spine OA compared to hip OA, with knee OA being the most prevalent form of OA [10], [25], [29], [34]. A meta-analysis of the global and regional prevalence of knee OA further reported the highest prevalence of knee OA in the continent of Asia, followed by North America, Europe, and South America [2]. The high prevalence of knee OA in Asia may be explained by the squatting and kneeling position in sociocultural and daily living activities in Asian populations, as an association between the kneeling/squatting position and OA risk has been established in various studies in this review. Similarly, the high prevalence of hand OA in Asia may be explained by the daily use of chopsticks. The Beijing Osteoarthritis study reported a positive association between chopstick use and risk of developing hand OA [85].

Identified risk factors for OA in the Southeast and East Asian populations included advanced age, sex (female in knee OA, male in hip OA), excess body weight, comorbidities joint injury or trauma, and

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motion or position that increases stress on the joints, residence in rural or mountainous areas, and lower SES (indicted by educational level or occupations). These are consistent with well-known risk factors OA in global populations including non-Asian populations [2], [5], [86], [87]. The association between smoking and OA was inconsistent in several studies in this review, with different studies reporting increased or decreased risk of OA associated with smoking. To address these mixed findings, Felson and Zhang (2015) reviewed epidemiological evidence of the smoking-OA relationship and reported a moderate protective effect of smoking from radiographic knee and hip OA, but cautioned that smoking was also associated with increased risk of musculoskeletal pain [88].

Another behavioral factor that was identified as a risk factor for radiographic knee OA (in men) was daily consumption of 7 or more cups of coffee [42]. However, this finding, which came from a cross-sectional study in South Korea, contradicted the results of another cross-sectional study conducted in Japan. The Japanese study reported an inverse association between daily coffee consumption at age 40 and the prevalence of severe radiographic knee OA, suggesting the protective effect of antioxidant and anti-inflammatory micronutrients in coffee [89]. Nevertheless, evidence from extensive studies have indicated that caffeine – the major ingredient of coffee – negatively affects the articular and growth plate cartilage and is thus a promoting factor for OA, thereby supporting findings of the Korean study [90]. The inconsistency in findings between the cross-sectional studies of coffee consumption and OA prevalence may be explained by differences in dietary habits between Japanese and Korean people. Foods commonly consumed by Japanese people may interact with different ingredients in coffee to counteract the adverse effect of caffeine on the cartilage and enhance the protective role of coffee in OA. Regardless of the different observations between the two cross-sectional studies, it is important to note that in the Korean study, the daily consumption of 1-2 cups of coffee (which is the amount of coffee that the average person consumes) was not associated with OA prevalence.

Altogether, the diversity of OA risk factors demonstrates that OA is a multifactorial disease that is more than a "wear and tear" condition.

4.2. The patient's perspective

Qualitative studies provide valuable insight into the lived experiences and perspectives of people living with OA. Qualitative studies on the OA experience in Southeast and East Asia identified common themes among people with OA, including insufficient knowledge of OA and OA management, the desire to learn more about OA and OA management, OA-induced pain disability having a negative impact on both physical and psychological health. A preference for non-invasive and non-pharmacological OA interventions was also reported among participants who were dissatisfied with or skeptical of the side-effects of commonly prescribed western medications for OA. Similarly, in a qualitative study on the perceptions of people with knee OA in Japan, factors that explained the patients' desire to avoid surgery included fear of surgery and the Japanese virtue of patience [91].

Further exploration of the OA patients' self-management of OA also revealed the vicious cycle that OA imposes on patients. Even when patients are aware of the importance of exercise in OA management, the pain makes it impossible for them to exercise and exacerbates the patient's feelings of helplessness and frustration. Health providers should consider these feelings of the patient to provide empathetic healthcare advice and avoid blaming the patient for non-compliance. On the contrary, many OA patients were unaware of the role of exercise and the appropriate exercises in OA management, partly due to insufficient information given during consultation with health providers. Similarly, a cross-sectional study of older adults' satisfaction with chronic pain management in the National Geriatric Hospital in Vietnam found that chronic pain patients, especially outpatients, were most dissatisfied with information given about pain management, possibly because health providers in Vietnam lacked training on geriatric pain management or had limited time for patient consultation due to overburdening of the healthcare system [92]. Another factor that can create communication challenges between health provider and patient, and thus insufficient knowledge exchange, is the sociocultural doctor-patient hierarchy that limited the patient's communication. A qualitative study in Indonesia found that the Southeast Asian cultural values, including the values of respecting higher social roles and maintaining harmony, promoted a one-way communication between the doctor and the patient, although patients preferred a partnership communication style characteristics to the Western culture [93]. Given limitations in the patient's knowledge of OA and OA management, improved

doctor-patient communication and improved patient education on OA management are urgently needed in many Southeast and East Asian countries.

Delayed health seeking was another commonly reported issue among OA patients. In addition to limited knowledge of OA-related symptoms and the fear of reality, reasons for delayed health seeking likely included the high costs of care and the cultural perceptions of pain. For example, pain endurance among Chinese cancer patients was influenced by Taoism, Buddhism, and Confucianism [94]. Likewise, Japanese people with knee OA believed that pain and distress should be tolerated without complaining to others [91]. Consequently, many people with OA sought treatment and care only when their pain became unbearable or when it impacted their life functions. These personal, economic, and sociocultural factors affecting health seeking behavior should be considered in interventions and policies aiming to promote early health seeking for OA.

Next, despite the high prevalence of OA, many OA patients reported having no one to share their experience with and feeling that others did not understand them or their condition. This can be explained by the OA patients not wanting to bother their family and friends with complaints of their symptoms, as is the case with the Japanese knee OA patients [91]. The lack of social support for OA patients is also inherent to NCDs that do not affect a large number of people at the same time and thereby creating a shared social experience of illness. A platform to connect OA patients together is strongly desired [91] and will greatly benefit OA patients. Lastly, it is important to recognize the individuality of OA patients, despite their shared experience of OA-related symptoms and impact on their physical, sociocultural, and psychological health. As shown in the qualitative studies included in this review, the experience of OA is highly variable and dependent on many personal and social factors. For instance, although walking aids are widely used by OA patients, a participant in Chan and Chan's study (2011) perceived the prescribed walking stick as a sign of illness and disability and thus refused to use it [43]. Understanding the patient's unique experiences and perspective is thus vital to OA care and management.

4.3. Case studies

Both Vietnam and Japan are seeing a high prevalence of OA and have devised context-appropriate strategies for OA in their guidelines. For example, Vietnam integrated traditional and western medicine in OA diagnosis and treatment guidelines, and Japan removed treatments that are not reimbursed by the public health insurance from the OARSI guidelines. These approaches are in accordance with the Southeast Asia Working Group's recommendation for each country to adapt the internationally-derived OA management algorithm to their socioeconomic environment [95].

Given the extensive experience of Japan with a super-aged society, Vietnam can learn from Japan's strategies for OA care and, in general, for elderly healthcare. Current challenges for OA care that are inherent to the healthcare system in Vietnam include limited NCD and long-term care services, healthcare inequity in urban versus rural regions, and catastrophic health expenditures for NCDs. Thus, healthcare for chronic diseases in Vietnam overly relies on episodic, short-term hospital and long-term home care. Home care for adults with chronic diseases in Vietnam is primarily provided by children, reflecting the Confucianism-influenced value of filial piety. The cultural value of piety is also evident in national policies, notably the national Law on the Elderly that holds children and grandchildren responsible for caring for older adults, including older adults with illness [96]. Consequently, the OA caregiving burden rests heavily on family members, with little social or community support. In a study by Tiraphat et al. to evaluate perceived age-friendly environments in the Association of Southeast Asian (ASEAN) Plus Three countries, older adults in Vietnam most frequently reported perceived lack of "personal care or assistance needs met in your home setting by government/private care services" [97]. The lack of third-party assistance in the home setting for older adults is especially concerning for older adults with OA-induced disability and risk of falling. (In fact, hypertension and OA were the most prevalent comorbidities among older adults hospitalized for falling in Vietnam [92].)

To help support OA patients and families, we propose that Vietnam consider adopting Japan's LTCI system to provide quality home-based care for OA patients with disability. In addition to Japan, the public LTCI system has also been established in the Asian countries of South Korea (since 2008) and China (since 2016), and have resulted in significant improvement in the health of the beneficiaries, especially the

disabled elderly, while potentially reducing the family's financial burden of care [98]. A public LTCI system is feasible and culturally appropriate in Vietnam. Vietnam shares with Japan, South Korea, and China the Confucian values of community, so the redistribution the burden of caregiving from the families to the community and society through LTCI can be received positively by Vietnamese people. Nevertheless, a public LTCI system is expensive and may not be sustainable in Vietnam, given the country's limited resources. To address this issue, Vietnam can consider Rhee, Done, and Anderson's policy recommendations for implementing a LTCI system in middle-income countries, including starting with a small LTCI scheme with cost-sharing to discourage service overuse [99].

Other challenges in OA management in Vietnam are low awareness of disease and unhealthy lifestyle that increases the risk OA. Educational campaigns are needed to promote public awareness of OA and prevention and management strategies for OA.

Development and implementation of an effective national OA strategy will require strong collaboration with multisectoral stakeholders. While the task is daunting, Vietnam has been making significant progress in improving elderly healthcare with a strong political leadership in public health. Most recently, in 2020, the government launched a 10-year Healthcare for the Elderly Program to meet the demands of a growing aging population, expand geriatric care in traditionally underserved areas, and improve healthcare (especially long-term care) for older adults [100].

4.4. Limitations and future directions

There are several limitations in this study. First, the search for peer-reviewed literature were limited to the PubMed and Google Scholar databases. Secondly, the search for peer-reviewed and grey literature was limited to English and Vietnamese language. As a result, the search likely missed important work published in different languages and databases, including country-specific databases. Thirdly, studies on risk factors are observational and should not be used to infer causation. Lastly, many studies had smaller sample sizes, so their results could not be generalized. Despite these limitations, this review provides a glimpse of the impact OA on the individual and society in Southeast and East Asia from an

epidemiological and social standpoint. This review also underscores that high quality of future studies on the modifiable risk factors and social factors of OA are necessary and crucial for health professionals and policy makers to plan the healthcare system of the future in these countries. In conclusion, with increased aging population and the burden of healthcare to the society, awareness of the high prevalence of OA, particularly knee OA, and its modifiable risk factors should happen at all levels including the general public, healthcare providers, and policy makers.

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Table 1: OA prevalence and associated factors in Southeast and East Asian countries. Up to three most recent epidemiological studies on OA prevalence were included; up to four most recent epidemiological studies or case reports of characteristics of OA patients were included. Different forms of OA, assessed with different methods, were included. PubMed search using the search strategy described in Methods yielded no findings on OA prevalence and associated factors for the following countries: Brunei, Burma (Myanmar), Cambodia, Timor-Leste, Laos in the Southeast Asian region; and Macau and North Korea in the East Asian region.

Southeast Asia						
Study & type of study	**Study location**	**Participant characteristics**	**Type of OA**	**Diagnostic criteria**	**OA prevalence**	**OA-associated risk factors (protective factors)**
Kasjmir, Nasution, and Daud 2009 [9], **case-control**	Indonesia	n=127 knee OA cases (75% female), mean age=60; n=102 control (68% female), mean age=50	Knee OA	ACR criteria		Advanced age, history of obesity or being overweight, kneeling activity, knee trauma and longer interval between trauma and OA onset. (Protective: current and past smoking)

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Destiani, Fatimah, and Dewi 2017 [10], **cross-sectional**	Indonesia	n=47 knee OA cases	Knee OA	Patients from Rheumatology Outpatient Clinic		advanced age, female sex, lower educational level, occupation in public services, passive smoking, high BMI, history of repetitive use of the knee (in pushing or lifting heavy objects, standing or walking for ≥ 2 hours, climbing stairs ≥ 2 times, and squatting for ≥ 2 hours or regularly), and family history of OA

Table 1: continued

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
I. W. Ahmad et al., 2018 [41], **cross-sectional**	Indonesia	n=35 knee OA cases (83% female), mean age=59	Knee OA	Patients from Outpatients Clinic of Rheumatology, Internal Disease and Outpatients clinic. Kellgren-Lawrence grading and Leodesne severity index for severity classification.		Advanced age, female sex, and high BMI
Mat et al., 2019 [12], **cross-sectional**	Malaysia	n=1,226 (57% female) aged ≥55 (mean age=69); Ethnicities Chinese 34%, Malay 33%, Indian 33%	Knee OA	Self-reported knee pain and OA-related symptoms (pain, achinig, stiffness)	33.3% (crude) and 30.8% (weighted)	female sex, lower educational level, comorbidities, obesity, certain occupations (not working or housewife, service or sales, and plant and machine operators), and Malay ethnicity

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Racaza et al. 2012 [13], **cross-sectional**	Philippines	n=859 OA cases (63% female), mean age=63	Primary OA	Patients from 2 arthritis clinics, perviously diagnosed using the ACR criteria, or pain with radiographic OA (Kellgren-Lawrence grade ≥2)	Knee OA (62.5%) > 2 joint areas (14.3%) and ≥ 3 joint areas (13.5%) > spine (5.2%) > hand (4.5%) > hip OA (2.9%)	advanced age, female sex, obesity or excess weight, metabolic syndrome, lower SES, and no smoking or alcohol consumption
Y.-Y. Leung et al. 2015 [15], **retrospective cohort study** (mean follow up time=14.5 years) using data from the population-based prospective cohort Singapore Chinese Health Study (SCHS)	Singapore	n=52,780 (55% female) aged 45-74	Total knee replacement (TKR) due to severe knee OA	First total knee replacement (TKR) due to severe OA, identified from national hospital discharge databases	1649 (3.1%) cases of incident TKR due to severe OA	Increased risk of incident TKR due to severe knee OA per BMI unit in lower BMI range ($< 27kg/m^2$) greater than that in the higher BMI range ($>27kg/m^2$)

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Leung et al, 2014 [14], **retrospective cohort** (mean follow up time=14.5 years) using data from the population-based prospective cohort Singapore Chinese Health Study (SCHS)	Singapore	n=63,129 (56% female) aged 45-74	TKR due to severe knee OA	First total knee replacement (TKR) due to severe OA, identified from national hospital discharge databases	1,973 (3.1%) cases of inciddent TKR due to severe OA	(Protective: currrent and past smoking)
Teng et al. 2017 [17], **retrospective cohort** (mean follow-up time=9.7 years) using data from the population-based prospective cohort Singapore Chinese Health Study (SCHS)	Singapore	n=51,858 (57% female) aged 45-74	TKR due to severe knee OA	First total knee replacement (TKR) due to severe OA, identified from hospital discharge databases	1,435 (2.8%) cases of incident TKR due to severe OA	Increased risk of incident TKR due to severe OA in women with gout, with a stronger association in leaner women.

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Y.-Y. Leung et al. 2019 [16], **retrospective cohort** (mean follow-up time= years) using data from the population-based prospective cohort Singapore Chinese Health Study (SCHS)	Singapore	n=35,191 (100% female) aged 45-74	TKR due to severe knee OA	First total knee replacement (TKR) due to severe OA, identified from hospital discharge databases	1,645 (4.7%) cases of incident TKR due to severe OA	Increased risk of incident TKR due to severe OA in women with higher parity (stronger association in leaner women), earlier age of menarche, and having used oral contraceptives.
Kuptniratsaikul et al. 2002 [18], **cross-sectional**	Thailand	n=392 (78% female) aged >60 (mean age=68) with knee pain, from an urban area	Knee OA	History of knee pain, confirmed with radiographic OA (Kellgren-Lawrence grade ≥2)	Radiographic: 34.5% of 392 study participants who reported knee pain Symptomatic: 45.6% (623 out of 1,366 older adults reported knee pain)	Advanced age and female sex.
Tangtrakulwanich et al. 2007 [19], **cross-sectional**	Thailand	n= 576 (50% female) aged ≥40 from Songhkla, southern Thailand	Knee OA	Radiohraphic (Kellgren-Lawrence)		Habitual squatting and lotus/side-knee bending positions

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Tangtrakulwanich & Suwanno 2012 [20], **cross-sectional**	Thailand	n=576 (50% female) aged ≥40 from Songhkla, southern Thailand	Patellofemoral OA	Radiographic OA (grade 0-3, with grade ≥1 indicating OA)	37.9% (79.6% of people with radiographic OA reported knee pain)	Advanced age and higher BMI
Chokkhanchitchai et al. 2010 [21], **cross-sectional**	Thailand	n=303 (153 Buddhists, 150 Muslims) aged ≥50 from 2 subdistricts of Phranakhon Sri Ayutthaya	Knee OA	Knee pain symptoms for at least 1 month Radiohraphic (Kellgren-Lawrence grade ≥2) Symptomatic (knee pain symptoms + ROA)	Knee pain: 49.2% Radiographic OA: 78.2% Symptomatic OA: 42.6%	Knee pain and radiographic knee OA (separately) associated with Buddhist religious practice
Ho-Pham et al. 2014 [22], **cross-sectional**	Vietnam	n= 658 (74% female) aged ≥40 (mean age=56) in urban Ho Chi Minh City	Knee OA	Radiographic OA (Kellgren-Lawrence grade ≥2) Knee pain symptoms (KNEST questionnaire, ACR criteria)	Radiographic OA: 34.2% (35.3% in women, 31.2% in men) Self-reported knee pain: 62% in women, 35% in men	Advanced age, higher BMI, and self-reported pain.

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Hoa et al. 2003 [23], **cross-sectional**	Vietnam	n=2,119 (54% female) aged ≥16 (mean age=40) in urban Ha Noi City	Knee and hip OA	ACR criteria	OA: 4.1% of adolescents and adults aged 16+ from an urban area. Of the OA cases, -Knee OA: 60% (78% in women) -Hip OA: 3.4%	Musculoskeletal pain associated with advanced age. Knee OA associated with female sex
Mwangi et al. 2015 [24], **cross-sectional**		n=1,145 (58% female) aged ≥ 60 in rural FilaBavi	OA	Self-report of diagnosed OA	Arthritis/OA: 35% of an elderly population (23% in men, 41% in women,) aged ≥60	

East Asia						
Study & type of study	**Study location**	**Participant characteristics**	**Type of OA**	**Diagnostic criteria**	**OA prevalence**	**OA-associated risk factors (protective factors)**
Jiang et al. 2012 [25], **cross-sectional**	China	n=1,196 aged 40-84 (mean age=63) in urban and rural areas	Knee OA	Radiographic OA (Kellgren-Lawrence grade ≥2) Symptomatic OA (radiographic OA + 1 month of knee pain)	Radiographic OA: 57% Symptomatic OA: 16.05%	Radiographic and symptomatic OA associated with female sex and advanced age. Symptomatic OA associated with advanced age, female sex, higher BMI, physical work in urban subjects; age, BMI, and smoking habits in rural subjects (Protective: current & past smoking)

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Tian et al. 2014 [26], **cross-sectional**	China	n=3,859 (47% female) aged ≥18 (mean age=46) in Beijing	Lumbar OA	Symptomatic OA: clinical symptoms (pain/numbness), physical examinations, imaging (radiography, computed tomography, and/or magnetic resonance imaging)	Adjusted prevalence: 7.44% (7.7% in urban, 10% in suburban,9.4% in rural areas) 84% of OA cases had back pain.	Female sex, advanced age, lower educational level, lowest monthly income, physical labor, and the insurance of new rural cooperative medical services, higher BMI, work posture (frequent stooping, maintaining posture for 1-1.9 hours/day, and vibration), transportation (bicycle), and having <7 hours of sleep a day
Tang et al. 2016 [27], **cross-sectional** using data from the 2011-2012 China Health and Retirement Longitudinal Study	China	n= 17,128 (51% female) aged ≥45 (mean age=60)	Knee OA	Symptomatic OA: self-reported pain symptoms and self-reported doctor-diagnoses arthritis	8.1%	Female sex, advanced age, living in rural or underdeveloped areas, living in South-West and North-West regions, lower educational level

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Meng et al., 2020 [28], **cross-sectional**	China	n=2,746 (100% female) aged 50-83 (mean age=60) in Hunan	Knee OA	ACR criteria	13.4%	Abortion, advanced age, higher weight, higher educational level, lower household income, and chronic gastritis.
Lau et al. 2000 [29], **case-control**	Hong Kong	n=138 hip OA cases (78% female), 658 knee OA cases (75% female) n=324 controls	Hip and knee OA	Cases were patients with previously diagnosed OA and Kellgren-Lawrence grade ≥3		Hip and knee OA associaetd with joint injury;frequent stair climbing, frequent heavy lifiting at work. Hip OA associaed with tall height. Knee OA associated with high weight. (Protective: smoking)
Kodama et al. 2016 [30], **cross-sectional**, from the Research on Osteoarthritis/Osteoporosis Against Disability (ROAD) study	Japan	n= 1,535 (67% female) aged ≥40 (mean age=66)	Hand OA	Radiographic OA (Kellgren-Lawrence grade ≥2)	89.9% in men, 92.3% in women	Advanced age, high BMI,

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Iidaka et al. 2016 [31], **cross-sectional, cross-sectional**, from the Research on Osteoarthritis/Osteoporosis Against Disability (ROAD) study	Japan	n=2,975 (65% female) aged 23-94 (mean age=70.2)	Hip OA	Radiographic OA (Kellgren-Lawrence grade ≥2, severe radiographic OA if KL grade ≥3) Sympotamatic OA: hip pain with radiographic OA	Radipgraphic OA: 15.7% (18.2% in men, 14.3% in women) Severe radipgraphic OA: 1.34% in men, 2.54% in women Symptomatic OA: 0.75% (0.29 in men, 0.99% in women)	Radiographic hip OA associated with residence in coastal area, male sex, and high BMI. Severe radiographic OA associated with female sex.
Oya et al. 2018 [32], **cross-sectional**	Japan	n=354 (63% female) aged ≥40 (mean age=67) from same village	Elbow OA	Radiographic OA (Kellgren-Lawrence grade ≥2) Symptomatic OA (Radiographic OA with Patient-Rated Elbow Evaluation (PREE) score > 0)	Radipgraphic OA: 52.3% Symptomatic OA: 22.6%	Advanced age, male sex, history of elbow trauma

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Kojima et al. 2017 [33], **prospective cohort** with four-year follow-up 2008-2012	Japan	n=867 (100% female) aged 75-85	Knee OA	Self-reported doctor-diagnosed OA		Incident OA associated with insufficient soy/soy product consumption, slow walking speed, low serum albumin at baseline.
Takiguchi et al., 2019 [34], **prospective cohort** with 5-year follow-up (2011-2016)	Japan	n=11,091 (49% female) aged ≥40 (mean age=58)	Knee OA	Symptomatic OA (incident OA defined with Kellgren-Lawrence grade ≥2)		Incident OA associated with advanced age and higher BMI in both sexes; and higher metabolic equivalent (MET) score, less smoking, and lower green tea consumption in men; and alcohol consumption in women

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Wang et al. 2013 [35]	Mongolia	n=1,877 aged 45+ from three areas in the autonomous region	Waist, neck, knee, hand OA	Radiographic OA (Kellgren-Lawrence grade ≥2) Symptomatic OA OA (clinical criteria)	Radiographic OA: 62.17% Symptomatic OA: 56.17% (44% waist OA, 37% neck OA, 12% knee OA, 7% hand OA)	OA associated with age and comorbidities (hypertension, diabetes, atherosclerosis). Knee and hand OA associated with female sex. Cervical spine OA associated with urban residence. Lumbar OA associated with rural residence.
S. Lee et al. 2018 [37], **cross-sectional**, from 2013 Korea National Health and Nutrition Examination Survey	South Korea	n= 2,280 (57% female) aged ≥50 (mean age=63)	Knee OA	ACR clinical/radiographical criteria	13%	Advanced age, female sex, obesity, hypertension, lower educational level, low frequency of strength exercise
Hong et al. 2020 [38], **cross-sectional**, from 2010-2013 Korea National Health and Nutrition Examination Survey	South Korea	n=12,287 (54% female) aged ≥50	Knee OA	Radiographic OA (Kellgren-Lawrence grade ≥2)	35.1%	female sex, advanced age, residence in rural area, low educational level, low household income, and obesity

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Ah. H. Kang et al. 2020 [39], **cross-sectional,** from 2010-2012 Korean National Health and Nutrition Examination Survey	South Korea	n=7,165 aged ≥50	Knee, hip, lumbar spine	Radiographic OA (Kellgren-Lawrence grade ≥2)		Radiographic knee OA associated with higher alcohol consumption. Hip and lumbar OA showed similar trend but without statistical significance.
J. H. Park et al., 2021 [40], **cross-sectional,** Korean National Health and Nutrition Examination Survey	South Korea	n=11,814 (57% female) aged ≥50	Hip OA	Radiographic OA (Kellgren-Lawrence grade ≥2) Symptomatic OA: radiographic OA with hip pain	Radiographic hip OA: 1.1% (1.6% in men, 0.7% in women) Symptomatic OA: 0.2%	Radiographic hip OA associated with advanced age, male sex, and knee pain. Painless hip OA associated with advanced age, male sex, and moderate physical activity. Painful hip OA associated with male sex and knee pain.

Study & type of study	Study location	Participant characteristics	Type of OA	Diagnostic criteria	OA prevalence	OA-associated risk factors (protective factors)
Y.-H. Lee et al. 2020 [36], **retrospective cohort** with 13-year follow-up (2000-2012)	Taiwan	Rheumatoid arthritis (RA) cohort: n= 31,813 (77% female), aged ≥20 mean age=47 Control (non-RA) cohort: n=31,813 (76% female) aged ≥20 mean age=48	Knee OA	ICD-9-CM code: 715		Incident OA associated with having rheumatoid arthritis, advanced age, female sex, residence in areas with low urbanization, manual occupation, and comorbidities (particularly hypertension and gout in rheumatoid arthritis patients)

Table 2: Participant characteristics in qualitative studies of the OA experience.

Study, country	Number of participants (men, women)	Mean age (range)	OA-affected joint	OA duration	Most common educational level	Occupation
Xie et al., 2006 [49], Singapore	41 (27 women): 20 Chinese, 10 Malay, 11 Indian	64 (41-84)	Knee	≤1 to 5 years (n=25) >5 years (n=16)	7-10 years of formal education (n=21)	Retired/homemaker (n=31)
Chan & Chan, 2011 [43], Hong Kong	20 (7 men, 13 women)	57 (<40->60)	Knee	≥ 10 years (n=9) <10 years (n=11)	Not reported	Not reported
Kao & Tsai, 2014 [45], Taiwan	17 (3 men, 14 women)	49 (40-55)	Knee	Mean=26.6 months (range 3-132 months)	Not reported	Not reported
Thumboo et al., 2017 [47], Singapore	26 (23 women, 3 men)	63 (52-78)	Hand	Not reported	Secondary 61.5% (primary and tertiary 19.2% each)	Retired 35% Employee 27% Housewife 23% Employer/self-employed 12% Looking for job 4%
Leung et al., 2019 [48], Singapore	45 (91% women)	64 (51-82)	Hand	Not reported	Secondary 81% (primary 14%, tertiary 5%)	Retired 35.6% Housewife 22.2% Employee 22.2% Unemployed 11% Employer/Self-employed 9%
Ahmad et al., 2018 [11], Malaysia	12 (4 men, 8 women)	67 (53-85)	Knee	Not reported	Not reported	Not reported
Kamsan et al., 2020 [44], Malaysia	16 (3 men, 13 women)	73 (61-89)	Knee	3-5 years (n=3) >5 years (n=13)	Secondary and college/university 38% each (post-secondary certificate 25%)	Not reported
Park et al., 2020 [46], South Korea	10 (all women)	71 (56-88)	Knee	<10 years (n=5) ≥10 years (n=5)	Not reported	Not reported