

**Estimation of prevalence of osteoporosis risk among postmenopausal women in
Udaipur district, Rajasthan**

Dr Akanksha

**Dissertation submitted in partial fulfilment of the requirements for the award of the
degree of Master of Public Health**



**ACHUTHA MENON CENTRE FOR HEALTH SCIENCE STUDIES
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND
TECHNOLOGY, TRIVANDRUM**

Thiruvananthapuram, Kerala. India – 695011

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DECLARATION

I hereby declare that this dissertation entitled **“Estimation of prevalence of osteoporosis risk among postmenopausal women in Udaipur district, Rajasthan”** is a bonafide record of my original research work. This dissertation has not been submitted, either in part or in full, to any other university or institution for the award of any degree or diploma. All sources of information, including published and unpublished works of other authors, have been appropriately cited and acknowledged within the text.

Akanksha

Dr Akanksha (Student ID:50338)

Achutha Menon Centre for Health Science Studies

Sree Chitra Tirunal Institute for Medical Science and Technology, Trivandrum

Thiruvananthapuram, Kerala, India – 695011

June 2025

CERTIFICATE

This is to certified that the dissertation entitled **“Estimation of prevalence of osteoporosis risk among postmenopausal women in Udaipur district, Rajasthan”** is a Bonafide record of the research work carried out by Dr. Akanksha under my guidance and supervision.

This dissertation is submitted in partial fulfilment of the requirements for the award of the Master of Public Health degree.



Guide: Dr. Srikant A.

Additional Professor

Achutha Menon Centre for Health Science Studies

Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum

Thiruvananthapuram, Kerala. India -695011

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ABBREVIATIONS

BMD: Bone Mineral Density

BMI: Body Mass Index

CT: Computed Tomography

DEXA: Dual-energy X-ray Absorptiometry

DALY: Disability-Adjusted Life Year

LBD: Low Bone Density

OSTA: Osteoporosis Self-Assessment Tool for Asians

ORAI: Osteoporosis Risk Assessment Instrument

SCORE - Simple Calculated Osteoporosis Risk Estimation

ABONE - A tool for Osteoporosis Risk Assessment

IPAQ: International Physical Activity Questionnaire

WHR: Waist-Hip Ratio

VDIRS: Vitamin D Insufficiency Risk Score

MRI: Magnetic Resonance Imaging

QCT: Quantitative Computed Tomography

QUS: Quantitative Ultrasound

Abstract

Background: Among postmenopausal women, osteoporosis is characterized by compromised bone strength due to loss of mineral density and disruption of bone microstructure, leading to an increased fracture risk. In India, screening for osteoporosis is rarely practiced at the community level as there are inadequate available diagnostic options such as DEXA. Therefore, simple screening tools, such as the Osteoporosis Self-Assessment Tool for Asians (OSTA), have been designed to facilitate the estimation of osteoporosis risk in communities. This study aimed to assess the prevalence of osteoporosis risk and identify the factors associated with osteoporosis risk in the Udaipur district, Rajasthan.

Methods: A total of 370 postmenopausal women from rural and urban regions of Udaipur district, Rajasthan, were included in this cross-sectional study. Participants were selected through multistage random sampling, and a structured questionnaire on sociodemographic, reproductive, lifestyle, and clinical factors was administered to collect the data. The OSTA tool was utilized to assess the prevalence of Osteoporosis risk, and participants were categorized into at-risk and not at-risk categories based on the OSTA scores. R software version 4.4.1 was used for data analysis and associations between risk categories and different variables were analyzed by appropriate statistical tests

Result: The prevalence of osteoporosis risk among postmenopausal women was 30.5 percent (95% CI: 25.8 % –35.2 %). Study participants holding private health insurance (AOR: 9.5; 95% CI: 2.4 – 41.0) high parity (AOR: 3.4, 95% CI: 1.2 – 9.6) and prolonged menopause duration (AOR: 1.1, 95% CI: 1.0–1.1) had higher odds of being at risk of osteoporosis. While women with formal education had lower odds of being at risk of osteoporosis (AOR: 0.5, 95% CI: 0.2 – 0.9).

Conclusion: Almost one third of postmenopausal women in Udaipur district were at risk for osteoporosis. Osteoporosis was linked with risk factors like lower educational attainment, higher parity, holding private insurance, and longer duration since menopause. No direct association was found between osteoporosis and frailty indicating different pathways for the development of these two conditions. Our results underscore the utility of early evaluation by utilising simple, inexpensive screening tools such as the OSTA to triage postmenopausal women at high risk of osteoporosis. This will in turn help in carrying out necessary interventions needed to improve long-term health in postmenopausal females, specifically focusing on nutrition, reproductive health education, and support for vulnerable at-risk subgroups.

Keywords: Osteoporosis, Postmenopausal women, OSTA, Risk factors, Udaipur, Rajasthan

Chapter 1

Introduction

1.1 Background

Osteoporosis is an important public health disorder, defined by low bone mass and microarchitectural disruption of bony tissue that increases bony fragility and fragility fractures (Compston, McClung and Leslie, 2019). It is often referred to as a ‘silent disease’ due to its asymptomatic progression until a fragility fracture occurs (Chaudhary et al., 2024; Kale et al., 2024). Bones become weak, and a fall or even minor stress, such as coughing or bending over, can result in a fracture because osteoporosis results in easy breakage of bones. Osteoporosis-related fractures commonly happen at the hip, wrist, or spine (Osteoporosis - Symptoms and causes, 2024). Considering this, in 1998, the WHO reported that osteoporosis should be treated as a public health priority (Petersen, 2003).

In addition, the global economic burden of osteoporosis is substantial, and primarily consists of the costs of treating fractures. The average annual direct costs in Canada, Europe, and the USA to manage osteoporotic fractures vary between USD 5,000 and 6,500 billion. These figures do not consider indirect costs, such as long-term disability, loss of independence, and reduced productivity. By implementing effective preventive strategies, the overall socioeconomic strain on healthcare could be alleviated (Rashki Kemmak et al., 2020).

The consequences of osteoporosis are not limited to physical health. Fragility fractures, such as hip fractures, are associated with severe pain, disability, loss of independence, and premature mortality. Approximately 20 percent of patients following a history of hip fracture die within one year (Xiao et al., 2022). Fractures — especially hip, spine, and wrist fractures — are the most devastating outcomes of osteoporosis and can happen quietly, often not until after serious damage has been done. In fact, vertebral fractures are

commonly undiagnosed, since they may manifest simply as back pain or upright postural changes. Thus, early screening and secondary prevention, particularly following an initial fragility fracture, are critical in minimizing future fracture risk and improving patient outcomes (Salari et al., 2021).

Globally, osteoporosis resulted in more than nine million osteoporotic fractures per year, 1.6 million hip fractures, 1.7 million forearm fractures, and 1.4 million clinical vertebral fractures, with a substantial impact on disability-adjusted life years and healthcare systems (Johnell and Kanis, 2006). Low bone mineral density (BMD) is found to be common in Asian countries, contributing to the increased burden of the disability-adjusted life years (DALYs) for osteoporosis in Asian populations, including India (2,510,288 DALYs) > China (1,839,375 DALYs) > USA (819,445 DALYs) (Shen et al., 2022), with a disproportionately high prevalence in women due to postmenopausal estrogen decline (Hunter and Sambrook, 2000).

Estimates show that 75 million people are affected by osteoporosis across Europe, the USA, and Japan. However, osteoporosis continues to be underdiagnosed and undertreated in Asia, particularly in those most at risk of the disease who already have bone fractures. In the most populous nations like China and India, hip fractures are predominantly managed conservatively at home in comparison with surgical treatment in a hospital (*Epidemiology | International Osteoporosis Foundation*, 2023).

The incidence of osteoporotic fractures varies geographically, with increasing rates in developing countries, especially in Asia (Curtis et al., 2017). By 2050, more than 50 percent of global hip fractures are projected to occur in Asia (Thulkar et al., 2016). In India, the low calcium intake, vitamin D deficiency, early menopause, and genetics make osteoporosis very common (Anuradha V Khadilkar and Mandlik, 2015; Kaushal et al.,

2018). Additionally, rural and tribal communities may experience combined risks because of nutritional deficiency, high parity, and lack of screening services (Joshi and Singh, 2013).

Given that osteoporosis has no symptoms, early screening and diagnosis are essential to avoid fragility fractures in the future. Early diagnosis is vital for the timely prevention of morbidity, mortality, and socioeconomic burden (Pisani et al., 2016). There are a variety of techniques for measuring bone mineral density (BMD) and identifying osteoporosis. Among them, dual-energy X-ray absorptiometry (DEXA) is the gold standard and is widely accepted. DEXA, which utilizes two energies of X-ray to measure bone mineral content, usually at the hip and spine, results in accurate measurements with minimal discomfort. While accurate, DEXA is expensive and impractical in many settings, particularly in rural and underserved regions. In India, there are only around 700-800 DEXA machines for around 140 million postmenopausal women population, of which half of them live in rural areas (Cherian et al., 2022).

Other diagnostic options are Quantitative CT(QCT), which constructs transverse bone images that are formed by multiple X-ray cross-sections, and MRI, can offer detailed information on soft tissue and might differentiate vertebral fragility and fracture risk. Quantitative Ultrasound (QUS) is an appealing alternative as it is non-invasive, portable, and safer, particularly for field settings, but lacks sensitivity and specificity compared to that of DEXA (Oliveira et al., 2022).

To overcome these limitations, simplified screening tools have been developed to predict osteoporosis risk, especially in regions where diagnostic resources may not be available. One such tool is the Osteoporosis Self-Assessment Tool for Asians (OSTA), specifically designed to assist in identifying postmenopausal women likely to benefit from further testing (Koh et al., 2001).

This risk tools predict the chances of being diagnosed with osteoporosis based on easy-to-identify variables such as age and weight (Cherian et al., 2022). Of the existing risk assessment tools, OSTA is especially suitable for application in the Asian population because OSTA is simple to use, low in resource requirements, user-friendly, and has well-established predictive capability (Chan et al., 2006; Cherian et al., 2018). It could be particularly applicable in resource-constrained, community-based settings, where DEXA is not easily accessible. While OSTA is a simple and effective tool for evaluation of individuals at risk for osteoporosis, it's more effective in doing so for those at very high risk, as it leads to more cost-effective decisions regarding bone mineral density assessment (Muslim et al., 2012).

OSTA demonstrates a number of benefits that make it more suitable for community-based screening. Most importantly, OSTA shows higher sensitivity in capturing individuals at risk. OSTA sensitivity has been reported as high as 91.9 percent and 88.5 percent. OSTA has an area under the curve (AUC) method with higher values, AUC 0.7 and 0.7, compared to other screening tools, suggesting a slightly higher predictive value (Chan et al., 2006; Cherian et al., 2018). This feature makes OSTA particularly suitable for primary care and public health screening (Chin, 2017), where the stronger imperative is to avoid missing a case (true positive) than to over-refer. Therefore, OSTA represented a more practical and situation-adapted instrument in limited healthcare settings.

Considering the increasing osteoporosis burden in India, especially among postmenopausal women and less accessibility to diagnostic services in rural settings, we aimed to assess the risk of osteoporosis along with socio-demographic, reproductive & gynaecological history and lifestyle determinants among postmenopausal women in Udaipur district, Rajasthan. An understanding of the burden and risk profile of this silent but debilitating disease can

inform future interventions and policies regarding prevention, early detection, and management at the community level.

1.2 Osteoporosis

Definition

Osteoporosis is referred to as a “silent disease”. It is the most prevalent metabolic bone disorder that is characterized by universal clinical characteristics like loss of bone mass and alterations in bone tissue architecture. This subsequently reduces bone tension and strength. It leads to complications such as a fragility fracture. Osteoporosis is generally asymptomatic and is commonly diagnosed after the occurrence of a fragility fracture (Chaudhary et al., 2024; Kale et al., 2024).

1.2.1 Types of Osteoporosis

Osteoporosis is of two types-

a) Primary osteoporosis

It is the most common type of osteoporosis. It is due to age-related changes and a decline in sex hormones (Hendrickx, Boudin and Van Hul, 2015). It can further be subdivided into two subcategories:

i.) Postmenopausal Osteoporosis

One of the most important causes of osteoporosis is menopause. Postmenopausal women lose three to five percent of their total bone mass per year (Ji and Yu, 2015). Women lose their bone mass and remain at risk of osteoporosis for as long as seven years after menopause. The cause of postmenopausal bone loss is the decline of estrogen production from the ovaries (Demir et al., 2008). Menopausal osteoporosis is significant because women experience a third of their life with low bone mass and remain at a higher risk for

fracture, and the rate of bone loss during the first few years of menopause is high (Ji and Yu, 2015). Bone loss in postmenopausal women is a two-phase phenomenon. The short period occurs three to five years, and trabecular bone loss is faster (menopause-related bone loss), while in the long period, a gradual loss of cortical and trabecular bones occurs for over 10–20 years (age-related bone loss) (Imran et al., 2022).

ii.) Senile Osteoporosis

Senile osteoporosis is a significant reduction of bone mass and is attributed to a long-standing imbalance between bone resorption and bone formation. Bone resorption and formation are the fundamental remodelling in the adult skeleton that persist throughout life. The fact remains, however, that the older you get, the bone resorption is slower, which eventually shrinks the entire bone mass. This gradually progresses into osteoporosis, which most observers define as a clear sign, as one in which the bone mass has decreased in quantity more than 30 percent from the average bone mass for a certain age and sex category. Osteoporosis typically does not develop before the fifth decade and is more common and more severe in females than in males. That, at least in part, is due to the steep fall of estrogens at menopause versus the more gradual decline of testosterone with aging in males (*Senile Osteoporosis - an overview | ScienceDirect Topics*, 2003).

b) Secondary Osteoporosis

Secondary osteoporosis develops as a consequence of specific underlying medical conditions or environmental factors that interfere with normal bone formation or resorption. In contrast to primary osteoporosis, secondary forms can occur in people of all ages, including young men and premenopausal women (Templeton, 2005). Secondary osteoporosis can contribute to similar rates, with literature reporting up to two-thirds of older men, greater than 50 percent of premenopausal women, and up to 30 percent of

postmenopausal women having additional risk factors (e.g., age, weight) related to secondary osteoporosis. These risk factors are often linked to underlying medical conditions or long-term medication use, further complicating diagnosis and timely intervention (Hudec and Camacho, 2013). The systems associated with this multifactorial pathophysiology range from endocrine disorders (e.g., hyperparathyroidism, Cushing syndrome, diabetes) through chronic inflammatory diseases (e.g., rheumatoid arthritis, COPD), gastrointestinal diseases (e.g., celiac disease, chronic liver disease), renal impairment, neurological diseases, malnutrition, bad habits and the prolonged consumption of some drugs like glucocorticoids and antiepileptics. Secondary osteoporosis can sometimes also be seen in genetic diseases and post-transplant situations (Hosein-Woodley et al., 2024).

1.2.2 Prevalence of Osteoporosis

a) Demographic prevalence of Osteoporosis

Osteoporosis is a highly prevalent condition with significant public health implications worldwide, with the global prevalence for people aged 15–105 years being approximately 18.3 percent (Kale et al., 2024). Currently, 10 percent (over 100 million) of India's population are over 50 years. Nevertheless, on the basis of the above estimate, the number of people aged 50 years and above would be 22 percent of population in 2025 and 33 percent in 2050. Osteoporosis is a major problem for the aging population. In 2013, estimates suggest that 50 million people in India experienced T-scores of <-1 , indicating low bone mass density. It also showed that in 2015, 23 crore Indians above fifty years of age had osteoporosis. A recent study revealed that around 80 percent of Indian women were osteoporotic (Sriharsha and Yadav, 2025). The prevalence of osteoporosis among Indian women of various ages has been reported between 8 and 62 percent in multiple studies (Agrawal and Garg, 2023).

1.2.2.1 Literature Search Strategy

A systematic literature search was conducted to identify relevant studies on the prevalence and risk factors of osteoporosis, particularly among postmenopausal women. The search strategy was designed to be both broad and inclusive, ensuring that a wide array of peer-reviewed research articles, reviews, and clinical studies were captured. The search was carried out using established and credible electronic databases such as PubMed, Google Scholar, Scopus, and ScienceDirect, which are widely recognized for their extensive repositories of public health literature.

To maximize the relevance and specificity of search results, a well-structured set of keywords and search terms was employed. These included various combinations of: “osteoporosis,” “postmenopausal women,” “risk factors,” “prevalence,” “OSTA,” “India,” and “frailty.” Boolean operators (AND/OR) were strategically used to refine and optimize the search logic, thereby increasing the precision and breadth of the retrieved articles.

Additionally, specific filters were applied to limit the results to studies published in the English language to ensure clarity and accessibility of content. Both international and Indian research articles were considered to ensure that the global as well as local perspectives on osteoporosis were adequately captured. Systematic reviews and meta-analyses were given particular attention for their ability to synthesize large volumes of data and present broader epidemiological trends.

i). International scenario

Global estimates are summarized in Table 1.1, which provides a comprehensive overview of systematic reviews and meta-analyses on the global prevalence of osteoporosis and its associated risk factors.

Table 1.1 A comprehensive overview of systematic reviews and meta-analyses on the global prevalence of osteoporosis and its associated risk factors

Authors	Study settings	Study design	Exposure variables	Findings
(Xiao et al., 2022)	Asia Europe Africa America	Systematic review and Meta-analysis	Age, Sex, location, SES, BMI, Lifestyle factors, Family history, Health conditions	Global osteoporosis prevalence is 19.7%, in postmenopausal women, 27.4%. Prevalence in Asia > Africa. BMI, Education, and smoking are positively correlated to osteoporosis
(Salari et al., 2021)	Asia Europe America Africa Australia	Systematic review and Meta-analysis	Age, Sex, Geographical location, Diagnostic tools, Socio-economic status	Global prevalence of osteoporosis is estimated at 18.3. Continent-wise Prevalence: Africa>Asia>Europe>America. Sex-specific prevalence: women> men 23.2% and 11.7% respectively.
(Thulkar et al., 2016)	India, China, Korea, Japan, Hong kong, Sri-Lanka, Nepal, Singapore, Pakistan	Systematic review and Meta-analysis	Age, Height, Postmenopausal status, Exercise, Geographical variation	Range of osteoporosis prevalence: 15-68%. Pooled prevalence: 41.1%.
(Mohammedi et al., 2023)	Iran	Systematic review and Meta-analysis	Age, BMI, Postmenopausal status	Pooled prevalence of osteoporosis at the neck site is 17.4%
(Lyu et al., 2024)	China	Systematic review and Meta-analysis	Age, Gender, Geographic region	Pooled prevalence of Primary Osteoporosis is 18.2%, with higher rates in women than men (23.4%, 11.5% respectively)
(Reza, 2019)	UK, Brazil, India, Hungary, Poland, USA	Systematic review	Age, BMD, Gender, Location	Overall pooled prevalence of Osteoporosis is 14.2%

As per WHO, in the USA, 10 million people aged over 50 are affected by osteoporosis, and 34 million Americans have low bone density. The lifetime risk of sustaining hip, spine, and wrist injuries is reported in 40 percent of females and 13 percent of men aged 50 years or older (Burke-Doe et al., 2008).

In adults aged >50 years, osteoporosis in non-Hispanic whites, non-Hispanic blacks, Mexican Americans, and all races were 20 percent, five percent, 10 percent, and 18 percent, respectively (Xiao et al., 2022). Osteoporosis is more prevalent amongst older Asians, who have a much smaller body size than Caucasians and thus lower bone density (Xiao et al., 2022). Globally, around 200 million people are suffering from low bone density (Zhang et al., 2024). The overall prevalence of osteoporosis risk is reported to be 52 percent in a cross-sectional study in Singapore (Wang et al., 2019). In a study from China, a high risk of osteoporosis was observed to be 37.1 percent in males and 64 percent among female study participants (Chen, Li and Hu, 2016), while a study from the USA reported a cross-sectional study with 60.9 percent of participants having a high risk of Osteoporosis (Burke-Doe et al., 2008).

ii). National scenario

Primary osteoporosis is linked to natural ageing and is the most common form of Osteoporosis. In India, there are approximately 84.9 million individuals aged 65 and older, making it the second country with the largest elderly population (Lyu et al., 2024). The lifetime fracture risk is estimated to be between 15-30 percent for Indian men and 30-50 percent for women (Kadam et al., 2019). Specifically, in Indian postmenopausal women, osteoporosis is prevalent, with a prevalence of around 40–50 percent (Raveendran et al., 2011). Considering a high prevalence of osteoporosis, more so in postmenopausal women,

the burden of osteoporosis in the Indian setting is high and is going to increase as the population ages (Cherian et al., 2022).

Table 1.2 A comprehensive overview of systematic reviews and meta-analyses on the national prevalence of osteoporosis and its associated risk factors

Authors and years	Study setting	Study designs	Exposure variable	Findings
(Anupama et al., 2022)	Chandigarh, Tamil Nadu, Hyderabad, Delhi, West Bengal, Pune	Systematic review and Meta-analysis	Age, Gender, Physical activity, Location	Pooled prevalence of osteoporosis at spine: 29%, hip: 6%, femoral neck: 29%. Low calcium and vitamin D, longer lifespan, gender disparity, lack of awareness, and low physical activity are contributing factors.
(Sabat et al., 2022)	New Delhi, Haryana, Tamil Nadu, Maharashtra, Chandigarh, Uttar Pradesh, Punjab	Systematic review and Meta-analysis	Age, Gender, BMD	Prevalence of osteoporosis: 22.9% overall, 26.3% females, 10.9% males
(Anuradha V Khadilkar and Mandlik, 2015)	Mumbai, Hyderabad, Jammu, and Delhi, along with rural areas in Haryana, Kerala, Pune, and Chandigarh	Narrative, Non-systematic review	Dietary factors, Lifestyle factors, Genetic factors, and medical factors	Prevalence of osteoporosis: ranges from 8% to 62%. Vertebral fracture: 17.1% in older women. Advanced age, Low body weight, poor nutritional status linked to osteoporosis.
(Nair et al., 2024)	Ernakulam, Kerala	Cross-sectional	Age, Demographics, BMI, Education, Health history	53% moderate risk of Osteoporosis and 10.6% high risk of developing Osteoporosis
(Babhulkar, 2021)	northern, eastern, western, and southern regions of India.	Cross-sectional	Age, Gender, Menopausal status, Demographic region	Prevalence of osteoporosis is 18.3%. Elderly individuals have high risk of developing Osteoporosis than young adults.

Osteoporosis is very common in India, and about 61 million people are suffering from osteoporosis, of whom 80 percent are female (Imran et al., 2022). A study across North, East, West, South India reported an overall 47.4 percent prevalence of osteoporosis (Agarwal et al., 2022). In contrast, a cross-sectional study from South India reported 80.5 percent of participants fell under Low risk of Osteoporosis, 16.1 percent and 3.5 percent of participants were reported intermediate and high risk of Osteoporosis, respectively (Cherian et al., 2018). Additionally, national estimates are summarized in Table 1.2.

iii) Regional scenario

In a cross-sectional study from Rajasthan, the overall osteoporosis prevalence was found to be 35.5 percent, with a higher prevalence of osteoporosis in females (49.5%) than males (22.3%). The higher prevalence among females was attributed to postmenopausal bone loss (Sharma et al., 2017). A cross-sectional study from Western Rajasthan found that almost half of the individuals (48 %) diagnosed with Osteoporosis had chronic obstructive pulmonary disease (Soni et al., 2024). While a cross-sectional study from Bikaner, Rajasthan reported the prevalence of osteoporosis to be 13.8 percent (Wotsa and Dunkwal, 2022).

Prevalence of osteoporosis and CVD risk was assessed jointly in a study conducted among 322 postmenopausal women aged 45–55 years in Udaipur, Rajasthan, using the Osteoporosis Self-Assessment Tool for Asians (OSTA) along with a standard CVD risk assessment tool. The results showed that around 24.22 percent of the study participants had a medium-risk of osteoporosis (Hussain, 2021).

1.2.3 Risk factors

Osteoporosis risk factors can largely be divided into non-modifiable and modifiable factors. Knowledge of these categories assists in identifying individuals at higher risk and deploying focused preventive practices (Vijayakumar and Büsselberg, 2016).

1.2.3.1 Non-modifiable factors include

a) Age (for both men and women)

Osteoporosis is a slowly progressing disease that is related to aging. Ageing leads to bone loss in both genders after peak bone mass is reached at the age of 25 years. Women will lose approximately 35-50 percent of skeletal mass between the middle of the third decade of life and older age, while men lose about two-thirds of this amount during their lifetime (Hunter and Sambrook, 2000).

Age-related variation in Osteoporosis prevalence: In a meta-analysis from Asia, Europe, Africa, America, and Oceania, the prevalence of Osteoporosis increases with age. For age groups 50-59, 60-69, 70-79, 89-90, and >50 years, the prevalence was 11.4 percent, 24.8 percent, 37.6 percent, 40.8 percent, and 20.5 percent, respectively (Xiao et al., 2022). In a separate Meta-analysis done in China, it was found that the prevalence of osteoporosis also rose steadily with age, from 1.2 percent in the 20s to 53.9 percent among those 80 years or older, with the low steady prevalence of young and middle-aged people being the most prevalent group (Lyu et al., 2024). A cross-sectional study involving participants from North, East, West, and South India reported that the prevalence of osteoporosis was 12.5 percent and 37 percent in adults and the elderly, respectively (Babhulkar and Seth, 2021).

b) Ethnicity

Osteoporosis is commonly found in people from all ethnic groups, but the prevalence is significantly greater in Asian and African populations. Among such populations, the

elderly Asians are notably more impacted than the Caucasians (Xiao et al., 2022). According to a meta-analysis done with studies from China, India, Germany, Japan and the USA, it was found that low bone mineral density (BMD) and osteoporosis burden is significantly increasing in Asian countries, adding to the disability-adjusted life years (DALYs) in Asian nations, including India (2,510,288 DALYs), China (1,839,375 DALYs), and the USA (819,445 DALYs) (Shen et al., 2022). Many studies show a lower bone mineral density (BMD) in Asian Indian women than Caucasian (Anuradha V. Khadilkar and Mandlik, 2015).

c) Genetics

The role of genetic changes in the development of osteoporosis is developing, and the studies are inconclusive. Variations in the Vitamin D receptor (VDR) gene among different ethnic groups may contribute to differences in bone mineral density, potentially explaining ethnic disparities in osteoporosis risk (Anuradha V. Khadilkar and Mandlik, 2015). An observational study from Karnataka (Thomas et al., 2021) shows positive correlation between low bone density and familial history of osteoporosis; whereas, a Meta-analysis from Asia, America, Europe, and Africa (Xiao et al., 2022) indicates no significant association between those with a familial history of osteoporosis and those without (Relative Risk 1.2, 95% CI, 0.9-1.74, $p=0.09$).

d) Place of residence

In a study done in China, it was revealed that the prevalence of osteoporosis is higher in the urban community (20.7%, 95% CI, 15%-27%) than in the rural community 18.5%, 95% CI, 7.5% - 33.2% (Xiao et al., 2022) similar to a study done in Amritsar (17.6%). These differences are attributed to the role of new-age lifestyle adaptation (Singh et al., 2013) and

deficiency of Vitamin D in Urban residents (90%) as compared to rural residents (69%) (Laddha, 2017; Qureshi et al., 2017).

e) Sex and Sex hormones

Skeletal depletion begins at approximately 30–40 years of age, although this decline appears more pronounced in women. It can affect men and women, but is most common among women in postmenopausal age because of a deficiency of the hormone estrogen, leading to a higher risk of fracture (Charde, Joshi and Raut, 2023). Traditionally, estrogen has been viewed as the primary sex steroid mediating both resorption and bone formation in the skeleton, but the decline in testosterone in men also impacts bone metabolism (Khosla, Melton and Riggs, 2001).

A cross-sectional study from Singapore showed an overall prevalence of osteoporosis to be 52 percent in which female sex found to be significantly associated with osteoporosis development, where 64 percent of females were at high risk of osteoporosis (Wang et al., 2019). This maybe because females are smaller than males and males have larger, stronger bones, and they have a slower rate of bone loss during adulthood (Zhang et al., 2024). Females have five times the risk for osteoporosis (Chaudhary et al., 2024). Another meta-analysis study from Chandigarh, Tamil Nadu, Hyderabad, Delhi, West Bengal, and Pune also showed the prevalence of osteoporosis in females (26.3%) being higher as compared to males (10.9%) (Anupama et al., 2022).

f) Menopause

Osteoporosis can affect both premenopausal and postmenopausal women, but generally speaking, premenopausal women have a higher level of estrogen, which works to keep the bones dense. In postmenopausal women, estrogen levels drop, which leads to higher bone resorption and reduced bone formation (Keen and Reddivari, 2024).

Prevalence in postmenopausal and premenopausal women also shows a marked difference according to a systematic review and meta-analysis study from China, demonstrating that prevalence in postmenopausal women varies among different age groups, ranging from 22.6% - 63.2% but a much lower prevalence in premenopausal women has been reported with ranges of 1.4% - 4.9% (Lyu et al., 2024). A cross-sectional study conducted in different regions of India also documented similar findings that the prevalence of osteoporosis in premenopausal women in the north region was 3 percent, compared to postmenopausal women (36.4%) (Babhulkar and Seth, 2021).

g) Medicine Induced

Osteoporosis induced by glucocorticoids is the most prevalent type of medication-associated osteoporosis. Medications such as cortisone, prednisone, dexamethasone, and hydrocortisone are all glucocorticoids and are used to treat many inflammatory conditions like COPD, asthma, rheumatoid arthritis, emphysema, etc. The chronic use of glucocorticoids is a leading cause of osteoporotic fractures in men and women. Individuals taking oral glucocorticoids have a threefold increased risk of vertebral and a two-fold increased risk of hip fracture. It might cause impaired insulin sensitivity and hyperglycaemia, which is indirectly involved in bone loss and osteoporosis (Anaraki et al., 2023; Zhang et al., 2024).

1.2.3.2 Modifiable factors

a) BMI

Osteoporosis and body mass index have a complex relationship. In general, higher BMI is believed to be related to a higher bone mineral density, thus protecting against osteoporosis risk in postmenopausal females with mechanical loading on bone protection and vice versa (Asomaning et al., 2006). A cross-sectional study from China showed that bone mineral

density was negatively correlated with body mass index (BMI), which indicates that higher BMI (OR: 0.7, 95% CI: 0.6–0.8, $p < 0.001$) has some protective effect on bone density (Tang et al., 2023). A study from Vellore, Tamil Nadu reported similar findings (Paul et al., 2008). Whereas a study from Korea suggested an inverted “U-shaped” relationship between BMI and bone health, emphasizing that while a higher BMI can prevent loss of bone, excessively high BMIs may be harmful to bone quality and structure due to high body fat (Kim et al., 2017). Osteoporosis was strongly associated with lower BMI. Higher BMI also has a link in decreasing fracture risk among individuals, as the extra cushioning provided by body fat over bones can absorb fall impact, which has been associated with reduced risk of hip fractures (Choi et al., 2021).

b) Low calcium and Vitamin D intake

Calcium is an important mineral for ensuring a good peak bone mass in childhood and adolescence. Higher calcium intake in these periods is linked to higher bone mass density, reduced fracture risk, and higher adult bone density. The rate of age-related bone loss in middle-aged and older adults is 0.5 - 1.0 percent per year. Calcium intakes below 700-800 mg/day are related to increased loss of bone mass and risk of fracture. Calcium can decrease fracture risk by 38 percent in postmenopausal women. (Zhu and Prince, 2015). A study from Jhadol and Girwa, Rajasthan, found less primary calcium intake than the recommended value in both of the panchayat samities. (Joshi and Singh, 2013).

The body needs Vitamin D for calcium absorption and to keep bones healthy. On the other hand, in elderly men and women, the association between vitamin D levels and bone mineral density is not consistent; some have shown a positive link and others have found no such association. Vitamin D is an important factor for muscle health, and helps prevent falls. However, studies examining vitamin D levels and fracture risk in older adults have

yielded mixed findings. Some studies show a decreased risk for both hip and non-vertebral fractures with high intake of Vitamin D (≤ 800 IU/day) (Zhu and Prince, 2015).

In a cross-sectional study in Vellore, Tamil Nadu, it was reported that despite sufficient exposure to sunlight, there is a higher prevalence of vitamin D insufficiency and deficiency in 50 percent of the studied population, and a positive correlation between vitamin D levels and femoral neck bone mass density (Paul et al., 2008).

A previous study on the same cohort of older women over five years reported that it involved combined calcium and vitamin D supplementations that avoided bone loss at the hip (Zhu and Prince, 2015). For Indians, the daily recommended dietary allowance for Calcium and Vitamin D is 1000mg and 600IU respectively (Harinarayan, 2018).

c) Physical Activity

Regular exercise bears a benefit in terms of osteoporosis prevention, working by stimulating the formation of bone, together with mineral deposition and muscle enhancement, and improving balance. Exercise before puberty, especially with sufficient calories and calcium, increases bone width and mineral content. Also, in postmenopausal women, the improvements in bone mineral density occur, which rely on exercise, which keeps increasing the bone diameter with age, counteracting the thinning and porosity, respectively, leading to lower fracture risks (Borer, 2005).

Osteoporosis has been increasingly blamed on poor lifestyle and, in particular, increased sedentary lifestyle factors. Exercise is a protective factor for bone mass (Bijelic, Milicevic and Balaban, 2017). However, a cross-sectional study from Chennai reported contradictory findings, citing no significant difference in bone mineral density scores between women who were sedentary compared to those who were active (Thangappah et al., 2022a).

d) Salt intake

WHO recommends that the sodium intake should be reduced to less than two gm/day (Mente, O'Donnell and Yusuf, 2021). Postmenopausal women have been reported to have calcium loss from excessive dietary salt intake. Common dietary salt has long been viewed as possibly harmful, as it is known that enlarging the normal range of salt consumption goes together with a higher urinary calcium excretion (Teucher et al., 2008). However, changes in BMD at either the hip or the lumbar spine across three to six years were not significantly associated with calibrated salt intake ($p>0.06$) and higher intakes of salt were associated with a tendency for a greater increase in total body BMD over the baseline to six years period ($p=0.08$) and an increase during the baseline to three years period ($p=0.00$). This study found a reduced risk of hip fractures associated with higher sodium intakes (HR=0.8, 95% CI, 0.6-0.9) (Carbone et al., 2016).

e) Alcohol and Smoking

The impact of alcohol on bone is mediated through inhibition of bone cell function, interference with vitamin D metabolism, and disturbance of hormonal status. It is well established that alcohol abuse contributes significantly to the pathogenesis of osteoporosis, as alterations in bone strength and fracture repair are critically influenced by the pattern and amount of alcohol intake (Eby, Sharieh and Callaci, 2020).

Almost 7,000 chemicals are found in tobacco smoke. It impairs the process of turnover of the bone, resulting in decreased bone mass and lower bone mineral density, with greater susceptibility to osteoporosis and fractures (Al-Bashaireh et al., 2018).

However, one narrative non-systematic review study stated that smoking cigarettes and consuming alcohol were not significantly related to the risk of bone fractures. Moreover, smoking among Indian women is already very low as compared to other populations,

although it is a risk factor for the prevalence of osteoporosis (Anuradha V. Khadilkar and Mandlik, 2015). However, the incidence of osteoporosis in a cross-sectional study from Pilani, Rajasthan, showed that smoking and alcohol consumption acted as risk factors for osteoporosis (Pareek, 2014).

f) Caffeine drinks and Carbonated drinks

Intake of soft drinks, in particular carbonated soft drinks, showed an association with low BMD and increased fracture risk (Tucker et al., 2006). Consuming high amounts of caffeine-containing drinks such as coffee, tea, and cola, increases the risk of osteoporotic fractures, through urinary calcium excretion and decreased calcium absorption (Massey and Whiting, 1993). A study found a trend for a higher risk of fracture with greater coffee consumption and no association with tea (Dai et al., 2018). Likewise, another cross-sectional study from Pilani found that 65 percent of the subjects had at least three cups of tea or coffee daily and there was significant association of tea intake with low bone mineral density (Pareek, 2014).

1.2.4 Co-morbidities of osteoporosis

An observational cohort study published recently focused on the impact of comorbidities on osteoporosis risk in older adults. Results show that multimorbidity is a major contributor to osteoporosis vulnerability and that integrated approaches to risk assessment should be considered in the elderly population (Dennison et al., 2012). Some of the co-morbidities associated with osteoporosis are: myocardial infarction (MI), Congestive heart failure, peripheral vascular disease (PVD), dementia, peptic ulcers, liver disease, diabetes, rheumatic disease, COPD, renal disease, HIV/AIDS, etc. The most commonly reported co-morbidities in this study were diabetes (39.2 %), followed by peptic ulcers (16.8 %) and cerebrovascular disease (15.7 %) (Pan et al., 2024).

1.2.5 Frailty

Frailty is a multidimensional syndrome resulting from age-related decline that leads to increased vulnerability and has recently emerged as a powerful predictor of osteoporotic fractures (Li et al., 2017). In a recent multi-ethnic study from Singapore, frailty was not associated with osteoporosis, although they frequently occur together, frailty is not a good predictor of low bone mineral density in different populations (Heng et al., 2023).

1.2.6 Fragility fractures

Fragility fractures resulting from minor trauma due to weak bones are one of the biggest complications of osteoporosis in postmenopausal women. They typically occur in the hip, spine, or wrist, but hip fractures are associated with high rates of mortality and disability. Vertebral fractures may also lead to chronic pain and impaired mobility. Early screening (e.g., DEXA scans) and preventive measures (e.g., calcium, vitamin D, exercise, and use of medications) play an important role in minimizing fracture risk and optimizing outcomes in this high-risk patient population (van Oostwaard, 2018).

1.2.7 Rationale

Postmenopausal women are particularly at high risk of osteoporosis because of the reduction in the levels of estrogen following menopause, leading to increased bone loss and weakened bone architecture. Osteoporosis remains underdiagnosed and undertreated among Indian women, contributing to significant disability, compromised quality of life, and increased mortality. It also leads to fragility fractures which are expected to triple by 2050 because of a growing elderly population. Due to such a high burden, and the limited availability of DEXA, particularly in rural areas, early risk assessment by a screening tool becomes critical. Hence, the present study was conducted to estimate the prevalence of osteoporosis risk among postmenopausal women, to determine modifiable contributors,

and inform public health initiatives for improving early detection due to osteoporosis.

Filling these gaps can improve preventive care and life quality in at-risk populations.

1.2.8 Objectives

1. To estimate the prevalence of osteoporosis risk among postmenopausal women in Udaipur district, Rajasthan.
2. To find factors associated with osteoporosis risk among postmenopausal women in Udaipur district, Rajasthan.

Chapter 2

Methodology

The methodology for the two objectives of this study is presented in this chapter. This chapter discusses the study design, study setting, study participants, data collection, and analysis.

2.1 Study design

A cross-sectional community-based study was done to assess the prevalence of risk of osteoporosis in postmenopausal women in Udaipur district, Rajasthan.

2.2 Study setting

The study was conducted in urban and rural areas of the Udaipur district in Rajasthan. The rural and urban areas selected for the study are shown in Figures 2.1 and 2.2, respectively.

The study participants included community-dwelling postmenopausal women in residing in Udaipur district, Rajasthan.

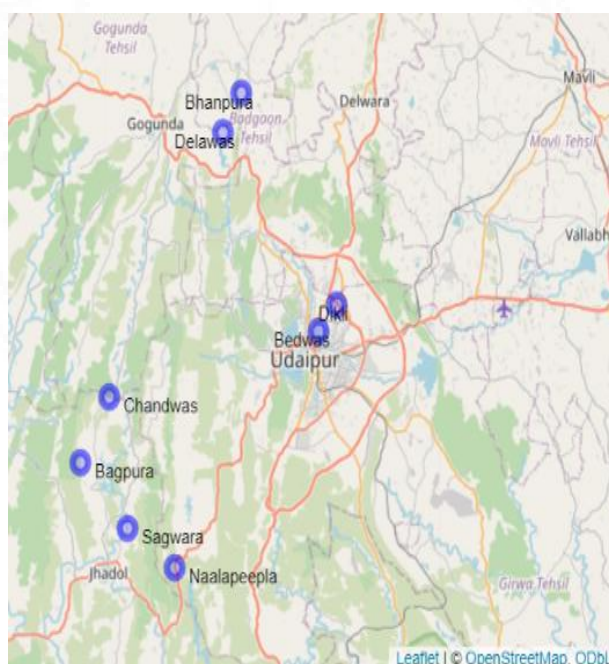


Figure 2.1 Map of rural study setting

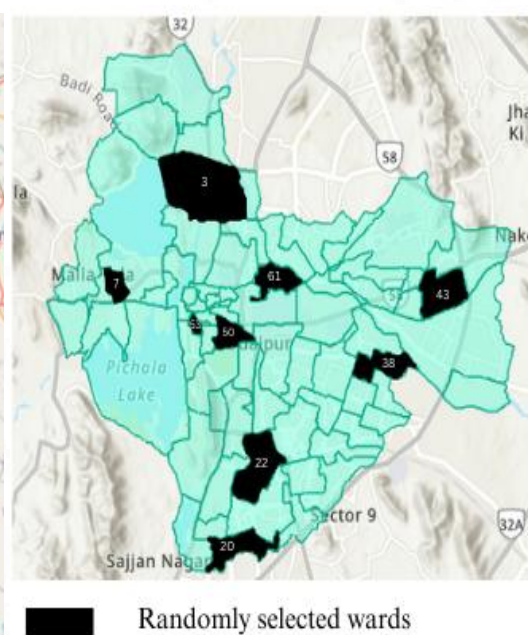


Figure 2.2 Map of urban study setting

Inclusion criteria

Postmenopausal women (natural menopause: self-reported absence of menstruation for more than 12 months), who were able to walk, willing to participate in the study, and provide written informed consent, were included.

Exclusion criteria

Bedridden women, those with menopause due to surgical intervention, hysterectomy, bilateral oophorectomy, or who did not consent to participate were excluded from the study.

2.3 Study population and response rate

This study addressed postmenopausal women residing in the Udaipur district, Rajasthan, which included urban and rural populations per the census 2011. Out of 1,501,619 total women in Udaipur district, 292,941 (19.9%) women resided in Urban areas and 1,208,678 (80.1 percent) women resided in rural areas. The study population included postmenopausal women aged ≥ 45 years.

Table 2.3.1 Distribution of Study Participants Across Selected Rural and Urban Areas

Area Type	Selected Locations	N (%)
Rural	Bedwas	37 (10.0%)
	Dikli	37 (10.0%)
	Sagwara	37 (10.0%)
	Naalapeepala	37 (10.0%)
	Delawas	37 (10.0%)
	Bhanpura	37 (10.0%)
	Bagpura	37 (10.0%)
	Chandwas	37 (10.0%)
Urban	Ward 3	8 (2.2%)
	Ward 7	9 (2.4%)
	Ward 20	8 (2.2%)
	Ward 22	8 (2.2%)
	Ward 38	8 (2.2%)
	Ward 43	9 (2.4%)
	Ward 50	8 (2.2%)
	Ward 53	8 (2.2%)
	Ward 61	8 (2.2%)

From randomly selected gram panchayat (rural) and wards (urban), all eligible postmenopausal women aged 45 and above were interviewed. The selected wards from rural and urban areas are shown in Table 2.3.1.

Table 2.3.2 Response rate and reasons for non-participation among study participants

Category	Number (n)	Percentage (%)
Total approached	448	100%
Completed responses	370	82.6%
Non-responders	78	17.4%
Reasons-		
1) Refused to participate		
• No interest in study	10	2.2%
• Family members prevented from participation	12	2.7%
• Preferred to wait for advice from their spouse or family before responding	6	1.3%
• Worried about financial fraud	8	1.8%
• Expected the need to pay or purchase something	5	1.1%
2) Unavailable-		
• Moved temporarily (visiting relatives)	4	0.9%
3) Ineligible-		
• Hysterectomy history	19	4.2%
4) Health-related issues		
• Memory loss	1	0.2%
• Hospitalization	2	0.5%
5) Incomplete responses		
• Withdrew midway	4	0.9%
• Thought the study was an insurance related visit	2	0.5%
• Suspected tax inquiry	5	1.1%

Table 2.3.2 presents the response rate and the reasons for non-participation among the study participants. The table helps highlight the challenges faced during data collection, which may have influenced the overall response rate in the study population.

Apart from the specific reasons mentioned in the table, some non-participation may have been indirectly influenced by factors like household chores (especially in rural settings),

and low awareness about research studies. Communication barriers and misconceptions about the purpose of the survey occasionally emerged as a reason for non-participation.

2.4 Timeframe for data collection

The data were collected from 18 January 2025 to 7 March 2025.

2.5 Sample size estimation

The sample size was determined in the Open Epi version 3.1 software with a primary focus on the postmenopausal women. A recent study showed that the prevalence of the risk of developing osteoporosis was 20 percent using the OSTA tool (Yuvaraja et al., 2024). Considering this, the sample size was estimated with a five percent absolute precision and a 1.5 design effect. The estimated sample size calculated was 369, rounded off to 370.

2.6 Procedure of sample selection

The current study adapted cluster and simple random sampling. Figure 2.3 describes the sampling in more detail.

According to Census 2011, Udaipur district's total female population was 1,501,619, of which 20 percent were found to be living in the urban area and 80 percent in the rural area. Sample size of 370 was proportionally divided into urban area 20 percent ($n=74$) and rural area 80 percent ($n=296$) proportionally.

In urban areas, there were 70 wards in the Udaipur Municipal Corporation. Out of these, nine wards were chosen through simple random sampling. Within each chosen ward, eight households were selected, except in two wards where nine households were selected to achieve the sample size through systematic sampling. The selection process included the identification of a central landmark, and the pen-rotation method was used to determine the first household to be selected. Further households were selected in a systematic order. If

there were multiple eligible women in a household, we randomly selected one using the paper-chit method.

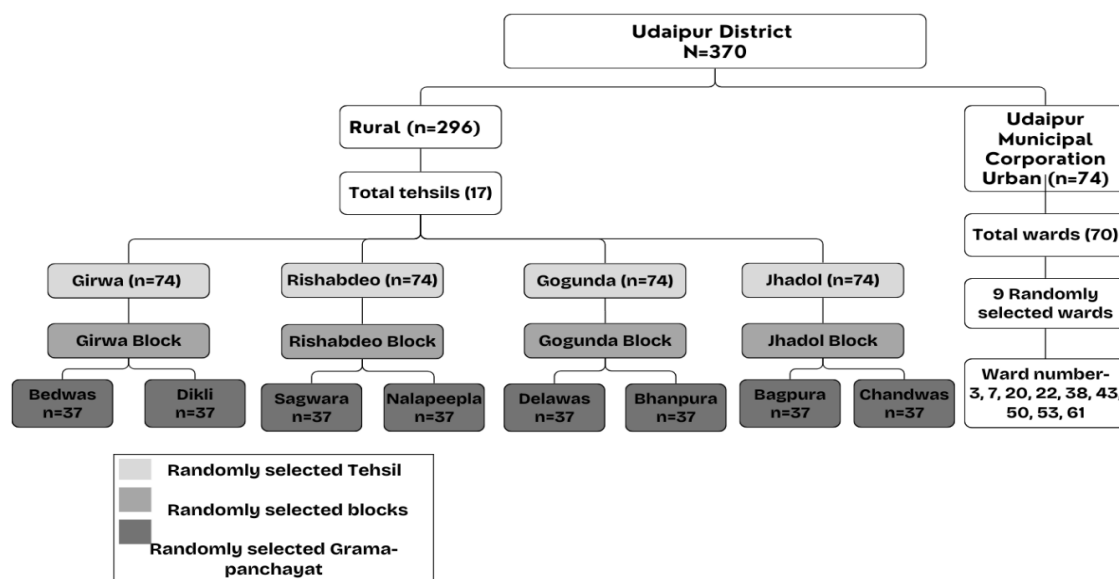


Figure 2.1 Sampling strategy

Udaipur district has 17 tehsils in rural areas. Four tehsils were randomly selected using simple random sampling. One block was randomly selected within each of the selected tehsils. Two-gram panchayats were randomly selected from every selected block. Thirty-seven households were identified within each grama panchayat using systematic sampling from a central landmark. One eligible postmenopausal woman was selected from each household. When more than one eligible woman was present, one was randomly chosen using the paper chit method.

2.7 Data collection technique

For the cross-sectional survey, a structured interview schedule was developed in English and later translated into Hindi. This tool was used to collect information on socio-demographic, gynaecological and reproductive history, clinical characteristics, anthropometric measurements, lifestyle factors such as calcium intake, physical activity

levels, Vitamin D intake, tobacco and alcohol history, salt intake, carbonated and caffeinated drinks intake.

The details presented in the information sheet and the additional information sheet were communicated to the participants before the interview. Informed consent of the participant was obtained.

Section 1: This section covered the survey information about the place of residence and the generation of a unique respondent ID.

Section 2: This section covered socio-demographic and personal information of the postmenopausal women (age, religion, caste, occupation, education, family type, marital status, ration card details, and mode of payment for healthcare expenses).

Section 3: Medical history information was collected, including the reproductive and gynaecological history, comorbidities, medication, and history of fractures.

Section 4: Data was collected for lifestyle factors like tobacco, alcohol use, carbonated and caffeinated beverages consumption, sun exposure, salt intake, physical activity, and dietary pattern.

Section 5: Anthropometric measurements of the participants were taken (weight, height, waist and hip circumference, hand grip strength by a dynamometer, and walking speed).

OSTA tool was used to assess risk for osteoporosis as part of the screening process. The details of the calculation for obtaining OSTA scores are described in detail under OSTA tool.

The principal investigator kept a field diary to record important observations during data collection, such as participants' answers, obstacles encountered during interviews, and key

patterns regarding risk factors of osteoporosis. The diary helped more to record the non-participations and the reasons for non-participation.

2.8 Data collection

Data collection started after explaining the details mentioned in the participant information sheet (attached in Annexure I and II) and obtaining written informed consent from the postmenopausal women (attached in Annexure III and IV). Furthermore, all interviews took place within the respondents ' residences. Participants were assured that their responses would be treated strictly confidential and purely for research purposes. After data collection, additional information on osteoporosis was provided to the participants, as detailed in Annexure V and VI.

2.9 Data entry

The PI used a pen-and-paper method for data collection. The collected responses were then entered manually into Microsoft Excel. The dataset was subsequently imported into R for cleaning and preparing for statistical analysis. It was coded and appropriately categorized to ensure proper data analysis.

2.10 Data cleaning

All records were checked for missing values, which were removed from the dataset before further analysis. We performed a frequency analysis in R to identify inconsistencies in the dataset.

2.11 Variable Used

This study considered a range of variables to explore the risk of osteoporosis among postmenopausal women. The information of all variables used in the study have been detailed in the annexures (Annexure VII and VIII).

2.11.1 Dependent Variable

Risk of osteoporosis

The main dependent variable in the present study was risk of osteoporosis, identified as the probability and/or risk of reduced bone mineral density (BMD) and the increased risk of osteoporotic fractures. Since there is limited availability of dual-energy X-ray absorptiometry (DEXA) to measure BMD directly in resource-limited settings, the risk of osteoporosis is assessed through the validated tool OSTA (Osteoporosis Self-Assessment Tool for Asians).

1. Osteoporosis Self-Assessment Tool for Asians (OSTA)

OSTA is a validated risk assessment tool to identify postmenopausal women at risk of osteoporosis at the femoral neck or lumbar spine. The OSTA score is calculated by multiplying the difference between body weight in kgs and age in years by a factor of 0.2, as proposed by (Koh et al., 2001)

For the purpose of this study women were classified as ‘at risk’ for osteoporosis including either intermediate risk (index -1 to -4) or a high risk (index < -4) and ‘not at risk’: ≥ -1 of osteoporosis (Yuvaraja et al., 2024).

2.11.2 Independent variables

This study examined a range of independent variables to understand their association with osteoporosis risk among postmenopausal women. These were divided into sociodemographic, reproductive, clinical, and lifestyle factors.

Personal and sociodemographic variables included age, religion, caste category, educational qualification, marital status, family type, household income, ration card status, mode of healthcare payment, and occupation.

Reproductive and gynaecological history included parity, age at first pregnancy, history of abortion, age at menarche, age at menopause, years menstruating, and years since menopause.

Clinical history included the presence of chronic comorbidities (such as diabetes, hypertension, thyroid disorders), history of fragility fractures, family history of osteoporosis, and history of unintentional weight loss.

Lifestyle behaviours included smoking status, smokeless tobacco use, alcohol consumption, consumption of caffeinated beverages (tea, coffee), sunlight exposure, and level of physical activity.

Dietary patterns included the type of diet and regular calcium-rich food intake.

Anthropometric measurements included height (cm), weight (kg), waist circumference and hip circumference (cm).

Frailty status was assessed using Fried's frailty criteria, which included hand grip strength and walking speed.

2.12 Data analysis

Data analysis was done using R version 4.4.1. Descriptive statistics were applied to all variables. For categorical variables, frequency counts were obtained, while for continuous variables, the central tendency (mean) and variability (standard deviation) were calculated. The median was preferred to the mean for variables with skewed distributions.

We estimated the prevalence of osteoporosis risk and analysed the associations between risk factors and osteoporosis risk among postmenopausal women. Pearson's Chi-square test or Fisher's Exact test was applied to examine the relationships between categorical

variables, depending on the distribution of expected cell counts. Statistical significance was set as p-value <0.05 .

Multivariable analysis: Variables that showed an association with the outcome in the bivariate analysis were incorporated into a logistic regression model. These significant variables were entered into a multivariable logistic regression model to identify the optimal model for predicting osteoporosis risk.

Finally, the parsimonious model demonstrating the lowest Akaike Information Criterion (AIC) was chosen as the best model. The final model's relationships between predictors and osteoporosis risk were assessed through Adjusted Odds Ratios (AORs) and their 95% Confidence Intervals (CIs).

2.13 Data storage

Hard copies of the interview schedules and signed informed consent forms are kept in the custody of the PI in a secure place. A unique respondent identification number was assigned to each participant to maintain confidentiality and privacy. These identification numbers are only known to the principal investigator.

Under no circumstances were any personal details of any participant shared. All data collected, besides personal identifiers, were used solely for analysis. The data will be stored for five years, from the time of collection, and then destroyed permanently.

2.14 Ethical consideration

Ethical approval for the study was received from the Institutional Ethics Committee (IEC) of Sree Chitra Tirunal Institute for Medical Sciences and Technology before the study commenced. (Ref No: SCT/IEC/2337/DECEMBER/2024). The document is attached as Annexure IX.

In addition, permission was obtained from the Chief Medical and Health Officer (CMHO), Udaipur, to conduct the study in the Udaipur district, Rajasthan. The document is attached as Annexure X.

Written informed consent was obtained from all participants prior to data collection. Informed consent was obtained, participation was entirely voluntary, and no individuals were coerced and were free to withdraw at any point or refuse to answer any question without repercussions.

Participants were connected with a health worker for those at high risk of osteoporosis.

2.15 Operationalization of terms

Bone Mineral Density or BMD: ‘A measurement of this mineral content used to determine the strength of bone and especially to detect osteoporosis’ (*Medical Definition of BONE MINERAL DENSITY*, 2025).

Osteoporosis: ‘A condition that affects especially older women and is characterized by decrease in bone mass with decreased density and enlargement of bone spaces producing porosity and fragility’ (*Definition of OSTEOPOROSIS*, 2025).

Osteopenia: ‘Reduction in bone volume to below normal levels especially due to inadequate replacement of bone lost to normal lysis’ (*Medical Definition of OSTEOPENIA*, 2025).

Frailty: ‘A clinically recognizable state of increased vulnerability resulting from aging-associated decline in reserve and function across multiple physiologic systems such that the ability to cope with every day or acute stressors is comprised’ (Xue, 2011).

BMI: Body Mass Index (kg/m²): ‘A measure of body fat that is the ratio of the weight of the body in kilograms to the square of its height in meters’ (*Definition of BODY MASS INDEX*, 2025).

Fragility Fracture: ‘A fracture that occurs in a bone weakened by osteoporosis. It notes that individuals who have experienced a fragility fracture are at higher risk for future fractures’ (*fragility fracture* | *Taber’s Medical Dictionary*, 2025).

Ration card types

According to the Government of Rajasthan, ration card categories are linked to the financial status of the family presented in Table 2.15.1.

Table 2.15.1 Ration card types

Ration card type	Ration card colour	Eligible families
Above poverty line (APL)	Blue/Green	General consumers
Below poverty line (BPL)	Dark pink	Families identified under poverty line by local bodies
State BPL	Dark green	Families identified under poverty line by grama sabha or municipality
Antyodaya anna yojana	Yellow	AAY families chosen by village assembly, municipality

(*Rajasthan Ration Card - Eligibility & Application Process*, 2020)

Chapter 3

Results

This chapter presents the findings of the study based on the analysis of data collected from postmenopausal women in the selected rural and urban areas of Udaipur district. It begins with a detailed description of the personal and socio-demographic characteristics of the participants, such as age, residence, caste, education level, occupation, marital status, and healthcare access.

Subsequent sections explore the reproductive and gynaecological histories of the participants, including parity, age at first pregnancy, contraceptive use, and menstrual irregularities. Clinical characteristics including comorbidities, use of medications affecting bone mineral density, history of fragility fractures, family history of osteoporosis, and anthropometric indicators like BMI and waist-hip ratio are presented in a separate section.

Lifestyle-related factors such as levels of physical activity, sun exposure, calcium and vitamin D intake, salt consumption, and substance use are discussed independently to highlight behavioural influences on bone health.

The chapter further presents the prevalence of osteoporosis risk in the study population using the Osteoporosis Self-Assessment Tool for Asians (OSTA).

In the latter sections, the chapter explores statistical associations between independent variables and osteoporosis risk. Bivariate analysis was performed using Pearson's Chi-square or Fisher's Exact test, and significant variables were included in multivariable logistic regression to identify independent predictors. The strength of associations is presented as adjusted odds ratios (AORs) with 95% confidence intervals (CIs), providing insights into key risk factors relevant to osteoporosis prevention in this population.

3.1 Personal and socio-demographic characteristics of participants

Table 3.1 Personal and socio-demographic characteristics of participants

Variable	Category	Frequency, N=370
Age of the participants in years	Mean±SD	59.7±9.5
Place of residence	Rural	296 (80.0%)
	Urban	74 (20.0%)
Religion	Hindu	335 (90.5%)
	Jain	30 (8.1%)
	Muslim	5 (1.4%)
Caste	General	147 (39.7%)
	OBC	104 (28.2%)
	SC	36 (9.7%)
	ST	83 (22.4%)
Education	No formal education	168 (45.5%)
	Formal schooling	140 (37.8%)
	Graduate and above	62 (16.7%)
Family type	Nuclear	341 (92.2%)
	Joint	29 (7.8%)
Ration card	Yes	307 (83.0%)
	No	63 (17.0%)
Ration card type	Below poverty line	106 (28.6%)
	State below poverty line	65 (17.6%)
	Antayodya anna yojana	86 (23.2%)
	Blue and others	113 (30.6%)
Mode of payment for healthcare expenditure	State Insurance	324 (87.7%)
	Self-payment	32 (8.7%)
	Private insurance	13 (3.6%)
Occupation	Unskilled workers	333 (90.0%)
	Skilled/Professional workers	37 (10.0%)
Marital status	Married	325 (87.8%)
	Widowed	45 (12.2%)

The socio-demographic and personal details of the postmenopausal women are presented in Table 3.1. The study comprised 370 postmenopausal women, with an average age of 59.7 years (SD ±9.5). The participants were mainly from rural (80 percent) backgrounds. The highest proportion of ration card holders were blue or other category cards, which generally indicates above the poverty line (30.6 percent). But many of them were found to

be economically vulnerable: 28.6 percent had Below Poverty Line (BPL) cards and 17.6 percent had State BPL cards. In comparison, 23.2 percent were Antayodaya Anna Yojana (AAY) beneficiaries targeted at the poorest households. Most of the participants were unskilled workers (90%) and were married (87.8%).

3.2 Reproductive and gynaecological history of the participants

Table 3.2 Reproductive and gynaecological history of the participants

Variable	Category	Frequency, N=370
Parity	2 or less children	127 (34.3%)
	3-5 children	212 (57.3%)
	6 or more children	31 (8.4%)
Age at first pregnancy	Mean±SD	20.5±3.4
Age at menarche (years)	Mean±SD	14.6±1.4
Years of menstruation (years)	Mean±SD	35.9±5.1
Age at menopause (years)	Mean±SD	50.5±4.9
Duration of menopause (years)	Mean±SD	9.3±7.9
History of abortion	Yes	30 (8.1%)
	No	340 (91.9%)
Oral Contraceptive pills	Yes	13 (3.5%)
	No	357 (96.5%)
Duration of Oral contraceptive pills (years)	Mean±SD	2.385±1.19
Gynaecological conditions	Yes	44 (11.9%)
	No	326 (88.1%)

Table 3.2 presents the reproductive and gynaecological history of the participants. Most participants (57.3 percent) had three to five children, with an average of three children per person. The average age of pregnancy was 20.5 years, with 8.1 percent having experienced at least one abortion. Oral contraceptive use was low (3.5 percent), with an average duration of 2.4 years. Gynaecological conditions menstrual irregularities, early menopause, PCOS were reported.

3.3 Clinical and anthropometric characteristics of the participants

Table 3.3 Clinical and anthropometric characteristics of the participants

Variable	Category	Frequency, N = 370
Comorbidities	Yes	108 (29.2%)
	No	262 (70.8%)
Medicine reducing bone mineral density	Yes	25 (6.8%)
	No	345 (93.2%)
Dietary supplements	Yes	48 (13.0%)
	No	322 (87.0%)
Familial history of osteoporosis	Yes	4 (1.1%)
	Don't know	34 (9.2%)
	No	332 (89.7%)
Self-history of fragility fracture	Yes	25 (6.8%)
	No	345 (93.2%)
BMI (kg/m ²)	Underweight	18 (4.9%)
	Normal	107 (28.9%)
	Overweight	136 (36.9%)
	Obese	108 (29.3%)
Waist hip ratio	Mean±SD	0.87±0.05
Hormone replacement therapy	Yes	0
	No	370 (100%)

Table 3.3 outlines the clinical and anthropometric characteristics of the study participants.

Of the participants, 29.2 percent had comorbid conditions. Only 6.8 percent used medicine reducing bone mineral density (BMD), and none used hormone replacement therapy. Dietary supplement use was low (vitamin D: 5.4 percent, calcium: 4.6 percent). Fragility fractures, most commonly at the wrist (32 percent) and hip (24 percent). The average BMI was 27.1 kg/m², with 36.8 percent overweight, 29.2 percent obese, and 28.9 percent with a normal BMI. The average waist-to-hip ratio was 0.8, indicating variation in fat distribution.

3.4 Lifestyle factors of respondent

Table 3.4 presents the lifestyle factors of the respondents. Over half (51.2 percent) had low physical activity, and 73.5 minutes of sun exposure was reported on average. Regarding nutrition, 34.3 percent were vitamin D deficient, while 58.1 percent had adequate calcium

intake. Most participants (80.8 percent) followed a vegetarian diet. Salt intake varied, and tea consumption was high (91.4 percent), with minimal coffee intake (1.1 percent) and no alcohol or tobacco use reported.

Table 3.4 Lifestyle factors of respondent

Variable	Category	Frequency, N = 370
Physical activity*	Low	189 (51.2%)
	Moderate	134 (36.3%)
	High	46 (12.5%)
Sun exposure in mins	Mean±SD	73.5±63.4
Salt intake**	Low	138 (37.3%)
	Adequate	149 (40.3%)
	High	83 (22.4%)
Vitamin D***	Deficient	127 (34.3%)
	Insufficient	139 (37.6%)
	Sufficient	104 (28.1%)
Dietary calcium****	Low	147 (39.7%)
	Adequate	215 (58.1%)
	High	8 (2.2%)

*IPAQ, **WHO STEPS, *** VDIRS (Vitamin D insufficiency Risk Score), **** 24-hour Dietary recall

3.5 Prevalence of Osteoporosis Risk

Table 3.5 Prevalence of Osteoporosis Risk

Variable	Category	Frequency, N = 370	95% (CI)
OSTA	At risk	113 (30.5%)	25.8% – 35.2%

The overall prevalence of osteoporosis risk among postmenopausal women is summarized in Table 3.5. OSTA Score (Osteoporosis Self-Assessment Tool for Asians) ranged between -9.2 to 9.8 with mean of 0.6 (SD: 3.2). Using the standard cutoff score of ≥ -1 , 30.5% of participants were categorized at risk for osteoporosis.

3.6 Factors associated with Osteoporosis risk

In this study, we examined various socio-demographic, reproductive, and clinical variables

to explore their relationship with osteoporosis risk, as assessed using the OSTA tool.

3.6.1 Association of Personal and socio-demographic factors with Osteoporosis risk

Table 3.6.1 Association of Personal and socio-demographic factors with Osteoporosis risk

Variable	‘At Risk’	‘Not at Risk’	p-value Chi-sq	χ ² statistic	Crude OR
Age Median (SD)	67 (9.9)	56 (7.8)	< 0.01 *	22467*	1.1 (1.0-1.1)
Place of residence					
Rural	92(31.1%)	204(68.9%)	>0.05	0.09635	1
Urban	21(28.4%)	53(71.6%)			1.1 (0.6-2.0)
Religion					
Hindu	100(29.9%)	235(70.1%)	>0.05**	-	1
Jain	12(40%)	18(60.0%)			0.6 (0.2-1.4)
Muslim	1(20%)	4(80%)			1.5(0.2-42.5)
Caste					
General	47(32%)	100(68%)	>0.05	2.0619	1
OBC	28(26.9%)	76(73.1%)			1.2 (0.7-2.2)
SC	9(25%)	27(75%)			1.3 (0.6-3.3)
ST	29(35%)	54(65%)			0.8 (0.4-1.5)
Education					
No formal education	62(37.6%)	103(62.4%)	< 0.05	7.5236	1
Formal schooling	38(23.6%)	123(76.4%)			0.5 (0.3-0.8)
Graduate and above	13(29.5%)	31(70.5%)			0.6 (0.3-1.4)
Family type					
Joint	6(20.7%)	23(79.3%)	>0.05	0.97965	1
Nuclear	107(31.4%)	234(68.6%)			0.5 (0.2-1.3)
Occupation					
Skilled/Professional	9(24.3%)	28(75.7%)	0.4983	0.45866	1
Unskilled Workers	104(31.2%)	229(68.8%)			0.7 (0.3-1.5)
Marital status					
Widowed	31(68.9%)	14(31.1%)	< 0.01	33.487	1
Married	82(25.2%)	243(74.8%)			0.1 (0.0-0.2)
Ration card					
No	21(33.9%)	41(66.1%)	>0.05	0.22367	1
Yes	92(29.9%)	216(70.1%)			1.2 (0.6-2.1)
Ration card type					
BPL	28(26.4%)	78(73.6%)	>0.05	3.2857	1
State BPL	18(27.7%)	47(72.3%)			1.0 (0.4-2.3)
AAY	32(37.2%)	54(62.8%)			0.6 (0.3-1.3)
APL	35(31.0%)	78(69.0%)			1.0 (0.4- 1.4)
Mode of payment for healthcare expenses					
State Insurance	94 (28.9%)	231 (71.1%)	< 0.05	6.5111	1
Self-payment	11 (34.4%)	21 (65.6%)			1.2 (0.5-2.7)
Private Insurance	8 (61.5%)	5 (38.5%)			3.9(1.2-13.3)

* Mann-Whitney U Test, ** Fisher's Exact Test

Table 3.6.1 shows that osteoporosis risk was associated with increasing age (OR = 1.1, 95% CI: 1.0 – 1.1), marital status (widowed vs married, OR = 0.1, 95% CI: 0.0 – 0.2), education status (no formal education vs formal schooling, OR = 0.5, 95% CI: 0.3 – 0.8), and mode of payment for healthcare (private insurance vs state insurance, OR = 3.9, 95% CI: 1.2 – 13.3). Higher age, being widowed, having no formal education, and paying through private insurance were associated with higher odds of being at risk.

3.6.2: Association of Reproductive and gynaecological history factors with Osteoporosis risk

Table 3.6.2 Association of Reproductive and gynaecological history factors with Osteoporosis risk

Variable	‘At Risk’	‘Not at Risk’	p-value chi-sq	χ ² statistic	Crude OR
Parity					
2 or less	26 (20.5%)	101 (79.5%)	<0.05	11.893	1
3-5	72 (34.0%)	140 (66.0%)			2 (1.2-3.3)
6 or more	15 (48.4%)	16 (51.6%)			3.6 (1.5-8.3)
Age at first pregnancy					
Median (SD)	20 (3.8)	20 (3.2)	>0.05*	13968*	0.9 (0.9-1.0)
Age at menarche (years)					
Median (SD)	14 (1.4)	15 (1.5)	>0.05*	13552*	0.9 (0.7-1.0)
Years of menstruation (years)					
Median (SD)	38 (5.0)	34 (4.9)	<0.01*	18882*	1.1 (1.0-1.1)
Age at menopause (years)					
Median (SD)	52 (4.7)	49 (4.8)	<0.01*	18784*	1.1 (1.0-1.1)
Duration of menopause (years)					
Median (SD)	14 (8.8)	4 (6.4)	<0.01*	21540*	1.1 (1.0-1.1)
History of abortion					
No	100 (29.4%)	240 (70.6%)	>0.05	1.9051	1
Yes	13 (43.3%)	17 (56.7%)			0.1 (0.1-0.4)
Oral Contraceptive pills					
Yes	4 (30.8%)	9 (69.2%)	>0.05**	-	1
No	109 (30.5%)	248 (79.5%)			0.5 (0.2-1.8)
Duration of Oral contraceptive pills (years)					
Median (SD)	2.5 (0.9)	2.0 (1.3)	>0.05***	0.3357 ***	1.0 (0.6-1.6)
Gynaecological conditions					
No	106 (31.7%)	228 (68.3%)	>0.05	1.7715	1
Yes	7 (19.4%)	29 (80.6%)			1.8 (0.8-4.8)

* Mann-Whitney U Test, ** Fisher's Exact Test, *** Independent t-test

As shown in Table 3.6.2, reproductive and gynaecological factors such as parity, years of menstruation, age at menopause, and duration of menopause were associated with osteoporosis risk among the participants. Women with six or more children had a higher risk of osteoporosis than those with two or fewer children, with a crude odds ratio (COR) of 3.6 (95% CI: 1.5–8.3). Longer years of menstruation were associated with increased risk, with a COR of 1.1 (95% CI: 1.0–1.1). Similarly, a higher age at menopause (COR = 1.1, 95% CI: 1.0–1.1) and a longer duration of menopause (COR = 1.1, 95% CI: 1.0–1.1) were associated with greater osteoporosis risk among postmenopausal women.

3.6.3: Association of Clinical features with Osteoporosis risk

Table 3.6.3 Association of Clinical features with Osteoporosis risk

Variable	'At Risk'	'Not at Risk'	p-value chi-sq	χ^2 statistic	Crude OR
Comorbidities					
No	68 (26.0%)	194 (74%)			1
Yes	45 (41.7%)	63 (58.3%)	<0.05	8.175	0.4 (0.3-0.7)
Medicine reducing bone mineral density					
No	101 (29.3%)	244 (70.7%)			1
Yes	12 (48%)	13 (52%)	>0.05	3.0207	0.4 (0.1-1.0)
Dietary supplements					
No	94 (29.2%)	228 (70.8%)			1
Yes	19 (39.6%)	29 (60.4%)	>0.05	1.6645	0.6 (0.3-1.1)
Family history of symptoms related to osteoporosis					
Don't know	9 (26.5%)	25 (73.5%)			1
No	103 (31%)	229 (69.0%)			0.8 (0.3-1.7)
Yes	1 (25.0%)	3 (75.0%)	>0.05**	-	1 (0.1-31.4)
Self-declared history of fragility fracture					
No	101 (29.3%)	244 (70.7%)			1
Yes	12 (48%)	13 (52%)	>0.05	3.0207	0.4 (0.1-1.0)
BMI (kg/m²)					
Median (SD)	22.8 (4.0)	28.5 (4.4)	<0.01***	-12.79 ***	0.7 (0.6-7.7)
Waist hip ratio					
Median (SD)	0.86 (0.05)	0.87 (0.05)	>0.05*	13304*	0.1 (0.0-6.8)
Frailty status					
Frail	35 (31.0%)	50 (69.0%)			1
Non-frail	78 (19.5%)	207 (80.5%)	<0.05	5.2517	1.8 (1.1-3.0)

* Mann-Whitney U Test, ** Fisher's Exact Test, *** Independent t-test

Table 3.6.3 illustrates the association between clinical features. An association was observed between osteoporosis risk and comorbidities, BMI, and frailty status. Women with comorbidities had higher odds of being at risk, with a crude odds ratio (COR) of 0.4 (95% CI: 0.3–0.7). Lower BMI was strongly associated with higher osteoporosis risk, with a COR of 0.7 (95% CI: 0.6–7.7). Additionally, frail women were more at risk compared to non-frail women, with a COR of 1.8 (95% CI: 1.1–3.0).

3.6.4: Association of lifestyle factors with Osteoporosis risk

Table 3.6.4: Association of lifestyle factors with Osteoporosis risk

Variable	‘At Risk’	‘Not at Risk’	p-value	χ^2 statistic	Crude OR
Physical activity					
Low	70 (36.8%)	120 (63.2%)	<0.05	10.768	1
Moderate	27 (20.1%)	107 (79.9%)			0.9 (0.4-1.7)
High	16 (34.8%)	30 (65.2%)			0.4 (0.2-0.7)
Sun exposure in mins					
Median (SD)	60 (66.5)	60 (61.8)	>0.05*	16061*	1 (0.9-1.0)
Salt intake					
Low	42 (30.4%)	96 (69.6%)	>0.05	1.024	1
Adequate	29 (22.5%)	100 (77.5%)			0.7 (0.4-1.3)
High	22 (26.5%)	61 (73.5%)			0.8 (0.4-1.5)
Vitamin D					
Deficient	38 (30.0%)	89 (70.0%)	>0.05	3.809	1
Insufficient	36 (25.9%)	103 (74.1%)			1.2 (0.7-2.0)
Sufficient	39 (37.5%)	65 (62.5%)			0.7 (0.4-1.2)
Dietary calcium					
Low	51 (34.7%)	96 (65.3%)	>0.05**	-	1
Adequate	58 (27.0%)	157 (73.0%)			0.3 (0.0-1.6)
High	4 (50.0%)	4 (50.0%)			0.6 (0.4-1.0)

* Mann-Whitney U Test, ** Fisher’s Exact Test

Among lifestyle factors represented in Table 3.6.4, a significant association was found between physical activity and osteoporosis risk. The odds of being at risk of osteoporosis were less among those who were doing high physical activity than those who were doing low physical activity (COR 0.4; 95% CI: 0.2–0.7), suggesting that higher physical activity levels may be associated with lower odds of osteoporosis risk.

3.6.5: Multivariable Analysis Between factors and Osteoporosis risk

Osteoporosis risk in postmenopausal women was predicted by multivariable analysis (Table 3.6.5). After controlling for potential confounders, those who used the private healthcare payment system were at 9.5 times (aOR=9.5, 95% CI: 2.4-41.0) higher odds of being at risk for osteoporosis compared to those who used the state funded healthcare followed by high parity, with three to five children having two times (aOR=2.0; 95% CI: 1.1-3.9) and $\geq$ six children 3.4 times odds (aOR=3.4; 95% CI: 1.2-9.6) than women with $\leq$ two children. The risk of developing osteoporosis increased by 10 percent for each additional year after menopause (aOR=1.1/year, 95%CI:1.0-1.1). Formal education in women with a school education had a 50 percent reduced risk (aOR=0.5, 95% CI: 0.2-0.9) compared with no formal education. Importantly, neither self-payment for healthcare nor graduate-level education was associated with osteoporosis risk in the adjusted analysis.

Table 3.6.5: Multivariable Analysis Between factors and Osteoporosis risk

Variable	Osteoporosis risk (Not at risk/At risk) Adjusted Odd's ratio	
	OR (95% CI)	p-value
Mode of Payment For health- Care expenses		
State	1	
Private	9.5 (2.4-41.0)	<0.05
Self-payment	1.4 (0.5-3.5)	>0.05
Parity		
Less than or 2 children	1	
3-5 children	2.0 (1.1-3.9)	<0.05
6 or more children	3.4 (1.2-9.6)	<0.05
Duration since menopause (years)		
Continuous	1.1 (1.0-1.1)	<0.01
Education		
No formal education	1	
Formal schooling	0.5 (0.2-0.9)	<0.05
Graduate and above	0.7 (0.3-1.8)	>0.05

Chapter 4

Discussion

This study aimed to estimate the prevalence of osteoporosis risk among postmenopausal women in Udaipur district, Rajasthan- a demographic that is still under-researched and underrepresented. This was particularly important as the district has a significant tribal population. Our findings reveal critical insights into the sociodemographic, reproductive, clinical, and lifestyle factors associated with the risk of osteoporosis in this region.

The mean age of participants in the present study was 59.7 years (SD: 9.5, range: 45 to 85 years). The greatest proportion of women (38.4%) were in between the age of 55–64 years. In contrast, a study among menopausal women for osteoporosis reported that the average age of the participants was 52.6 ± 9.4 and ranged from 40 to 76 years (Thangappah et al., 2022b). The participants in the present study were older which may influence the prevalence of osteoporosis.

A study conducted in the Mewat region of Haryana reported that almost half of the participants had no formal education, one-fourth only attained primary or middle school level education, and less than one-fourth were graduates or above (Imran et al., 2022). In comparison, in the present study, the mean years of formal education was 6.2 years (SD: 6.9; range: 0–24), and more than half of the participants had only up to five years of education, while less than half reported no formal schooling. It shows a low education level in the study population, whereas the average literacy rate in the Udaipur district is almost 80 percent (*Udaipur City Population 2025 | Literacy and Hindu Muslim Population, 2025*). This may also be because most study participants were from rural areas, where the education level may be lower than in urban areas (Maddah, Sharami and Karandish, 2011). The absence of association of the education level of graduates and above with a lower risk

of osteoporosis may be due to the small number of study participants in the category, which was only around 17 percent.

In our study, a vast majority of participants were Hindu, followed by a small proportion of Jain and a very small number of Muslim respondents. This finding was similar to the Census data for the Udaipur district, where Hindus constitute more than nine-tenths of the population, Muslims form around three percent, and Jains account for about two to three percent (*RAJASTHAN DISTRICT FACTBOOK : UDAIPUR DISTRICT*, 2018). While the proportion of Hindus in our study closely mirrored the district average, there were relatively more Jain participants and fewer Muslim participants than the Census figures.

This difference may be explained by the selection of random study areas — both rural gram panchayats and urban wards — which were predominantly Hindu-populated and had smaller Muslim and Jain populations (*India - Census of India 2011 - Rajasthan - Series 09 - Part XII A - District Census Handbook, Udaipur*, 2014). Two-fifths of our study participants were in the General category followed by over one-fourth as OBC and about one-fifth as Scheduled Tribe (ST). Notably, the proportion of ST participants in our study was considerably higher compared to the Census data for Udaipur city, which reports only around five percent ST population (*Udaipur Population, Caste Data Udaipur Rajasthan - Census India*, 2025; *Udaipur City Population 2025 | Literacy and Hindu Muslim Population*, 2025).

The higher representation of ST participants in our study may be attributed to including Gram Panchayats with a higher ST population. For instance, Sagwara village has an ST population of approximately 99.8 percent, and Delawas has about 86.6% (*Delawas Village Population - Gogunda - Udaipur, Rajasthan*, 2025; *Sagwara Village Population - Rishabhdeo - Udaipur, Rajasthan*, 2025), both significantly higher than the Udaipur city

average of five percent. Such demographic concentrations in randomly selected sampling areas may have influenced the overall composition of our study population.

According to the colour-coded ration card categories followed in Rajasthan, nearly one-third were surveyed with Below Poverty Line (BPL) cards (dark pink), less than one-fifth were under State BPL (dark green), and almost one-fourth were Antyodaya Anna Yojana (AAY) cardholders (yellow). About one-third had Blue or another ration card. A small proportion of 63 participants lacked any ration card. On further exploration, it was observed that these households pay taxes regularly and were ineligible for ration cards, indicating their classification under middle- or higher-income groups. This also aligned with NITI Aayog's 2023 report, which showed that about one-third of Rajasthan's population lived in multidimensional poverty in 2015–16. This highlights the economic vulnerability of the study population, which may impact access to nutrition and healthcare (NITI Aayog, 2023). Similar findings were reported by another study conducted in rural Udaipur district which revealed that the population was economically disadvantaged, with more than one-third living below the official poverty line (Banerjee, Deaton and Duflo, 2004).

Regarding, healthcare spending, a vast majority of participants in our study were covered by state-sponsored insurance schemes, alleviating the burden of out-of-pocket payments. When compared to similar comparative studies, the different notions were presented where a slightly lower proportion of individuals had to pay out-of-pocket to treat their health issues, claiming an absence of proper financial protection, which is one of the areas that could impact these two populations (Nair et al., 2024).

Only a small proportion of participants reported a history of fragility fractures, even lower than the less than one-tenth observed in a comparative study. Nearly one-third of the participants had comorbid conditions. Vitamin D and calcium supplements use was notably

low. Similarly, a study reported that more than half of their study population had insufficient calcium intake, highlighting a substantial burden of nutritional deficiency (Thangappah et al., 2022b).

Mean Menarche age 14.6 ± 1.4 years, compared to 13.1 ± 1.8 years in another study. Later menarche and shorter menstruation duration (35.9 vs. 37.2 years) (Imran et al., 2022) might be due to less exposure to estrogen, a risk factor for osteoporosis, throughout life (Sioka et al., 2010).

Another study reported the average BMI of 26.4 ± 3.7 , and the majority of the women presented overweight or obese. This is consistent with our finding of close to one-third overweight and less than one-third obese women. Average sunlight exposure was 73.5 minutes/day in our study compared with more than three-fourth of the net studied having minimal to inadequate exposure in the comparative study, demonstrating a common risk of vitamin D deficiency. Half of our participants were found to be less active, with a median IPAQ score 584. In the comparative study, less than one-third of the participants were sedentary which represents a low mobility and higher fall risk, similar to our research findings. Our sample had high tea consumption nearly all participants reported it. There was no alcohol and tobacco use in either study, which may reflect sociocultural factors or underreporting (Khinda et al., 2022; Thangappah et al., 2022b).

Choice of Assessment Tool and Osteoporosis Prevalence

In this study, we assessed osteoporosis risk among postmenopausal women using the Osteoporosis Self-Assessment Tool for Asians (OSTA). This tool was simple, inexpensive, and easily implemented in community and rural settings where sophisticated diagnostic techniques (e.g., DEXA) are not feasible. The estimation of osteoporosis prevalence in these studies has primarily relied on bone mineral density (BMD) measurements using

dual-energy X-ray absorptiometry (DEXA), which is considered the gold standard for diagnosis (Chavda, Chavda and Dube, 2022; Dodda et al., 2023). However, due to limited availability and high costs of DEXA, many Indian studies also utilize validated risk assessment tools such as the Osteoporosis Self-Assessment Tool for Asians (OSTA), Osteoporosis Risk Assessment Instrument (ORAI), Simple Calculated Osteoporosis Risk Estimation (SCORE), and Age, Bulk, One or Never Estrogen (ABONE) (Chavda, Chavda and Dube, 2022; Cherian et al., 2022). These tools use combinations of clinical risk factors—such as age, weight, and estrogen use—to identify individuals at high risk for osteoporosis, enabling targeted referrals for DEXA testing where resources are constrained (Chavda, Chavda and Dube, 2022; Cherian et al., 2022).

Differences in reported osteoporosis prevalence across studies often stem from the choice of screening tool. OSTA and ORAI differ in included variables—OSTA uses age and weight, while ORAI adds current estrogen use, affecting their sensitivity and specificity. OSTA generally shows higher sensitivity but lower specificity, making it more suitable for community-level screening where missing true positives is riskier than over-referral. For example, one study reported OSTA sensitivity at 91.9 percent (specificity 42.9 percent, ROC 0.7), compared to ORAI's 62 percent sensitivity and specificity (ROC 0.6) (Chan et al., 2006). Another showed OSTA with 88.5 percent sensitivity (ROC 0.7) vs. ORAI's 81 percent (ROC 0.7) (Cherian et al., 2018). Given its simplicity, better sensitivity, and relevance to the study population, OSTA was selected as the preferred tool for screening at-risk postmenopausal women.

The current study identified the prevalence of risk for osteoporosis to be 30.5 percent. This is higher than a previous study done in Udaipur, where more than one-fourth of the respondents were in the medium risk category and none in the high-risk category. The

higher at-risk proportions in our study may be due to the inclusion of older age participants compared to the other study (Hussain, 2021).

The prevalence observed in this study is comparable to findings from other Indian regions, though some studies report even higher rates. For instance, a hospital-based study in North India found the prevalence of osteoporosis among postmenopausal women to be 37.5 percent (Imran et al., 2022). Community-based studies from Andhra Pradesh and other regions have reported osteoporosis prevalence rates ranging from 40 percent to 53 percent among postmenopausal women, with rates increasing sharply with age-up to 70 percent in women aged 71–78 years (Patil et al., 2022). In summary, while the prevalence of osteoporosis in postmenopausal Indian women is consistently high across studies, the exact figures depend on both the population studied and the diagnostic or screening tool used. The use of different tools, each with its own strengths and limitations, partly explains the variability in reported prevalence (Ahmadzadeh et al., 2014; Cherian et al., 2018; Chavda, Chavda and Dube, 2022).

Association of risk factors with Osteoporosis Risk

Research across India consistently highlights that, in addition to age and low body weight, several other determinants significantly increase osteoporosis risk in postmenopausal women. These include higher parity (number of childbirths), low body mass index (BMI), low dietary calcium, low intake of vitamin D, low levels of physical activity, positive family history of osteoporosis, and lifestyle factors such as smoking or use of tobacco (Raveendran et al., 2011; Imran et al., 2022; Jogi et al., 2024). Socioeconomic status and educational background also play a role, as lower awareness and limited access to preventive care can exacerbate risk (Anupama et al., 2022). Furthermore, hormonal changes post-menopause,

particularly the withdrawal of estrogen's protective effect, are central to the pathogenesis of postmenopausal osteoporosis (Rajan et al., 2020).

Multivariate analysis showed that those with private insurance demonstrated significantly higher odds, which may indicate differential access to medical care or health awareness. A nationwide survey of Indian orthopaedic surgeons highlighted that despite a high prevalence of osteoporosis in one-third population, approximately one in ten of patients are actually diagnosed and treated, partly due to limited access to diagnostic tools and specialist care (Jhaveri et al., 2015). However, there is only a handful of Indian studies directly examining the association between mode of payment for healthcare expenses and osteoporosis risk, highlighting a gap.

Parity was also a significant predictor; women with three to five children had two times higher odds and those with six or more children had 3.4 times higher odds of osteoporosis risk than those with $\leq$ two children similar to a study where high parity is associated with osteoporosis risk (Imran et al., 2022). Similarly, a large community-based cohort study reported that the risk of low bone density increased steadily with the number of children, and women with three or more children had almost double the risk compared to those with only one child (Terzi et al., 2017). A meta-analysis of studies in postmenopausal women also showed that higher parity was associated with a significantly increased risk of osteoporosis (Lee et al., 2019). Other research confirmed that bone mineral density, particularly at the femoral neck, decreased as parity increased, especially in women with five or more deliveries (Peker and Tosun, 2018). The association may be due to the progressive depletion of maternal calcium deposits over multiple pregnancies, particularly where nutritional supplementation was inadequate. Additionally, the lactation period was characterized by decreased estrogen levels, which accelerated bone resorption and contributed to long-term bone loss (Peker and Tosun, 2018; Lee et al., 2019).

The association of formal education with a 50 percent reduction in osteoporosis risk than those with no schooling, similar to a cross-sectional study from northern India (Kale et al., 2024). Education likely enhances awareness about nutrition, exercise, and preventive health behaviour, thereby reducing the risk of osteoporosis.

Overall, these results imply that reproductive history, healthcare access, and educational background are each significantly associated with the likelihood of having osteoporosis beyond what is predicted by age and weight.

Interestingly, osteoporosis risk (assessed using OSTA) was not found to be significantly associated with the frailty status among postmenopausal women in our treated study. These results also indicate a lack of direct prediction in this population; while both are known to share common risk factors like age, number of years since menopause, and deficiencies in nutrients, they do not directly influence each other in this population. This lack of association has been previously reported in the literature. For example, a cross-sectional study conducted by (Heng et al., 2023) indicated that frailty and osteoporosis were independently prevalent but showed no significant direct correlation. This may reflect the multifactorial nature of frailty, encompassing not only musculoskeletal decline but also cognitive, nutritional, and social determinants that may not directly map onto osteoporosis risk scores.

Together, these results highlight the interdependence of sociodemographic, reproductive, and clinical factors in influencing osteoporosis risk and frailty in postmenopausal women. Similarly, a lack of association with osteoporosis, as noted in previous studies, suggests that in spite of shared risk factors, the mechanisms underlying osteoporosis and frailty may be different. While some variables only had limited comparative literature, particularly with regard to private insurance, the associations were noted in this population, reinforcing

the demand for targeted and locally relevant prevention schemes. These findings can help in improving public health screening strategies and community health programs to target bone and functional health in older women in rural and urban settings of India.

Strength and Limitations

This study has several strengths. It utilised the Osteoporosis Self-Assessment Tool for Asians (OSTA), a simple and cost-effective screening method suitable for areas where DEXA scanning is not available, allowing early identification of individuals at risk and enabling timely preventive measures. The study design ensured proportional representation of both rural and urban populations based on Census 2011, enhancing the generalisability of findings. Furthermore, it was conducted in a tribal-dominant region, a population that remains largely understudied, and comprehensively assessed multiple contributing factors such as dietary intake, physical activity, calcium and vitamin D exposure. However, certain limitations should be acknowledged. While OSTA is valuable for screening, it does not replace DEXA, which remains the gold standard for diagnosing osteoporosis. Additionally, the study relied on self-reported data for some variables, which may be subject to recall or reporting bias.

Conclusion

Postmenopausal osteoporosis was reported in one third of the study participants, indicating that it is a common health issue in the region. Educational status, parity, type of health insurance, and duration of menopause were independent predictors of osteoporosis risk. The study indicates that reproductive, gynaecological, and socioeconomic factors may be used to prioritize screening for early identification of postmenopausal women at risk of osteoporosis. Further studies are needed to identify how these findings can be incorporated

in health policies to improve the bone health of postmenopausal women in resource poor settings.

Recommendations

Based on the study findings, it is recommended to prioritise osteoporosis screening among postmenopausal women with higher parity (three or more children) and those who are more than ten years post-menopause, particularly in underserved rural and tribal areas. Education level can serve as an important indicator to identify women who may benefit from tailored awareness efforts—simple, easy-to-understand materials should be developed for those with limited or no formal education. Additionally, there is a need to strengthen referrals and financial support through state health insurance schemes like the Mukhyamantri Ayushman Aarogya Yojana to ensure access to DEXA scans for women identified at high risk through tools like OSTA, especially those without private insurance. Finally, integration of osteoporosis screening into existing national programs such as NPCDCS and Ayushman Bharat is essential to promote early detection and management in women aged over 50 years with known risk factors.

References

- Agarwal, K. et al. (2022) 'OSTA as a screening tool to predict osteoporosis in Indian postmenopausal women — a nationwide study', *Archives of Osteoporosis*, 17(1), p. 121. Available at: <https://doi.org/10.1007/s11657-022-01159-w>.
- Aggarwal, N. et al. (2011) 'Prevalence and related risk factors of osteoporosis in peri- and postmenopausal Indian women', *Journal of Mid-Life Health*, 2(2), pp. 81–85. Available at: <https://doi.org/10.4103/0976-7800.92537>.
- Agrawal, A.C. and Garg, A.K. (2023) 'Epidemiology of Osteoporosis', *Indian Journal of Orthopaedics*, 57(Suppl 1), pp. 45–48. Available at: <https://doi.org/10.1007/s43465-023-01012-3>.
- Ahmadzadeh, A. et al. (2014) 'Comparison of three different osteoporosis risk assessment tools: ORAI (osteoporosis risk assessment instrument), SCORE (simple calculated osteoporosis risk estimation) and OST (osteoporosis self-assessment tool)', *Medical Journal of the Islamic Republic of Iran*, 28, p. 94.
- Al-Bashaireh, A.M. et al. (2018) 'The Effect of Tobacco Smoking on Bone Mass: An Overview of Pathophysiologic Mechanisms', *Journal of Osteoporosis*, 2018, p. 1206235. Available at: <https://doi.org/10.1155/2018/1206235>.
- Anaraki, S.R. et al. (2023) 'Frailty syndrome in women with osteoporosis, should physicians consider screening? A cross-sectional study', *Bone Reports*, 19, p. 101722. Available at: <https://doi.org/10.1016/j.bonr.2023.101722>.
- Anupama, D.S. et al. (2022) 'Burden of Osteopenia and Osteoporosis Among Postmenopausal Women in India: A Systematic Review and Meta-Analysis', *Journal of Mid-life Health*, 13(2), p. 107. Available at: https://doi.org/10.4103/jmh.jmh_207_21.
- Asomaning, K. et al. (2006) 'The association between body mass index and osteoporosis in patients referred for a bone mineral density examination', *Journal of Women's Health* (2002), 15(9), pp. 1028–1034. Available at: <https://doi.org/10.1089/jwh.2006.15.1028>.
- Babhulkar, S. (2021) '(PDF) Prevalence of osteoporosis in India: an observation of 31238 adults', *ResearchGate* [Preprint]. Available at: https://www.researchgate.net/publication/349565832_Prevalence_of_osteoporosis_in_India_an_observation_of_31238_adults (Accessed: 29 April 2025).
- Babhulkar, S. and Seth, S. (2021) 'Prevalence of osteoporosis in India: an observation of 31238 adults', *International Journal of Research in Orthopaedics*, 7(2), pp. 362–368. Available at: <https://doi.org/10.18203/issn.2455-4510.IntJResOrthop20210630>.
- Banerjee, A., Deaton, A. and Duflo, E. (2004) 'HEALTH, HEALTH CARE, AND ECONOMIC DEVELOPMENT: Wealth, Health, and Health Services in Rural Rajasthan', *The American economic review*, 94(2), p. 326. Available at: <https://doi.org/10.1257/0002828041301902>.
- Bijelic, R., Milicevic, S. and Balaban, J. (2017) 'Risk Factors for Osteoporosis in Postmenopausal Women', *Medical Archives*, 71(1), pp. 25–28. Available at: <https://doi.org/10.5455/medarh.2017.71.25-28>.

Borer, K.T. (2005) 'Physical activity in the prevention and amelioration of osteoporosis in women: interaction of mechanical, hormonal and dietary factors', *Sports Medicine (Auckland, N.Z.)*, 35(9), pp. 779–830. Available at: <https://doi.org/10.2165/00007256-200535090-00004>.

Burke-Doe, A. et al. (2008) 'Knowledge of osteoporosis risk factors and prevalence of risk factors for osteoporosis, falls, and fracture in functionally independent older adults', *Journal of Geriatric Physical Therapy* (2001), 31(1), pp. 11–17. Available at: <https://doi.org/10.1519/00139143-200831010-00003>.

Carbone, L. et al. (2016) 'Sodium Intake and Osteoporosis. Findings From the Women's Health Initiative', *The Journal of Clinical Endocrinology and Metabolism*, 101(4), p. 1414. Available at: <https://doi.org/10.1210/jc.2015-4017>.

Chan, S.-P. et al. (2006) 'Validation of various osteoporosis risk indices in elderly Chinese females in Singapore', *Osteoporosis international: a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA*, 17(8), pp. 1182–1188. Available at: <https://doi.org/10.1007/s00198-005-0051-4>.

Charde, S.H., Joshi, A. and Raut, J. (2023) 'A Comprehensive Review on Postmenopausal Osteoporosis in Women', *Cureus*, 15(11), p. e48582. Available at: <https://doi.org/10.7759/cureus.48582>.

Chaudhary, N.K. et al. (2024) 'Prevalence of osteoporosis and associated factors among people aged 50 years and older in the Madhesh province of Nepal: a community-based cross-sectional study', *Journal of Health, Population and Nutrition*, 43(1), p. 100. Available at: <https://doi.org/10.1186/s41043-024-00591-7>.

Chavda, S., Chavda, B. and Dube, R. (2022) 'Osteoporosis Screening and Fracture Risk Assessment Tool: Its Scope and Role in General Clinical Practice', *Cureus*, 14(7), p. e26518. Available at: <https://doi.org/10.7759/cureus.26518>.

Chen, P., Li, Z. and Hu, Y. (2016) 'Prevalence of osteoporosis in China: a meta-analysis and systematic review', *BMC public health*, 16(1), p. 1039. Available at: <https://doi.org/10.1186/s12889-016-3712-7>.

Cherian, K.E. et al. (2018) 'Evaluation of Different Screening Tools for Predicting Femoral Neck Osteoporosis in Rural South Indian Postmenopausal Women', *Journal of Clinical Densitometry*, 21(1), pp. 119–124. Available at: <https://doi.org/10.1016/j.jocd.2017.08.002>.

Cherian, K.E. et al. (2022) 'Screening Tools for Osteoporosis in India: Where Do We Place Them in Current Clinical Care?', *Journal of Mid-Life Health*, 12(4), pp. 257–262. Available at: https://doi.org/10.4103/jmh.jmh_216_21.

Chin, K.-Y. (2017) 'A review on the performance of osteoporosis self-assessment tool for Asians in determining osteoporosis and fracture risk', *Postgraduate Medicine*, 129(7), pp. 734–746. Available at: <https://doi.org/10.1080/00325481.2017.1353394>.

Choi, M.H. et al. (2021) 'Prevalence and diagnosis experience of osteoporosis in postmenopausal women over 50: Focusing on socioeconomic factors', *PLOS ONE*, 16(3), p. e0248020. Available at: <https://doi.org/10.1371/journal.pone.0248020>.

Compston, J.E., McClung, M.R. and Leslie, W.D. (2019) 'Osteoporosis', *The Lancet*, 393(10169), pp. 364–376. Available at: [https://doi.org/10.1016/S0140-6736\(18\)32112-3](https://doi.org/10.1016/S0140-6736(18)32112-3).

Curtis, E.M. et al. (2017) 'The impact of fragility fracture and approaches to osteoporosis risk assessment worldwide', *Bone*, 104, pp. 29–38. Available at: <https://doi.org/10.1016/j.bone.2017.01.024>.

Dai, Z. et al. (2018) 'Coffee and tea drinking in relation to risk of hip fracture in the Singapore Chinese Health Study', *Bone*, 112, pp. 51–57. Available at: <https://doi.org/10.1016/j.bone.2018.04.010>.

Definition of BODY MASS INDEX (2025). Available at: <https://www.merriam-webster.com/dictionary/body+mass+index> (Accessed: 27 April 2025).

Definition of OSTEOPOROSIS (2025). Available at: <https://www.merriam-webster.com/dictionary/osteoporosis> (Accessed: 27 April 2025).

Delawas Village Population - Gogunda - Udaipur, Rajasthan (2025). Available at: <https://www.census2011.co.in/data/village/105723-delawas-rajasthan.html> (Accessed: 27 April 2025).

Demir, B. et al. (2008) 'Identification of the risk factors for osteoporosis among postmenopausal women', *Maturitas*, 60(3–4), pp. 253–256. Available at: <https://doi.org/10.1016/j.maturitas.2008.07.011>.

Dennison, E.M. et al. (2012) 'Effect of co-morbidities on fracture risk: findings from the Global Longitudinal Study of Osteoporosis in Women (GLOW)', *Bone*, 50(6), pp. 1288–1293. Available at: <https://doi.org/10.1016/j.bone.2012.02.639>.

Dodda, S.K. et al. (2023) 'INCIDENCE AND RISK FACTORS FOR OSTEOPOROSIS IN POSTMENOPAUSAL WOMEN: A POPULATION-BASED STUDY'.

Eby, J.M., Sharieh, F. and Callaci, J.J. (2020) 'Impact of Alcohol on Bone Health, Homeostasis and Fracture repair', *Current pathobiology reports*, 8(3), p. 75. Available at: <https://doi.org/10.1007/s40139-020-00209-7>.

Epidemiology | International Osteoporosis Foundation (2023). Available at: <https://www.osteoporosis.foundation/health-professionals/about-osteoporosis/epidemiology> (Accessed: 1 September 2024).

fragility fracture | Taber's Medical Dictionary (2025). Available at: https://www.tabers.com/tabersonline/view/Tabers-Dictionary/741973/all/fragility_fracture?refer=true (Accessed: 27 April 2025).

Harinarayan, C.V. (2018) 'How to treat Vitamin D deficiency in sun-drenched India - guidelines', *Journal of Clinical and Scientific Research*, 7(3), p. 131. Available at: https://doi.org/10.4103/JCSR.JCSR_1_19.

Hendrickx, G., Boudin, E. and Van Hul, W. (2015) 'A look behind the scenes: the risk and pathogenesis of primary osteoporosis', *Nature Reviews. Rheumatology*, 11(8), pp. 462–474. Available at: <https://doi.org/10.1038/nrrheum.2015.48>.

Heng, M.W.Y. et al. (2023) 'Individual and combined associations of sarcopenia, osteoporosis and obesity with frailty in a multi-ethnic asian older adult population', *BMC Geriatrics*, 23(1), p. 802. Available at: <https://doi.org/10.1186/s12877-023-04500-1>.

Hosein-Woodley, R. et al. (2024) 'Beyond the Surface: Uncovering Secondary Causes of Osteoporosis for Optimal Management', *Biomedicines*, 12(11), p. 2558. Available at: <https://doi.org/10.3390/biomedicines12112558>.

Hudec, S.M.D. and Camacho, P.M. (2013) 'Secondary causes of osteoporosis', *Endocrine Practice: Official Journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists*, 19(1), pp. 120–128. Available at: <https://doi.org/10.4158/EP12059.RA>.

Hunter, D.J. and Sambrook, P.N. (2000) 'Bone loss: Epidemiology of bone loss', *Arthritis Research*, 2(6), p. 441. Available at: <https://doi.org/10.1186/ar125>.

Hussain, S. (2021) *Indian Journal of Nutrition and Dietetics*, ResearchGate. Available at: <https://doi.org/10.21048/ijnd.2016.53.2.2369>.

Imran, M. et al. (2022) 'Prevalence of Osteoporosis and Associated Risk Factors among Postmenopausal Women: A Cross-Sectional Study from Northern India', *Journal of Mid-Life Health*, 13(3), pp. 206–212. Available at: https://doi.org/10.4103/jmh.jmh_114_22.

India - Census of India 2011 - Rajasthan - Series 09 - Part XII A - District Census Handbook, Udaipur (2014). Available at: <https://censusindia.gov.in/nada/index.php/catalog/1032> (Accessed: 28 April 2025).

Jhaveri, S. et al. (2015) 'Current Clinical Practice Scenario of Osteoporosis Management in India', *Journal of Clinical and Diagnostic Research : JCDR*, 9(10), pp. RC04–RC08. Available at: <https://doi.org/10.7860/JCDR/2015/13000.6635>.

Ji, M.-X. and Yu, Q. (2015) 'Primary osteoporosis in postmenopausal women', *Chronic Diseases and Translational Medicine*, 1(1), pp. 9–13. Available at: <https://doi.org/10.1016/j.cdtm.2015.02.006>.

Jogi, M.K. et al. (2024) 'Key determinants of postmenopausal osteoporosis: A mini-review of current insights', *Journal of Reproductive Healthcare and Medicine*, 5. Available at: https://doi.org/10.25259/JRHM_23_2024.

Johnell, O. and Kanis, J.A. (2006) 'An estimate of the worldwide prevalence and disability associated with osteoporotic fractures', *Osteoporosis international: a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA*, 17(12), pp. 1726–1733. Available at: <https://doi.org/10.1007/s00198-006-0172-4>.

Joshi, S. and Singh, V. (2013) 'Food Consumption Pattern and Dietary Adequacy Among Bhils of Udaipur (Rajasthan)', 4(2).

Kadam, N. et al. (2019) 'Low knowledge of osteoporosis and its risk factors in urban Indian adults from Pune city, India', *Public Health Nutrition*, 22(7), pp. 1292–1299. Available at: <https://doi.org/10.1017/S1368980018003634>.

Kale, A. et al. (2024) 'Knowledge, Attitudes, Practices, and Awareness Levels Among Indian Postmenopausal Women About Osteoporosis and Its Relationship With Sociodemographic Factors: A Cross-Sectional Study From Northern India', *Cureus*, 16. Available at: <https://doi.org/10.7759/cureus.59606>.

Kaushal, N. et al. (2018) 'Prevalence of osteoporosis and osteopenia in an apparently healthy Indian population - a cross-sectional retrospective study', *Osteoporosis and Sarcopenia*, 4(2), pp. 53–60. Available at: <https://doi.org/10.1016/j.afos.2018.04.002>.

Keen, M.U. and Reddivari, A.K.R. (2024) 'Osteoporosis in Females', in *StatPearls. Treasure Island (FL): StatPearls Publishing*. Available at: <http://www.ncbi.nlm.nih.gov/books/NBK559156/> (Accessed: 26 October 2024).

Khadilkar, Anuradha V and Mandlik, R.M. (2015) 'Epidemiology and treatment of osteoporosis in women: an Indian perspective', *International Journal of Women's Health*, 7, pp. 841–850. Available at: <https://doi.org/10.2147/IJWH.S54623>.

Khadilkar, Anuradha V. and Mandlik, R.M. (2015) 'Epidemiology and treatment of osteoporosis in women: an Indian perspective', *International Journal of Women's Health*, 7, p. 841. Available at: <https://doi.org/10.2147/IJWH.S54623>.

Khinda, R. et al. (2022) 'Prevalence and Predictors of Osteoporosis and Osteopenia in Postmenopausal Women of Punjab, India', *International Journal of Environmental Research and Public Health*, 19(5), p. 2999. Available at: <https://doi.org/10.3390/ijerph19052999>.

Khosla, S., Melton, L.J. and Riggs, B.L. (2001) 'Estrogens and bone health in men', *Calcified Tissue International*, 69(4), pp. 189–192. Available at: <https://doi.org/10.1007/s00223-001-1044-8>.

Kim, Y.-S. et al. (2017) 'The correlation between bone mineral density/trabecular bone score and body mass index, height, and weight', *Osteoporosis and Sarcopenia*, 3(2), pp. 98–103. Available at: <https://doi.org/10.1016/j.afos.2017.02.001>.

Koh, L.K.H. et al. (2001) 'A Simple Tool to Identify Asian Women at Increased Risk of Osteoporosis', *Osteoporosis International*, 12(8), pp. 699–705. Available at: <https://doi.org/10.1007/s001980170070>.

Laddha, A. (2017) 'Vitamin D Status Among the Elderly Persons of South Rajasthan – A Prospective Observational Study'. Available at: <https://doi.org/10.21276/iabcr.2017.3.4.02>.

Lee, E.N. et al. (2019) 'Effects of Parity and Breast Feeding Duration on the Risk of Osteoporosis in Postmenopausal Korean Women: A Systematic Review and Meta-Analysis', *Journal of Menopausal Medicine*, 25(2), pp. 100–107. Available at: <https://doi.org/10.6118/jmm.19197>.

Li, G. et al. (2017) 'An overview of osteoporosis and frailty in the elderly', *BMC Musculoskeletal Disorders*, 18(1), p. 46. Available at: <https://doi.org/10.1186/s12891-017-1403-x>.

Lyu, F.F. et al. (2024) 'Prevalence rate of primary osteoporosis in China: a meta-analysis', *BMC Public Health*, 24(1), p. 1518. Available at: <https://doi.org/10.1186/s12889-024-18932-w>.

Maddah, M., Sharami, S.H. and Karandish, M. (2011) 'Educational difference in the prevalence of osteoporosis in postmenopausal women: a study in northern Iran', *BMC public health*, 11, p. 845. Available at: <https://doi.org/10.1186/1471-2458-11-845>.

Massey, L.K. and Whiting, S.J. (1993) 'Caffeine, urinary calcium, calcium metabolism and bone', *The Journal of Nutrition*, 123(9), pp. 1611–1614. Available at: <https://doi.org/10.1093/jn/123.9.1611>.

Medical Definition of BONE MINERAL DENSITY (2025). Available at: <https://www.merriam-webster.com/medical/bone+mineral+density> (Accessed: 27 April 2025).

Medical Definition of OSTEOPENIA (2025). Available at: <https://www.merriam-webster.com/medical/osteopenia> (Accessed: 27 April 2025).

Mente, A., O'Donnell, M. and Yusuf, S. (2021) 'Sodium Intake and Health: What Should We Recommend Based on the Current Evidence?', *Nutrients*, 13(9), p. 3232. Available at: <https://doi.org/10.3390/nu13093232>.

Mohammadi, S. et al. (2023) 'Prevalence of hypertension in Iran: An updated systematic review and meta-analysis of community-based studies', *Caspian Journal of Internal Medicine*, 14(4), pp. 607–617. Available at: <https://doi.org/10.22088/cjim.14.43.607>.

Muslim, D. et al. (2012) 'Performance of Osteoporosis Self-assessment Tool for Asian (OSTA) for Primary Osteoporosis in Postmenopausal Malay Women', *Malaysian Orthopaedic Journal*, 6(1), pp. 35–39. Available at: <https://doi.org/10.5704/MOJ.1203.011>.

Nair, R.R. et al. (2024) 'Menopausal wellbeing: navigating quality of life and osteoporosis risk', *Frontiers in Public Health*, 12. Available at: <https://doi.org/10.3389/fpubh.2024.1343160>.

NITI Aayog (2023) 'India-National-Multidimensional-Poverty-Index-2023.pdf'. Available at: https://www.niti.gov.in/sites/default/files/2023-07/National_MPI_Progress_Review_2023.pdf.

Oliveira, M.A. de et al. (2022) 'Osteoporosis Screening: Applied Methods and Technological Trends', *Medical Engineering & Physics*, 108, p. 103887. Available at: <https://doi.org/10.1016/j.medengphy.2022.103887>.

van Oostwaard, M. (2018) 'Osteoporosis and the Nature of Fragility Fracture: An Overview', in K. Hertz and J. Santy-Tomlinson (eds) *Fragility Fracture Nursing: Holistic Care and Management of the Orthogeriatric Patient*. Cham (CH): Springer. Available at: <http://www.ncbi.nlm.nih.gov/books/NBK543829/> (Accessed: 24 April 2025).

Osteoporosis - Symptoms and causes (2024) *Mayo Clinic*. Available at: <https://www.mayoclinic.org/diseases-conditions/osteoporosis/symptoms-causes/syc-20351968> (Accessed: 1 November 2024).

Pan, Z.-M. et al. (2024) 'Age-adjusted Charlson comorbidity index is associated with the risk of osteoporosis in older fall-prone men: a retrospective cohort study', *BMC Geriatrics*, 24(1), p. 413. Available at: <https://doi.org/10.1186/s12877-024-05015-z>.

Pareek, R. (2014) 'A Study to Screen the Risk of Osteoporosis in the Population of Pilani, a Semi Urban Town Located in Rajasthan, North India', *International Journal of Science and Research (IJSR)* [Preprint]. Available at: https://www.academia.edu/54764952/A_Study_to_Screen_the_Risk_of_Osteoporosis_in_the_Population_of_Pilani_a_Semi_Urban_Town_Located_in_Rajasthan_North_India (Accessed: 27 October 2024).

Patil, V.S. et al. (2022) 'To Study the Osteoporosis in Pre and Post Menopausal Women', *International Journal of Medical and Biomedical Studies*, 6(2). Available at: <https://doi.org/10.32553/ijmbs.v6i2.2447>.

Paul, T.V. et al. (2008) 'Prevalence of Osteoporosis in Ambulatory Postmenopausal Women from A Semiurban Region in Southern India: Relationship to Calcium Nutrition and Vitamin D Status', *Endocrine Practice*, 14(6), pp. 665–671. Available at: <https://doi.org/10.4158/EP.14.6.665>.

Peker, N. and Tosun, Ö.Ç. (2018) 'Is grand multiparity a risk factor for the development of postmenopausal osteoporosis?', *Clinical Interventions in Aging*, 13, pp. 505–508. Available at: <https://doi.org/10.2147/CIA.S155793>.

Petersen, P.E. (2003) 'World Health Organization: Organisation Mondiale de la Sante', *Community Dentistry and Oral Epidemiology*, 31(6), pp. 471–471. Available at: <https://doi.org/10.1046/j.1600-0528.2003.00124.x>.

Pisani, P. et al. (2016) 'Major osteoporotic fragility fractures: Risk factor updates and societal impact', *World Journal of Orthopedics*, 7(3), pp. 171–181. Available at: <https://doi.org/10.5312/wjo.v7.i3.171>.

Qureshi, P. et al. (2017) 'Study of prevalence of osteoporosis in males of above 40 years age group attending SMS Hospital, Jaipur', *International Journal of Research in Orthopaedics*, 3(4), pp. 837–840. Available at: <https://doi.org/10.18203/issn.2455-4510.IntJResOrthop20172883>.

Rajan, R. et al. (2020) 'Postmenopausal Osteoporosis – An Indian Perspective', *Current Medical Issues*, 18(2), p. 98. Available at: https://doi.org/10.4103/cmi.cmi_5_20.

RAJASTHAN DISTRICT FACTBOOK: UDAIPUR DISTRICT (2018) *RAJASTHAN DISTRICT FACTBOOK: UDAIPUR DISTRICT*. Available at: <https://www.slideshare.net/slideshow/rajasthan-district-factbook-udaipur-district/90622321> (Accessed: 28 April 2025).

Rajasthan Ration Card - Eligibility & Application Process (2020) *IndiaFilings*. Available at: <https://www.indiafilings.com/learn/rajasthan-ration-card/> (Accessed: 8 April 2025).

Rashki Kemmak, A. et al. (2020) 'Economic burden of osteoporosis in the world: A systematic review', *Medical Journal of the Islamic Republic of Iran*, 34, p. 154. Available at: <https://doi.org/10.34171/mjiri.34.154>.

Raveendran, A. et al. (2011) 'Prevalence and related risk factors of osteoporosis in peri- and postmenopausal Indian women', *Journal of Mid-life Health*, 2(2), p. 81.

Reza, G. (2019) (PDF) *Prevalence of osteoporosis and osteopenia in men and premenopausal women with celiac disease: A systematic review*. Available at: https://www.researchgate.net/publication/330944947_Prevalence_of_osteoporosis_and_osteopenia_in_men_and_premenopausal_women_with_celiac_disease_A_systematic_review (Accessed: 29 April 2025).

Sabat, S.K. et al. (2022) 'Prevalence of Osteoporosis in India: A Systematic Review and Meta-analysis', *International journal of health sciences*, 6(S4), pp. 10154–10166. Available at: <https://doi.org/10.53730/ijhs.v6nS4.11033>.

Sagwara Village Population - Rishabhdeo - Udaipur, Rajasthan (2025). Available at: <https://www.census2011.co.in/data/village/107589-sagwara-rajasthan.html> (Accessed: 27 April 2025).

Salari, N. et al. (2021) 'The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis', *Journal of Orthopaedic Surgery and Research*, 16(1), p. 609. Available at: <https://doi.org/10.1186/s13018-021-02772-0>.

Senile Osteoporosis - an overview | ScienceDirect Topics (2003). Available at: https://www.sciencedirect.com/topics/medicine-and-dentistry/senile-osteoporosis?utm_source=chatgpt.com (Accessed: 10 April 2025).

Sharma, B. et al. (2017) 'Osteoporosis in Otherwise Healthy Patients with Type 2 Diabetes: A Prospective Gender Based Comparative Study', *Indian Journal of Endocrinology and Metabolism*, 21(4), p. 535. Available at: https://doi.org/10.4103/ijem.IJEM_108_17.

Shen, Y. et al. (2022) 'The Global Burden of Osteoporosis, Low Bone Mass, and Its Related Fracture in 204 Countries and Territories, 1990-2019', *Frontiers in Endocrinology*, 13. Available at: <https://doi.org/10.3389/fendo.2022.882241>.

Singh, T. et al. (2013) 'Prevalence and Analysis of Risk Factors of Osteoporosis in Persons of Above 40 Years Age Group in Amritsar - A Study of 500 Cases', *Journal of Medical Thesis* [Preprint]. Available at: <https://journalmedicalthesis.com/wp-content/uploads/2013/10/Art-10-JMT-July-Sep-2013.pdf.pdf>.

Sioka, C. et al. (2010) 'Age at menarche, age at menopause and duration of fertility as risk factors for osteoporosis', *Climacteric*, 13(1), pp. 63–71. Available at: <https://doi.org/10.3109/13697130903075337>.

Soni, L. et al. (2024) 'Exploring prevalence and risk factors association of osteoporosis among chronic obstructive pulmonary disease patients: a cross-sectional study in western Rajasthan', *International Journal of Community Medicine and Public Health*, Vol 11(Issue 9), p. 3583. Available at: <https://dx.doi.org/10.18203/2394-6040.ijcmph20242562>.

Sriharsha, G. and Yadav, S. (2025) 'Low Bone Mass and Its Correlation in Systemic Sclerosis', *ResearchGate* [Preprint]. Available at: https://www.researchgate.net/publication/333895703_Low_bone_mass_and_its_correlation_in_systemic_sclerosis (Accessed: 26 April 2025).

Tang, G. et al. (2023) 'Low BMI, blood calcium and vitamin D, kyphosis time, and outdoor activity time are independent risk factors for osteoporosis in postmenopausal women', *Frontiers in Endocrinology*, 14. Available at: <https://doi.org/10.3389/fendo.2023.1154927>.

Templeton, K. (2005) 'Secondary osteoporosis', *The Journal of the American Academy of Orthopaedic Surgeons*, 13(7), pp. 475–486. Available at: <https://doi.org/10.5435/00124635-200511000-00007>.

Terzi, H. et al. (2017) 'Effect of multiparity on bone mineral density, evaluated with bone turnover markers', *Revista Brasileira de Reumatologia*, 57, pp. 371–377. Available at: <https://doi.org/10.1016/j.rbre.2015.09.002>.

Teucher, B. et al. (2008) 'Sodium and bone health: impact of moderately high and low salt intakes on calcium metabolism in postmenopausal women', *Journal of Bone and Mineral Research: The Official Journal of the American Society for Bone and Mineral Research*, 23(9), pp. 1477–1485. Available at: <https://doi.org/10.1359/jbmr.080408>.

Thangappah, R.B.P. et al. (2022a) 'A community-based study to evaluate the prevalence and risk factors for osteoporosis among menopausal and pre-menopausal women', *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, 11(11), pp. 3148–3155. Available at: <https://doi.org/10.18203/2320-1770.ijrcog20222811>.

Thangappah, R.B.P. et al. (2022b) 'A community-based study to evaluate the prevalence and risk factors for osteoporosis among menopausal and pre-menopausal women', *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*, 11(11), pp. 3148–3155. Available at: <https://doi.org/10.18203/2320-1770.ijrcog20222811>.

Thomas, B. et al. (2021) 'A study on prevalence of risk factors for osteoporosis in Postmenopausal women and the importance of Osteoporosis self- assessment tool (OST) in identifying osteoporotic risk', *Journal of Drug Delivery and Therapeutics*, 11, pp. 63–67. Available at: <https://doi.org/10.22270/jddt.v11i2.4595>.

Thulkar, J. et al. (2016) 'Preventable risk factors for osteoporosis in postmenopausal women: Systematic review and meta-analysis', *Journal of Mid-life Health*, 7(3), p. 108. Available at: <https://doi.org/10.4103/0976-7800.191013>.

Tucker, K.L. et al. (2006) 'Colas, but not other carbonated beverages, are associated with low bone mineral density in older women: The Framingham Osteoporosis Study', *The American Journal of Clinical Nutrition*, 84(4), pp. 936–942. Available at: <https://doi.org/10.1093/ajcn/84.4.936>.

Udaipur City Population 2025 | Literacy and Hindu Muslim Population (2025). Available at: <https://www.census2011.co.in/census/city/92-udaipur.html> (Accessed: 5 April 2025).

Udaipur Population, Caste Data Udaipur Rajasthan - Census India (2025) www.censusindia.co.in. Available at: <https://www.censusindia.co.in/towns/udaipur-population-udaipur-rajasthan-800623> (Accessed: 5 April 2025).

Vijayakumar, R. and Büsselberg, D. (2016) 'Osteoporosis: An under-recognized public health problem: Local and global risk factors and its regional and worldwide prevalence', *Journal of Local and Global Health Science*, 2016(1), p. 2. Available at: <https://doi.org/10.5339/jlghs.2016.2>.

Wang, P. et al. (2019) 'Estimation of Prevalence of Osteoporosis Using OSTA and Its Correlation with Sociodemographic Factors, Disability and Comorbidities', *International Journal of Environmental Research and Public Health*, 16. Available at: <https://doi.org/10.3390/ijerph16132338>.

Wotsa, S. and Dunkwal, V. (2022) 'Prevalence and risk factors of low bone mineral density among premenopausal women aged 40 to 45 years of Bikaner'.

Xiao, P.-L. et al. (2022) 'Global, regional prevalence, and risk factors of osteoporosis according to the World Health Organization diagnostic criteria: a systematic review and meta-analysis', *Osteoporosis International*, 33(10), pp. 2137–2153. Available at: <https://doi.org/10.1007/s00198-022-06454-3>.

Xue, Q.-L. (2011) 'The Frailty Syndrome: Definition and Natural History', *Clinics in geriatric medicine*, 27(1), pp. 1–15. Available at: <https://doi.org/10.1016/j.cger.2010.08.009>.

Yuvaraja, S. et al. (2024) 'High Body Fat as a Predictor of Osteoporosis Risk in Postmenopausal Women: Insights From a Community-Based Cross-Sectional Study in Rural South India', *Cureus*, 16(4), p. e59239. Available at: <https://doi.org/10.7759/cureus.59239>.

Zhang, Y.-Y. et al. (2024) 'Insights and implications of sexual dimorphism in osteoporosis', *Bone Research*, 12(1), pp. 1–30. Available at: <https://doi.org/10.1038/s41413-023-00306-4>.

Zhu, K. and Prince, R.L. (2015) 'Lifestyle and Osteoporosis', *Current Osteoporosis Reports*, 13(1), pp. 52–59. Available at: <https://doi.org/10.1007/s11914-014-0248-6>.

Annexure I

Participation information sheet (English)

**Achutha Menon Centre for Health Science Studies,
Sree Chitra Tirunal Institute for Medical Sciences & Technology,
Trivandrum, Kerala, 695011**

Participant Information Sheet

I am Dr Akanksha, currently pursuing Master of Public Health (MPH) at Achutha Menon Centre for Health Science Studies (AMCHSS), Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, Kerala. I am studying **“Estimation of prevalence of osteoporosis risk among postmenopausal women in Udaipur district, Rajasthan”** as a part of my course work.

You are being invited to participate in this research study. Before you decide on whether to participate in this study or not, you must understand why the research is being done and what it will involve. Please read/listen to the information sheet and the consent form carefully and don't hesitate to ask if you have any doubts.

Purpose of the study

Osteoporosis is a health condition that weakens bones, making them fragile and more likely to break. It develops slowly over several years and is often only diagnosed when a fall or sudden impact causes a bone to break (fracture). It is more prevalent in women, with postmenopausal women being particularly affected due to the hormonal changes that accelerate bone loss during this stage. The study aim is to find the estimated prevalence of osteoporosis risk among postmenopausal women in Udaipur district, Rajasthan.

Procedure

If you agree to participate in the study, you will be asked to complete an interview schedule that will include questions focussed on socio-demographic information, medical history related to osteoporosis and lifestyle factors. Additionally, we will use the Osteoporosis screening tools (**Osteoporosis Screening Tools for Asians (OSTA)** and **Osteoporosis Risk Assessment Instrument (ORAI)**), to assess the risk of osteoporosis. The interview will take approximately 30-35 minutes of your valuable time.

Potential risks and Inconveniences

Participating in the study imposes no risk to your health. Although while answering some questions you may feel anxious. Please feel free to skip any questions if they make you feel uncomfortable or anxious.

Possible benefits

Your participation in the study will not give any direct benefit to you now other than knowing your Osteoporosis risk status. However, the findings from the study will help us to understand the burden of Osteoporosis in postmenopausal women.

Cost and financial benefit

There is no cost to participate in this study. Participation is completely voluntary, and no payment will be provided. Similarly, money will not be taken from participants in the study.

Confidentiality

Information obtained in this study will be kept strictly confidential. A participant identification number will be assigned to each participant which will help maintain the strict confidentiality of the data collected. Your name will not be used in any reports for disseminating the findings of the study.

Withdrawal from the study

Your participation in the study will be completely voluntary. You are free and can withdraw at any time during the study. There will be no penalty for withdrawal or not participating in the study.

Contact information

If you have any research-related questions, you may contact me

Dr Akanksha

Principal Investigator

MPH 2023, AMCHSS, SCTIMST

Contact Number: 8295097052

Email: akankshajangra27@gmail.com

Alternatively, the member secretary of our institute's ethics committee at the following address:

Dr Srinivas G

Member Secretary Institutional Ethics Committee

SCTIMST, TRIVANDRUM- 695011

Office: 04712524689

Email: iec.mem.sec@sctimst.ac.in

Annexure II

Participation information sheet (Hindi)

अच्युत मेनन सेंटर फॉर हेल्थ साइंस स्टडीज,

श्री चित्रा तिरुनल इंस्टीट्यूट फॉर मेडिकल साइंसेज एंड टेक्नोलॉजी, त्रिवेंद्रम, केरल, भारत- 695011

प्रतिभागी सूचना पत्र

मेरा नाम डॉ. आकांक्षा है और मैं अभी अच्युता मेनन सेंटर फॉर हेल्थ साइंस स्टडीज (एएमसीएचएसएस), श्री चित्रा तिरुनल इंस्टीट्यूट फॉर मेडिकल साइंसेज एंड टेक्नोलॉजी, त्रिवेंद्रम, केरल में मास्टर ऑफ पब्लिक हेल्थ (एमपीएच) की पढ़ाई कर रही हूँ। अपने कोर्स के हिस्से के रूप में, मैं उदयपुर जिले, राजस्थान में मासिक धर्म बंद होने के बाद महिलाओं में ऑस्टियोपोरोसिस जोखिम के प्रसार का अनुमान लगाने पर अध्ययन कर रही हूँ।

आपको इस शोध में भाग लेने के लिए आमंत्रित किया जा रहा है। इससे पहले कि आप यह तय करें कि इस अध्ययन में भाग लेना है या नहीं, आपको यह समझना चाहिए कि शोध क्यों किया जा रहा है और इसमें क्या शामिल होगा। कृपया जानकारी पत्र और सहमति पत्र ध्यान से पढ़ें या सुनें अगर आपके कोई सवाल हैं, तो बेझिझक पूछें।

अध्ययन का उद्देश्य

ऑस्टियोपोरोसिस एक स्वास्थ्य स्थिति है जिसमें हड्डियाँ कमजोर हो जाती हैं, जिससे वे नाजुक हो जाती हैं और आसानी से टूट सकती हैं। यह धीरे-धीरे कई वर्षों में विकसित होती है और अक्सर इसका पता तब चलता है जब गिरने से या अचानक झटके से हड्डी टूट जाती है। यह स्थिति महिलाओं में अधिक आम है, खासकर मासिक धर्म बंद होने (मेनोपॉज) के बाद की महिलाओं में, क्योंकि इस समय हार्मोन में बदलाव के कारण हड्डियों का क्षरण तेजी से होता है। इस अध्ययन का उद्देश्य राजस्थान के उदयपुर जिले, राजस्थान में मासिक धर्म बंद होने के बाद महिलाओं में ऑस्टियोपोरोसिस जोखिम के प्रसार का अनुमान जानना है।

प्रक्रिया

यदि आप अध्ययन में भाग लेने के लिए सहमत हैं, तो आपसे कुछ प्रश्न पूछे जाएंगे जिनमें सामाजिक-जनसांख्यिकीय जानकारी, ऑस्टियोपोरोसिस से संबंधित चिकित्सा इतिहास और जीवनशैली से संबंधित प्रश्न शामिल होंगे। इसके अलावा, हम ऑस्टियोपोरोसिस स्क्रीनिंग टूल (ऑस्टियोपोरोसिस स्क्रीनिंग टूल फॉर एशियन (OSTA) और ऑस्टियोपोरोसिस रिस्क असेसमेंट इंस्ट्रूमेंट (ORAI)) का उपयोग करके ऑस्टियोपोरोसिस के जोखिम का अनुमान लगाएंगे। इंटरव्यू में आपका बहुमूल्य समय के लगभग 30-35 मिनट लगेंगे।

संभावित जोखिम और असुविधाएँ

अध्ययन में भाग लेने से आपके स्वास्थ्य को कोई जोखिम नहीं है। हालाँकि कुछ प्रश्नों का उत्तर देते समय आप चिंतित महसूस कर सकते हैं। कृपया किसी भी प्रश्न को छोड़ने के लिए स्वतंत्र महसूस करें यदि वे आपको असहज या चिंतित महसूस करते हैं।

संभावित लाभ

अभी के लिए इस अध्ययन में भाग लेने से आपको सीधा कोई लाभ नहीं मिलेगा, सिवाय इसके कि आप अपने ऑस्टियोपोरोसिस जोखिम की स्थिति के बारे में जान सकेंगे। हालाँकि, इस अध्ययन के परिणाम हमें मासिक धर्म बंद होने के बाद महिलाओं में ऑस्टियोपोरोसिस की समस्या को समझने में मदद करेंगे।

लागत और आर्थिक लाभ

इस अध्ययन में भाग लेने का कोई खर्च नहीं है। भागीदारी पूरी तरह से स्वैच्छिक है, और इसके लिए कोई भुगतान नहीं दिया जाएगा। इसी तरह, अध्ययन में भाग लेने वालों से कोई धनराशि नहीं ली जाएगी।

गोपनीयता

इस अध्ययन में प्राप्त जानकारी को पूरी तरह से गोपनीय रखा जाएगा। प्रत्येक प्रतिभागी को एक प्रतिभागी पहचान संख्या सौंपी जाएगी जो एकत्रित किए गए डेटा की सख्त गोपनीयता बनाए रखने में मदद करेगी। अध्ययन के निष्कर्षों को प्रसारित करने के लिए किसी भी रिपोर्ट में आपका नाम इस्तेमाल नहीं किया जाएगा।

अध्ययन से हटने की सहमति

अध्ययन में आपकी भागीदारी पूरी तरह से स्वैच्छिक होगी। आप किसी भी समय अध्ययन के दौरान भाग लेने से समय मना कर सकते हैं। बाहर निकलने या अध्ययन में भाग न लेने के लिए कोई जुरमाना नहीं होगा।

संपर्क जानकारी

अगर आपको अध्ययन से संबंधित कोई सवाल हो, तो आप मुझसे संपर्क कर सकते हैं:

डॉ. अकांक्षा

प्रमुख अनुसंधानकर्ता, MPH 2023, AMCHSS, SCTIMST

संपर्क नंबर: 8295097052, ईमेल: akankshajangra27@gmail.com

वैकल्पिक रूप से, आप हमारे संस्थान के नैतिकता समिति के सदस्य सचिव से निम्नलिखित पते पर संपर्क कर सकते हैं:

डॉ. श्रीनिवास जी

सदस्य सचिव, संस्थागत नैतिकता समिति, SCTIMST, त्रिवेंद्रम- 695011

कार्यालय: 04712524689

ईमेल: iec.mem.sec@sctimst.ac.in



Annexure III

Participation informed consent (English)

INFORMED CONSENT

I _____ have read the previous mentioned information or it has been read to me. I realize that the study will not cause any harm to me, and I have no direct benefits from participating in the study. Also, I understand that my identity/personal information will be kept confidential.

By signing, I confirm my voluntary participation in this study. I agree to be contacted again if any missing information or further clarification is needed. I understand my right to withdraw from the interview at any time without any obligation.

Signature of Participant: _____

Thumb impression of participant (if unable to sign):

Date: / /

If the participant is unable to sign, a witness must sign below:

A literate witness must sign (if possible, this person should be selected by the participant and should have no connection to the research team).

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness: _____

Signature of witness: _____

Date: /

/

Statement by the researcher/person taking consent

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Name of Researcher/person taking the consent _____

Signature of Researcher /person taking the consent _____

Date: / /

Place: _____

Annexure IV

Participation informed consent (Hindi)

सूचित सहमति

मैं _____ पिछली उल्लिखित जानकारी पढ़ चुकी हूँ या यह मुझे पढ़कर सुनाई गई है। मुझे एहसास है कि अध्ययन से मुझे कोई नुकसान नहीं होगा, और अध्ययन में भाग लेने से मुझे कोई प्रत्यक्ष लाभ नहीं है। साथ ही, मैं समझती हूँ कि मेरी व्यक्तिगत पहचान गोपनीय रखी जाएगी।

हस्ताक्षर करके, मैं इस अध्ययन में अपनी स्वैच्छिक भागीदारी की पुष्टि करती हूँ। यदि आगे कोई जानकारी या स्पष्टीकरण की आवश्यकता है तो मैं फिर से संपर्क करने के लिए अनुमति देती हूँ। मैं बिना किसी बाध्यता के किसी भी समय इंटरव्यू से हटने के अपने अधिकार को समझती हूँ।

प्रतिभागी के हस्ताक्षर: _____

प्रतिभागी के अंगूठे का निशान (यदि हस्ताक्षर करने में असमर्थ है):

दिनांक: //

यदि प्रतिभागी हस्ताक्षर करने में असमर्थ है, तो एक गवाह को नीचे हस्ताक्षर करना चाहिए:

एक साक्षर गवाह को हस्ताक्षर करना चाहिए (यदि संभव हो तो, इस व्यक्ति का चयन प्रतिभागी द्वारा किया जाना चाहिए तथा उसका शोध टीम से कोई संबंध नहीं होना चाहिए)।

मैंने संभावित प्रतिभागी को सहमति पत्र को सही ढंग से पढ़ते या सुनते हुए देखा है, और व्यक्ति को प्रश्न पूछने का अवसर मिला है। मैं पुष्टि करता/ करती हूँ कि व्यक्ति ने स्वतंत्र रूप से सहमति दी है।

गवाह का नाम: _____

गवाह के हस्ताक्षर: _____

दिनांक: /

/

शोधकर्ता/सहमति लेने वाले व्यक्ति का कथन

मैं पुष्टि करती हूँ कि प्रतिभागी को अध्ययन के बारे में प्रश्न पूछने का अवसर दिया गया था, और प्रतिभागी द्वारा पूछे गए सभी प्रश्नों का उत्तर सही ढंग से और मेरी सर्वोत्तम क्षमता के अनुसार दिया गया है। मैं पुष्टि करती हूँ कि व्यक्ति को सहमति देने के लिए मजबूर नहीं किया गया है, और सहमति स्वतंत्र रूप से और स्वेच्छा से दी गई है।

शोधकर्ता/सहमति लेने वाले व्यक्ति का नाम _____

शोधकर्ता/सहमति लेने वाले व्यक्ति के हस्ताक्षर _____

दिनांक: / /

स्थान: _____

Annexure V

Additional information sheet (English)

What is Osteoporosis?

Osteoporosis is a disease in which bones become weak. Osteoporotic bones are more likely to fracture (break), mostly at the wrists, hip and spine.

Are women at greater risk of osteoporosis after menopause? Why?

Yes, women are at greater risk of osteoporosis after menopause. Estrogen is a hormone that helps keep bones strong by balancing how quickly old bone breaks down and new bone forms. Throughout life, our bones go through a natural process of being built up and broken down. But when women stop having menstruation and their estrogen levels drop, bone breakdown starts to happen faster than bone building. Besides low estrogen, lower calcium absorption in the gut, more calcium loss in urine, and loss of other protective hormones also harm bone health.

FOUR ESSENTIALS STRATEGIES TO REDUCE OSTEOPOROSIS AND FRACTURE RISK

Your risk of osteoporosis and fragile bones depends on factors you can control, like exercise, nutrition, and smoking, and those you can't, like family history, age at menopause, and certain illnesses. While Inherited traits influence bone strength, after age 65, lifestyle choices like staying active and eating well become crucial. Following four main strategies can help protect your bones and reduce fracture risk.

Strategy 1- EXERCISE REGULARLY

Exercise becomes very important during and after menopause to help keep bones and muscles strong. Strong muscles and good balance lower the chance of falls and fractures. Certain types of exercise, like weight-bearing and resistance exercises, are best for strengthening bones and muscles. While it's hard to increase bone density as we age, these exercises can help.

Aim to exercise 30–40 minutes, 3–4 times a week, with activities that fit your needs, especially if you have osteoporosis or are at a high risk of falling.

Strategy 2- ENSURE A BALANCED DIET RICH IN BONE HEALTHY-NUTRIENTS

A balanced diet that includes adequate calcium, vitamin D, protein, and other bone-healthy nutrients is an important ingredient for good bone health. Below is a list of the key nutrients which contribute to strong and healthy bones and muscles.

Dairy: Milk, curd, and paneer.

Leafy Greens: Methi (fenugreek leaves), spinach, and mustard greens.

Sesame Seeds (Til): Use in winter.

Ragi (Finger Millet)

Egg Yolks: If consumed.

Fish: If consumed, certain types like sardines and mackerel.

Strategy 3- AVOID NEGATIVE LIFESTYLE HABITS AND MAINTAIN A HEALTHY WEIGHT

Avoid Smoking and alcohol intake

Maintaining a healthy weight

Strategy 4- TALK TO YOUR DOCTOR: Get tested & treated if required

If you are at risk of osteoporosis, then you will be recommended to a health care centre for further examination for the detection of osteoporosis.

Source: endocrinesocietyindia.org

Annexure VI

Additional information sheet (Hindi)

अतिरिक्त जानकारी

ओस्टियोपोरोसिस क्या है?

ओस्टियोपोरोसिस एक बीमारी है जिसमें हड्डियाँ कमजोर हो जाती हैं। ओस्टियोपोरोसिस से प्रभावित हड्डियाँ ज्यादा टूटने का खतरा रखती हैं, खासकर कलाई, हिप और रीढ़ की हड्डी में।

क्या महिलाओं को मासिक धर्म बंद होने के बाद ओस्टियोपोरोसिस होने का ज्यादा खतरा होता है? क्यों?

जी हाँ, महिलाओं को मासिक धर्म बंद होने के बाद ओस्टियोपोरोसिस होने का ज्यादा खतरा होता है। एस्ट्रोजन एक हार्मोन है जो हड्डियों को मजबूत रखने में मदद करता है, यह संतुलन बनाता है कि पुरानी हड्डी कितनी जल्दी घटती है और नई हड्डी बनती है और नई हड्डियाँ कितनी जल्दी बनती हैं। जीवन भर हमारी हड्डियाँ, बनने और टूटने की प्रक्रिया से गुजरती हैं। लेकिन जब महिलाओं को मासिक धर्म बंद होता है और उनका एस्ट्रोजन स्तर कम हो जाता है, तो हड्डियाँ घटने की प्रक्रिया निर्माण से तेज़ हो जाती है। कम एस्ट्रोजन के अलावा, आंत में कैल्शियम का कम समावेश, पेशाब में अधिक कैल्शियम की हानि, और अन्य सुरक्षात्मक हार्मोन का नुकसान भी हड्डियों की सेहत को नुकसान पहुँचाता है।

ओस्टियोपोरोसिस और हड्डी टूटने के जोखिम को कम करने के लिए चार आवश्यक रणनीतियाँ

ओस्टियोपोरोसिस और कमजोर हड्डियों का आपका जोखिम उन कारकों पर निर्भर करता है जिन्हें आप नियंत्रित कर सकते हैं (जैसे व्यायाम, पोषण और धूम्रपान) और जिन्हें आप नियंत्रित नहीं कर सकते (जैसे पारिवारिक इतिहास, रजोनिवृत्ति की उम्र और कुछ बीमारियाँ)। जबकि विरासत के गुण हड्डियों की मजबूती को प्रभावित करते हैं, 65 वर्ष की आयु के बाद, सक्रिय रहना और अच्छा खाना जैसे जीवनशैली विकल्प महत्वपूर्ण हो जाते हैं। निम्नलिखित चार मुख्य रणनीतियाँ आपकी हड्डियों की सुरक्षा करने और हड्डी टूटने के जोखिम को कम करने में मदद कर सकती हैं।

रणनीति 1- नियमित रूप से व्यायाम करें

मासिक धर्म के दौरान और उसके बाद हड्डियों और मांसपेशियों को मजबूत रखने में मदद करने के लिए व्यायाम बहुत महत्वपूर्ण हो जाता है। मजबूत मांसपेशियाँ और अच्छा संतुलन गिरने और हड्डी टूटने की संभावना को कम करता है। कुछ प्रकार के व्यायाम, जैसे वजन उठाने वाले और प्रतिरोध व्यायाम, हड्डियों और मांसपेशियों को मजबूत बनाने के लिए सबसे अच्छे हैं। हालाँकि उम्र बढ़ने के साथ हड्डियों का घनत्व बढ़ाना मुश्किल होता है, लेकिन व्यायाम मदद कर सकते हैं।

सप्ताह में 3-4 बार, 30-40 मिनट व्यायाम करने का लक्ष्य रखें, ऐसी गतिविधियों के साथ जो आपकी जरूरतों के हिसाब से हों, खासकर अगर आपको ओस्टियोपोरोसिस है या गिरने का ज्यादा जोखिम है।

रणनीति 2- हड्डियों के लिए स्वस्थ पोषक तत्वों से भरपूर संतुलित आहार सुनिश्चित करें

एक संतुलित आहार जिसमें पर्याप्त कैल्शियम, विटामिन डी, प्रोटीन और अन्य हड्डियों के लिए स्वस्थ पोषक तत्व शामिल हों, यह अच्छी हड्डियों के स्वास्थ्य के लिए एक महत्वपूर्ण घटक है। नीचे उन प्रमुख पोषक तत्वों की सूची दी गई है जो मजबूत और स्वस्थ हड्डियों और मांसपेशियों में योगदान करते हैं।

डेयरी: दूध, दही और पनीर।

पत्तेदार साग: मेथी (मेथी के पत्ते), पालक और सरसों का साग।

तिल: सर्दियों में उपयोग करें।

रागी

अंडे की जर्दी: अगर आप इसे खाते हैं।

मछली: अगर आप सार्डिन और मैकेरल जैसी कुछ खास तरह की मछलियाँ खाते हैं।

रणनीति 3- अस्वस्थ जीवनशैली की आदतों से बचें और स्वस्थ वजन बनाए रखें

धूम्रपान और शराब के सेवन से बचें

स्वस्थ वजन बनाए रखें

रणनीति 4- अपने डॉक्टर से बात करें: यदि आवश्यक हो तो जांच और इलाज करवाएं

यदि आपको ऑस्टियोपोरोसिस का खतरा है, तो फिर आपको हड्डियों की कमजोरी (ऑस्टियोपोरोसिस) की जांच के लिए आगे के परीक्षण हेतु एक स्वास्थ्य केंद्र पर भेजा जाएगा।

स्रोत: endocrinesocietyindia.org

Osteoporosis foundation



Annexure VII

Structured interview schedule (English)

**Achutha Menon Centre for Health Science Studies,
Sree Chitra Tirunal Institute for Medical Sciences & Technology,
Trivandrum, Kerala, 695011**

All information obtained from this interview will remain confidential and will be used for research purposes only. Individual information will not be disclosed to anyone under any circumstances.

Date: __ / __ /2025

Time: __ am/ __ pm

Contact no. _____

Have your menstrual periods stopped for more than 12 months, and if so, was this due to natural causes (not as a result of surgical intervention such as hysterectomy or removal of both ovaries.)? (Continue only if the answer is yes)	☐ Yes ☐ No
---	---

S.no	Section 1- SURVEY INFORMATION
1.1	What is the type of your residential area? ☐ Rural ☐ Urban
1.2	Respondent id

S.no	Section 2- PERSONAL AND SOCIODEMOGRAPHIC INFORMATION
2.1	What is your age? (in completed years as on 1, Jan, 2025) _____ years
2.2	Which religion you belong to? ☐ Hindu ☐ Muslim ☐ Sikh ☐ Christian ☐ Others specify _____ ☐ Prefer not to say
2.3	Which Caste you belong to? ☐ General ☐ OBC ☐ SC ☐ ST
2.4	What is the highest level of Education you have completed? ☐ No formal schooling ☐ Less than primary school ☐ Primary school completed ☐ High school completed

		☐ Senior Secondary school completed ☐ Degree/diploma/ITI completed ☐ Postgraduate and above
2.5	What is number of years of your formal education?	_____years
2.6	Family type	☐ Nuclear ☐ Joint family/extended
2.7	What is your current Marital Status? (Please enter the appropriate answer): If single, go to question no: ---2.10--	☐ Single ☐ Married ☐ Divorced ☐ Separated ☐ Widowed
2.8	Do you have any children? If no, go to question no: ---2.9--	☐ Yes ☐ No
A	How many children do you have?	
B	What was your age at first pregnancy?	_____years
C	Have you ever breastfed a child?	☐ Yes ☐ No
2.9	Have you ever had an abortion? (Spontaneous/MTP)	☐ Yes ☐ No if Yes, specify number _____
2.10	Taking the past year, what is the monthly average earnings of the household?	_____
2.11	Do you have ration card? if no, go to question no: ---2.12--	☐ Yes ☐ No
A	What is the colour of your ration card?	☐ Blue ☐ Green ☐ Dark Pink ☐ Dark green ☐ Yellow
2.12	What is your Mode of payment for healthcare expenses? (Please select all that apply)	☐ PMJAY ☐ ESI ☐ ECHS ☐ State Health insurance Specify _____ ☐ Private Health Insurance Specify _____ ☐ Self-payment ☐ Others specify _____
2.13	What is your current occupation?	☐ Homemaker ☐ Agricultural worker ☐ Office worker

		☐ Self-employed ☐ Labourer ☐ Retired ☐ Other (please specify)
--	--	--

S.no	Section 3 -Medical history information	
3.1	At what age did you experience your first menstrual period (menarche)?	_____ years
3.2	How many years have you been menstruating?	_____ years
3.3	At what age did you reach menopause (the end of your menstrual periods)?	_____ years
3.4	How many years have passed since you reached menopause?	_____ years
3.5	Do you have any of the following gynaecological conditions confirmed by a gynaecologist that may contribute to osteoporosis? (Please select all that apply)	☐ Early menopause (before age 45) ☐ Premature ovarian insufficiency ☐ Menstrual irregularities ☐ Polycystic ovary syndrome (PCOS) ☐ Endometriosis
3.6	Do you have any of the following medical condition confirmed by a physician. (Please select all that apply)	☐ Hypertension ☐ Diabetes (with/without complications) ☐ Stroke ☐ Congestive heart failure ☐ myocardial infarction ☐ Depression and Anxiety ☐ Chronic lung disease ☐ Gastrointestinal Disorders ☐ Chronic Liver Diseases ☐ Chronic Kidney Disease ☐ Cancer ☐ Rheumatoid Arthritis ☐ Hypothyroid ☐ Hyperthyroid ☐ Systemic lupus erythematosus ☐ Other (please specify) _____
3.7	Could you provide a list of all the medications you are currently taking,	☐ _____ ☐ _____

	including their dosages and frequency of use?	☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____
3.8	Are you currently using estrogen therapy? *(ET) is a medical treatment that involves the administration of estrogen hormones to alleviate symptoms associated with hormonal imbalances, particularly during menopause	☐ Yes ☐ No
3.9	Are you taking any dietary supplements.	☐ Calcium ☐ Vit. D ☐ Others (please specify) _____
3.10	Have you ever taken contraceptive pills as a method of family planning? If no, please go to question no: --- 3.11--	☐ Yes ☐ No
A	If you have previously taken contraceptive pills as a method of family planning, please provide the following details	☐ Start year of use _____ ☐ End year of use _____ ☐ Duration of Use _____
3.11	Have any of your close family members (like your mother, father, brother, or sister) experienced weak bones, fractures from small falls, or have been told by a doctor that they have a condition that makes their bones fragile?	☐ Yes ☐ No ☐ Don't know
3.12	Have you experienced any unintentional weight loss of >5 kg in the previous year?	☐ Yes ☐ No ☐ Don't know
3.13	History of fractures For each type (wrist, rib, hip) of non-traumatic fractures after the age of 45 years	☐ No ☐ If yes, specify _____ _____
3.14	How much difficulty in walking from one room to another at the same level	☐ Some ☐ Much ☐ Unable to

3.15	Do you feel less active as compared to most women of your age	☐ Yes ☐ No
------	---	---

S.no	Section 4 -Lifestyle factors			
4.1	Tobacco products			
4.1.1	Do you currently smoke any tobacco products, such as bidis, cigarettes, cigars or pipes, hookah or any other local tobacco products?	☐ Yes ☐ No If, no go to (4.1.6)		
4.1.2	How old were you when you first started smoking?	☐ Age (_____ years) ☐ Don't know		
4.1.3	On average, how many of the following products do you smoke each day/week? (IF LESS THAN DAILY, RECORD WEEKLY)	Products	Daily	Weekly
		Cigarettes		
		Bidi		
		Pipes full of tobacco		
		Cigars, cheroots, cigarillos		
		Shisha sessions		
		Other Specify:		
4.1.4	Do you currently use any smokeless tobacco products such as [snuff, chewing tobacco, tuibu, gutka, betel, Pan masala]?	☐ Yes ☐ No		
4.1.5	On average, how many times a day/week do you use? (IF LESS THAN DAILY, RECORD WEEKLY)	Products	Daily	Weekly
		Tobacco Snuff, by mouth		
		Snuff, by nose		
		Chewing tobacco		
		Betel, quid with tobacco		
		Other Specify:		
4.1.6	During the past 30 days, did someone smoke in your home or closed areas in your workplace?	☐ Yes ☐ No		
4.2	Alcohol Consumption			
4.2.1	Have you ever consumed any alcohol such as beer, wine, whisky spirits or locally prepared alcohol? If, no 4.3	☐ Yes ☐ No		
4.2.2	Have you consumed any alcohol within the past 12 months? If yes, go to 4.2.3	☐ Yes ☐ No		
4.2.3	During the past 12 months, how frequently have you had at least one standard alcoholic drink?	☐ Daily ☐ 5-6 days per week ☐ 3-4 days per week ☐ 1-2 days per week		

		☐ 1-3 days per month ☐ Less than once a month
4.2. 4	During the past 30 days, when you drank alcohol, how many standard drinks on average did you have during one drinking occasion?	☐ _____(number) ☐ Don't know
4.3	Do you consume the following beverages?	
A	Coffee	☐ Never ☐ Occasionally (1-2 times a week) ☐ Regularly (3-6 times a week) ☐ Daily
B	Tea	☐ Never ☐ Occasionally (1-2 times a week) ☐ Regularly (3-6 times a week) ☐ Daily
C	Caffeinated drinks (Energy Drinks, Soft Drinks-e.g. - Coca-Cola, Pepsi)	☐ Never ☐ Occasionally (1-2 times a week) ☐ Regularly (3-6 times a week) ☐ Daily
D	Carbonated drinks	☐ Never ☐ Occasionally (1-2 times a week) ☐ Regularly (3-6 times a week) ☐ Daily
4.4	Sun exposure Number of hours an individual spends in the sun daily	☐ _____/day

4.5	Physical Activity Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. How often do you engage in physical activities such as walking, yoga, or exercise?	
4.5. 1	Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.	
A	During the last 7 days, on how many days did you do vigorous physical activities like	☐ _____ days per week

	heavy lifting, digging, aerobics, or fast bicycling? If no vigorous physical activities -Skip to question 4.5.2	☐ No vigorous physical activities
B	How much time did you usually spend doing vigorous physical activities on one of those days?	☐ _____ hours/day ☐ _____ minutes/day ☐ Don't know/Not sure
4.5.2	Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.	
A	During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. If no moderate physical activities -Skip to question 4.5.3	☐ _____ days/week ☐ No moderate physical activities
B	How much time did you usually spend doing moderate physical activities on one of those days?	☐ _____ hours/day ☐ _____ minutes/day ☐ Don't know/Not sure
4.5.3	Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.	
A	During the last 7 days, on how many days did you walk for at least 10 minutes at a time? If no moderate physical activities -Skip to question 4.5.4	☐ _____ days per week ☐ No walking
B	How much time did you usually spend walking on one of those days?	☐ _____ hours/day ☐ _____ minutes/day ☐ Don't know/Not sure
4.5.4	The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.	
A	During the last 7 days, how much time did you spend sitting on a week day?	☐ _____ hours/day ☐ _____ minutes/day ☐ Don't know/Not sure

4.6	Diet	
4.6.1	What is your diet pattern?	☐ Eats plant-based foods like vegetables, fruits, grains, and legumes ☐ Eats plant-based foods and also consumes dairy products,

		but does not eat meat, fish, or eggs. ☐ Eats plant-based diet and eats eggs but avoids meat, fish, and dairy products. ☐ Eats plant-based foods, eggs, and dairy products, but does not eat meat or fish. ☐ Eats meat, fish, and poultry, along with other foods like vegetables and grains. ☐ Eats fish and seafood, along with other plant-based foods, but does not eat meat or poultry ☐ Eats plant-based foods but occasionally includes meat, fish, or poultry in their meals
4.6.2	Dietary intake of at least 100 Grams (gms) of milk/dairy products OR at least 100 gms fish or 1 egg with yolk for four or more days in the last seven days.	☐ Yes ☐ No
4.6.3	Dietary Salt The following questions are on adding salt to the food right before you eat it, on how food is prepared in your home, on eating processed foods that are high in salt such as pickles, chutneys, and questions on controlling your salt intake.	
A	How often do you add salt or a salty sauce such as soya sauce to your food right before you eat it or as you are eating it?	☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never ☐ Don't know
B	How often do you eat processed food high in salt? By processed food high in salt, I mean foods that have been altered from their natural state, such as packaged salty snacks, canned salty food, salty food prepared at a fast-food restaurant, pickles, chutneys	☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never ☐ Don't know
C	How much salt or salty sauce do you think you consume?	☐ Far too much ☐ Too much ☐ Just the right amount ☐ Too little ☐ Far too little ☐ Don't know

Annexure VIII

Structured interview schedule (Hindi)

राजस्थान के उदयपुर जिले में मासिक धर्म बंद होने के बाद महिलाओं में ऑस्टियोपोरोसिस जोखिम के प्रसार का अनुमान

अच्युता मेनन सेंटर फॉर हेल्थ साइंस स्टडीज,
श्री चित्रा तिरुनल इंस्टीट्यूट फॉर मेडिकल साइंसेज एंड टेक्नोलॉजी, त्रिवेंद्रम, केरल,
695011

इस इंटरव्यू से प्राप्त सभी जानकारी गोपनीय रहेगी और इसका उपयोग केवल शोध उद्देश्यों के लिए किया जाएगा। किसी भी परिस्थिति में व्यक्तिगत जानकारी किसी को नहीं बताई जाएगी।

दिनांक: __/__/2025

समय: __ सुबह/ __ शाम

संपर्क नंबर। _____

क्या आपका मासिक धर्म 12 महीने से अधिक समय से बंद है, और यदि हां, तो क्या यह प्राकृतिक कारणों से हुआ (न कि बच्चेदानी या दोनों अंडाशयों को निकालने जैसे ऑपरेशन की वजह से हुआ)? (यदि उत्तर हां हो तो ही आगे बढ़ें)	☐ हाँ ☐ नहीं
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क्र.सं.	अनुभाग 1- सर्वेक्षण जानकारी
1.1	आपका आवासीय क्षेत्र किस प्रकार का है? ☐ ग्रामीण ☐ शहरी
1.2	उत्तरदाता आईडी ☐☐ ☐☐☐☐☐☐☐

क्र.सं.	अनुभाग 2- व्यक्तिगत और सामाजिक जनसांख्यिकीय जानकारी
2.1	आपकी आयु क्या है? (1 जनवरी, 2025 तक पूर्ण वर्षों में) _____ साल
2.2	आप किस धर्म से सम्बंधित हैं? ☐ हिन्दू ☐ मुसलमान ☐ सिख ☐ ईसाई ☐ अन्य (निर्दिष्ट करें _____) ☐ कहना नहीं चाहते
2.3	आप किस जाति से हैं? ☐ सामान्य ☐ अन्य पिछड़ा वर्ग ☐ अनुसूचित जाति

		☐ अनुसूचित जनजाति ☐ कोई औपचारिक स्कूली शिक्षा नहीं ☐ प्राथमिक विद्यालय से कम ☐ प्राथमिक विद्यालय पूरा हुआ ☐ हाई स्कूल पूरा हुआ ☐ सीनियर सेकेंडरी स्कूल पूरा हुआ ☐ डिग्री/डिप्लोमा/आईटीआई पूर्ण ☐ स्नातकोत्तर और उससे ऊपर
2.4	आपने अब तक कौन सी उच्चतम शिक्षा पूरी की है?	
2.5	आपकी औपचारिक शिक्षा कितने वर्षों की है?	_____ साल
2.6	परिवार का प्रकार	☐ एकल परिवार ☐ संयुक्त परिवार/विस्तारित
2.7	आपकी वर्तमान वैवाहिक स्थिति क्या है? (कृपया उचित उत्तर दर्ज करें): यदि अविवाहित हैं, तो प्रश्न संख्या 2.10 पर जाएं	☐ अविवाहित ☐ विवाहित ☐ तलाकशुदा ☐ अलग हुये ☐ विधवा
2.8	क्या आपके कोई बच्चे हैं? यदि नहीं, तो प्रश्न संख्या 2.9 पर जाएं:	☐ हाँ ☐ नहीं
ए	आपके कितने बच्चे हैं?	_____
बी	पहली गर्भावस्था के समय आपकी उम्र क्या थी?	_____ साल
सी	क्या आपने कभी स्तनपान कराया है?	☐ हाँ ☐ नहीं
2.9	क्या आपको कभी गर्भपात हुआ है? (स्वाभाविक गर्भपात/एमटीपी)	☐ हाँ ☐ नहीं , यदि हां, तो संख्या बताएं _____
2.10	पिछले वर्ष को ध्यान में रखते हुए, परिवार की मासिक औसत आय क्या है?	_____
2.11	क्या आपके पास राशन कार्ड है? यदि नहीं, तो प्रश्न संख्या 2.12 पर जाएं:	☐ हाँ ☐ नहीं
ए	आपके राशन कार्ड का रंग क्या है?	☐ नीला ☐ हरा ☐ गहरा गुलाबी ☐ गहरा हरा ☐ पीला
2.12	स्वास्थ्य देखभाल व्यय के लिए भुगतान का आपका तरीका क्या है? (जो भी लागू होते हैं, उन सभी को चुनें)	☐ पीएमजेएवाई ☐ ईएसआई ☐ ईसीएचएस ☐ राज्य स्वास्थ्य बीमा निर्दिष्ट करें _____ ☐ निजी स्वास्थ्य बीमा निर्दिष्ट करें _____ ☐ आत्म भुगतान ☐ अन्य (निर्दिष्ट करें) _____ _____ _____

2.13	आपका वर्तमान व्यवसाय क्या है?	☐ गृहणी ☐ कृषि कार्यकर्ता ☐ कार्यालय कार्यकर्ता ☐ स्व-रोजगार ☐ मज़दूर ☐ सेवानिवृत्त ☐ अन्य (कृपया निर्दिष्ट करें) _____
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क्र.सं.	धारा 3 - चिकित्सा इतिहास की जानकारी	
3.1	आपको पहली बार मासिक धर्म (मेनार्चे) किस उम्र में हुआ था?	_____ साल
3.2	आपको कितने वर्षों तक मासिक धर्म हुआ?	_____ साल
3.3	आपकी मासिक धर्म की अवधि कब खत्म हुई थी?	_____ साल
3.4	आपका मासिक धर्म बंद हुए कितने साल हो गए हैं?	_____ साल
3.5	क्या आपको निम्नलिखित में से कोई भी स्त्री रोग संबंधी स्थिति है जिसकी पुष्टि स्त्री रोग विशेषज्ञ द्वारा की गई है और जो ऑस्टियोपोरोसिस में योगदान दे सकती है? (कृपया सभी लागू होने वाले का चयन करें)	☐ शीघ्र रजोनिवृत्ति (45 वर्ष की आयु से पहले) ☐ अंडाशय की अपर्याप्तता ☐ मासिक धर्म संबंधी अनियमितताएं ☐ पॉलीसिस्टिक ओवरी सिंड्रोम (पीसीओएस) ☐ एंडोमेट्रियोसिस
3.6	क्या आपको निम्नलिखित में से कोई ऐसी रोग की स्थिति है जिसकी पुष्टि किसी चिकित्सक द्वारा की गई हो? (जो भी लागू होते हैं, उन सभी को चुनें)	☐ उच्च रक्तचाप ☐ मधुमेह (जटिलताओं के साथ/बिना) ☐ स्ट्रोक ☐ हृदय संबंधी विफलता ☐ दिल का दौरा ☐ अवसाद और चिंता ☐ पुरानी फेफड़ों की बीमारी ☐ पाचन तंत्र की समस्याएं ☐ पुरानी जिगर की बीमारियां ☐ पुरानी किडनी की बीमारी ☐ कैंसर ☐ रूमेटाइड गठिया ☐ हाइपोथायराइड ☐ हाइपरथायराइड ☐ सिस्टेमिक ल्यूपस एरिथेमेटोसस ☐ अन्य (कृपया निर्दिष्ट करें) _____
3.7	क्या आप उन सभी दवाओं की सूची दे सकते हैं जो आप वर्तमान में ले रहे हैं, जिसमें उनकी	☐ _____ ☐ _____ ☐ _____

	खुराक और कितनी बार उपयोग होता है शामिल करें?	☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____
3.8	क्या आप वर्तमान में एस्ट्रोजन थेरेपी का उपयोग कर रहे हैं? *(ET) एक चिकित्सा उपचार है जिसमें हार्मोनल असंतुलन से जुड़े लक्षणों को कम करने के लिए एस्ट्रोजन हार्मोन का प्रशासन शामिल है, विशेष रूप से रजोनिवृत्ति के दौरान	☐ हाँ ☐ नहीं
3.9	क्या आप कोई आहार सप्लीमेंट ले रहे हैं?	☐ कैल्शियम ☐ विटामिन डी ☐ अन्य, कृपया निर्दिष्ट करें) _____
3.10	क्या आपने कभी परिवार नियोजन के तरीके के रूप में गर्भनिरोधक गोलियाँ ली हैं? यदि नहीं, तो कृपया प्रश्न संख्या 3.11 पर जाएँ :	☐ हाँ ☐ नहीं
ए	यदि आपने पहले भी परिवार नियोजन के तरीके के रूप में गर्भनिरोधक गोलियाँ ली हैं, तो कृपया निम्नलिखित विवरण प्रदान करें	☐ उपयोग का प्रारंभिक वर्ष _____ ☐ उपयोग का अंतिम वर्ष _____ ☐ उपयोग की अवधि _____
3.11	क्या आपके निकट संबंधी (जैसे आपकी माँ, पिता, भाई या बहन) को कभी कमजोर हड्डियों, हल्की चोट से फ्रैक्चर, या डॉक्टर द्वारा यह बताया गया है कि उनकी हड्डियाँ नाजुक हैं?	☐ हाँ ☐ नहीं ☐ पता नहीं
3.12	क्या आपने पिछले वर्ष अनजाने में 5 किलोग्राम से अधिक वजन कम होने का अनुभव किया है?	☐ हाँ ☐ नहीं ☐ पता नहीं
3.13	फ्रैक्चर का इतिहास 45 वर्ष की आयु के बाद प्रत्येक प्रकार (कलाई, पसली, कूल्हे) के गैर-आघातजन्य फ्रैक्चर के लिए	☐ नहीं ☐ यदि हां, तो बताएं _____ _____ _____
3.14	एक ही स्तर पर एक कमरे से दूसरे कमरे तक चलने में कितनी कठिनाई होती है	☐ कुछ ☐ अधिकता ☐ करने में असमर्थ
3.15	क्या आप अपनी उम्र की अधिकांश महिलाओं की तुलना में कम सक्रिय महसूस करती हैं?	☐ हाँ ☐ नहीं

क्र.सं.	धारा 4 - जीवनशैली कारक
4.1	तम्बाकू उत्पाद

4.1.1	क्या आप वर्तमान में कोई तम्बाकू उत्पाद, जैसे बीड़ी, सिगरेट, सिगार या पाइप, हुक्का या कोई अन्य स्थानीय तम्बाकू उत्पाद पीते हैं?	☐ हाँ ☐ नहीं , अगर नहीं तो प्रश्न नंबर (4.1.6) पर जाएं		
4.1.2	आप कितने साल के थे जब आपने पहली बार धूम्रपान करना शुरू किया था?	☐ उम्र (_____ साल) ☐ पता नहीं		
4.1.3	औसतन, आप निम्नलिखित में से कितने उत्पादों का सेवन प्रतिदिन/सप्ताह करते हैं? (यदि प्रतिदिन से कम है, तो साप्ताहिक रिकॉर्ड करें)	उत्पादों	दैनिक	साप्ताहिक
		सिगरेट		
		बीड़ी		
		तम्बाकू से भरे पाइप		
		सिगार, सिगारूत, सिगारिलोस		
		शीशा सत्र		
		अन्य निर्दिष्ट करें:		
4.1.4	क्या आप वर्तमान में किसी धूम्ररहित तम्बाकू उत्पाद जैसे [नसवार, चबाने वाला तम्बाकू, तुईबू, गुटका, पान, पान मसाला] का उपयोग करते हैं?	☐ हाँ ☐ नहीं		
4.1.5	औसतन, आप दिन/सप्ताह में कितनी बार इसका उपयोग करते हैं? (यदि प्रतिदिन से कम है, तो साप्ताहिक रिकॉर्ड करें)	उत्पादों	दैनिक	साप्ताहिक
		तम्बाकू सूंघना, मुंह से		
		नाक से सूंघना		
		चबाने वाला तंबाकू		
		पान, तम्बाकू के साथ किड		
		अन्य निर्दिष्ट करें:		
4.1.6	पिछले 30 दिनों के दौरान क्या किसी ने आपके घर या ऑफिस में कोई बंद क्षेत्र में किसी ने धूम्रपान किया?	☐ हाँ ☐ नहीं		
4.2	शराब का सेवन			
4.2.1	क्या आपने कभी कोई शराब जैसे बीयर, वाइन, व्हिस्की स्पिरिट या स्थानीय रूप से तैयार शराब का सेवन किया है? अगर नहीं तो प्रश्न नंबर (4.3) पर जाएं	☐ हाँ ☐ नहीं		
4.2.2	क्या आपने पिछले 12 महीनों में शराब का सेवन किया है? यदि हाँ, तो प्रश्न नंबर 4.2.3 पर जाएं	☐ हाँ ☐ नहीं		
4.2.3	पिछले 12 महीनों के दौरान, आपने कितनी बार कम से कम एक बार मानक मदिरापान किया है?	☐ दैनिक ☐ प्रति सप्ताह 5-6 दिन ☐ प्रति सप्ताह 3-4 दिन ☐ प्रति सप्ताह 1-2 दिन ☐ प्रति माह 1-3 दिन ☐ महीने में एक बार से भी कम		
4.2.4	पिछले 30 दिनों के दौरान, जब भी आपने शराब पी, तो एक बार में आपने औसतन कितने मानक पेय पिए?	☐ _____ (नंबर) ☐ पता नहीं		
4.3	क्या आप निम्नलिखित पेय पदार्थों का सेवन करते हैं?			
ए	कॉफी	☐ कभी नहीं		

		☐ कभी-कभी (सप्ताह में 1-2 बार) ☐ नियमित रूप से (सप्ताह में 3-6 बार) ☐ दैनिक _____
बी	चाय	☐ कभी नहीं ☐ कभी-कभी (सप्ताह में 1-2 बार) ☐ नियमित रूप से (सप्ताह में 3-6 बार) ☐ दैनिक _____
सी	कैफीनयुक्त पेय (ऊर्जा पेय, ठंडा - जैसे - कोका-कोला, पेप्सी)	☐ कभी नहीं ☐ कभी-कभी (सप्ताह में 1-2 बार) ☐ नियमित रूप से (सप्ताह में 3-6 बार) ☐ दैनिक _____
डी	कार्बोनेटेड पेय	☐ कभी नहीं ☐ कभी-कभी (सप्ताह में 1-2 बार) ☐ नियमित रूप से (सप्ताह में 3-6 बार) ☐ दैनिक _____
4.4	सूर्य के संपर्क में एक व्यक्ति द्वारा प्रतिदिन धूप में बिताए जाने वाले घंटों की संख्या	☐ _____/दिन

4.5	शारीरिक गतिविधि कृपया उन गतिविधियों के बारे में सोचें जो आप काम पर, घर और यार्ड के काम के हिस्से के रूप में, एक जगह से दूसरी जगह जाने के लिए, और अपने खाली समय में मनोरंजन, व्यायाम या खेल के लिए करते हैं। आप कितनी बार शारीरिक गतिविधियाँ जैसे कि टहलना, योग या व्यायाम करते हैं?	
4.5.1	पिछले 7 दिनों में आपने जो भी जोरदार गतिविधियाँ की हैं, उनके बारे में सोचें। जोरदार शारीरिक गतिविधियाँ उन गतिविधियों को संदर्भित करती हैं जिनमें कठोर शारीरिक प्रयास की आवश्यकता होती है और आपको सामान्य से कहीं ज्यादा साँस लेने में कठिनाई होती है। केवल उन शारीरिक गतिविधियों के बारे में सोचें जिन्हें आपने एक बार में कम से कम 10 मिनट तक किया था।	
ए	पिछले 7 दिनों में, आपने कितने दिन भारी वजन उठाना, खुदाई करना, एरोबिक्स या तेज़ साइकिल चलाना जैसी जोरदार शारीरिक गतिविधियाँ कीं? अगर कोई जोरदार शारीरिक गतिविधि नहीं की - प्रश्न 4.5.2 पर जाएँ	☐ प्रति सप्ताह ____ दिन ☐ कोई भी जोरदार शारीरिक गतिविधि नहीं करी
बी	आप आमतौर पर उन दिनों में से किसी एक दिन में कितना समय जोरदार शारीरिक गतिविधियों में बिताते थे?	☐ ____ घंटे/दिन ☐ ____ मिनट/दिन ☐ पता नहीं/निश्चित नहीं
4.5.2	पिछले 7 दिनों में आपने जो भी मध्यम गतिविधियाँ की हैं, उनके बारे में सोचें। मध्यम गतिविधियाँ उन गतिविधियों को संदर्भित करती हैं जिनमें मध्यम शारीरिक प्रयास की आवश्यकता होती है और आपको सामान्य से कुछ ज्यादा ही साँस लेने में कठिनाई होती है। केवल उन शारीरिक गतिविधियों के बारे में सोचें जिन्हें आपने एक बार में कम से कम 10 मिनट तक किया हो।	
ए	पिछले 7 दिनों में, आपने कितने दिन मध्यम शारीरिक गतिविधियाँ कीं जैसे हल्का भार उठाना, नियमित गति से साइकिल चलाना, या डबल्स टेनिस? इसमें पैदल चलना शामिल नहीं है। यदि कोई मध्यम शारीरिक गतिविधि नहीं की गई है - प्रश्न 4.5.3 पर जाएँ	☐ ____ दिन/सप्ताह ☐ कोई मध्यम शारीरिक गतिविधि न करें
बी	आप आमतौर पर उन दिनों में से किसी एक दिन मध्यम शारीरिक गतिविधियों में कितना समय व्यतीत करते थे?	☐ ____ घंटे/दिन ☐ ____ मिनट/दिन ☐ पता नहीं/निश्चित नहीं

4.5.3	पिछले 7 दिनों में आपने पैदल चलने में जो समय बिताया है, उसके बारे में सोचें। इसमें काम और घर पर, एक जगह से दूसरी जगह जाने के लिए पैदल चलना और कोई भी अन्य पैदल चलना शामिल है जो आपने केवल मनोरंजन, खेल, व्यायाम या अवकाश के लिए किया है।	
ए	पिछले 7 दिनों में, आपने कितने दिनों में कम से कम 10 मिनट तक पैदल चले? यदि कोई मध्यम शारीरिक गतिविधि नहीं की - प्रश्न 4.5.4 पर जाएँ	☐ प्रति सप्ताह ____ दिन ☐ पैदल नहीं चले
बी	आप आमतौर पर उन दिनों में से किसी एक दिन पैदल चलने में कितना समय बिताते थे?	☐ ____ घंटे/दिन ☐ ____ मिनट/दिन ☐ पता नहीं/निश्चित नहीं
4.5.4	आखिरी सवाल पिछले 7 दिनों में सप्ताह के दिनों में आपके द्वारा बैठे-बैठे बिताए गए समय के बारे में है। काम पर, घर पर, कोर्स वर्क करते समय और फुर्सत के समय में बिताए गए समय को शामिल करें। इसमें डेस्क पर बैठकर, दोस्तों से मिलने, पढ़ने, या बैठकर या लेटकर टीवी देखने में बिताया गया समय शामिल हो सकता है।	
ए	पिछले 7 दिनों के दौरान, आपने सप्ताह के किसी भी दिन बैठे हुए कितना समय बिताया?	☐ ____ घंटे/दिन ☐ ____ मिनट/दिन ☐ पता नहीं/निश्चित नहीं

4.6	आहार	
4.6.1	आपका आहार पैटर्न क्या है?	☐ शाकाहारी खाद्य पदार्थ जैसे सब्जियाँ, फल, अनाज, और दालें खाते हैं। ☐ शाकाहारी आहार और डेयरी उत्पाद खाते हैं, मांस, मछली या अंडे नहीं खाते। ☐ शाकाहारी आहार और अंडे खाते हैं, मांस, मछली और डेयरी से बचते हैं। ☐ शाकाहारी आहार, अंडे और डेयरी खाते हैं, मांस या मछली नहीं खाते। ☐ मांस, मछली और मुर्गी खाते हैं, साथ ही सब्जियाँ और अनाज भी। ☐ मछली और समुद्री भोजन खाते हैं, मांस या मुर्गी नहीं खाते। ☐ शाकाहारी खाद्य पदार्थ खाते हैं, लेकिन कभी-कभी मांस, मछली या मुर्गी खाते हैं।
4.6.2	क्या आपने पिछले सात दिनों में चार या अधिक दिनों तक कम से कम 100 ग्राम दूध/डेयरी उत्पादों का सेवन या कम से कम 100 ग्राम मछली या एक अंडे की जर्दी का सेवन किया है?	☐ हाँ ☐ नहीं
4.6.3	भोजन भोजन में नमक डालने के बारे में हैं, भोजन करने से ठीक पहले, आपके घर में भोजन कैसे तैयार किया जाता है, अचार, चटनी जैसे ज्यादा नमक वाले प्रसंस्कृत खाद्य पदार्थ खाने के बारे में, तथा नमक के सेवन को नियंत्रित करने के बारे में हैं।	
ए	आप कितनी बार भोजन करने से ठीक पहले या खाते समय उसमें नमक या सोया सॉस जैसी नमकीन चटनी डालते हैं?	☐ हर समय ☐ अक्सर ☐ कभी-कभी ☐ बहुत कम ☐ कभी नहीं ☐ पता नहीं
बी	आप कितनी बार नमक से भरपूर प्रोसेस्ड खाना खाते हैं? नमक से भरपूर प्रोसेस्ड खाने से	☐ हर समय ☐ अक्सर

5.3	कमर की परिधि सीधे खड़े होकर, सामान्य रूप से सांस छोड़ें, पसलियों और कूल्हे के बीच मध्य पर टेप लगाएं	____ सेमी
5.4	कूल्हे की परिधि सीधे खड़े होकर, कूल्हों/नितंबों के सबसे चौड़े हिस्से के चारों ओर टेप लगाएं	____ सेमी
5.5	हाथ की पकड़ की शक्ति (दोनों हाथ) बैठे हुए, कोहनी 90° पर मुड़ी हुई	(एल)____ किग्रा (आर)____ किग्रा
5.6	चलने की गति सामान्य गति से 15 फीट चलने का समय (दो रीडिंग में से तेज़)	____ सेकंड

Annexure IX

IEC clearance certificate



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
Thiruvananthapuram - 695 011, Kerala, India
(An Institute of National Importance under Govt. of India)
Grams : Chitramet, Phone : +91-471-2443152, Fax : +91-471-2550728/2446433, E-mail : sct@sctimst.ac.in, Website : www.sctimst.ac.in

Institutional Ethics Committee
CDSO Registration No: ECR/189/Inst/KL/2013/RR-24
DHR Registration No:EC/NEW/INST/2022/2775

SCT/IEC/2337/DECEMBER/2024

17.01.2025

Dr. Akanksha
MPH Student, AMCHSS
SCTIMST, Thiruvananthapuram

Dear Dr. Akanksha,

The Institutional Ethics Committee held on 30th December, 2024, reviewed and discussed your application to conduct the study titled "ESTIMATION OF PREVALENCE OF OSTEOPOROSIS RISK AMONG POSTMENOPAUSAL WOMEN IN UDAIPUR DISTRICT, RAJASTHAN" (IEC /2337) .

Principal Investigator	Dr. Akanksha, MPH Student, AMCHSS, SCTIMST
Co-Principal Investigator(s)	Dr. Srikanth A, Associate Professor, AMCHSS, SCTIMST
Duration of the study	6 months

The following members of the Ethics Committee were present at the meeting held on 30th December, 2024

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Dr. Manoj Murhekar	MD (Preventive & Social Medicine)	Male	Social Scientist	No
2.	Dr. Annapurna.Y	MD	Female	Basic Medical Scientist	No
3.	Adv. Priya Kaimal	LLM, MBL	Female	Legal Expert	No
4.	Dr. Indu PV	MBBS, DPM, MPhil, PhD	Female	Clinician	No
5.	Dr. Rejnish Kumar	MBBS,MD ,DNB	Male	Clinician	No
6.	Smt. Rekha Radhakrishnan	M.A (Eng.); B.Ed	Female	Lay person	No
7.	Dr. Biju Soman	MBBS,MD, DPH, MSc, DLSHTM	Male	Basic Medical Scientist	Yes
8.	Dr. Syam K	MBBS, MD, DM	Male	Clinician	Yes
9.	Dr. Srinivas G	PhD	Male	Basic Medical Scientist (Member Secretary)	Yes

1

SCT/IEC/2337/DECEMBER-2024

The following documents were reviewed:Original submission

1. IEC Application Form
2. Permission letters
3. Funding details and Budget
4. Covering letter addressed to the Chairperson, IEC, SCTIMST dated 07.12.2024 forwarded by HOD
5. Interview schedule in English and Malayalam
6. Informed Consent Form in English and Malayalam
7. Participant Information Sheet in English and v
8. Permission letter
9. Checklist Form
10. Proposal
11. Declaration Form
12. CV of PI and Co-PI

Revised submission

1. Covering letter addressed to the Member Secretary, IEC, SCTIMST dated 12.01.2025 with response to IEC comments
2. IEC Recommendation letter dated 09.01.2025
3. Proposal
4. Participant Information Sheets in English and Hindi
5. Informed Consent Forms in English and Hindi
6. Interview schedule in English and Hindi

IEC Decision

The IEC approved the conduct of the study in the present form.

Remarks:

The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team / Guide who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Sincerely,



Dr. G. Srinivas
Member Secretary, IEC

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE (IEC)
SCTIMST, THIRUVANANTHAPURAM



Annexure X

Permission letter from CMHO

कार्यालय मुख्य चिकित्सा एवं स्वास्थ्य अधिकारी उदयपुर राजः
 क्रमांक :- सामान्य/चि0प्र0/2024/ 6 206 दिनांक 11-11-24

डॉ०आकाक्षा
 एम०पी०एच०
 कोड न० 50338
 श्री चित्रा तिरुनाल आयुर्विज्ञान ओर प्रोद्योगिकी संस्थान
 तिरुवनन्तपुरम -11

विषय:- जिले मे 45 वर्ष से अधिक उम्र की महिलाओ की osteoporosis सर्वे के कम मे
 संदर्भ:- विभागाध्यक्ष श्री चित्रा तिरुनाल आयुर्विज्ञान ओर प्रोद्योगिकी संस्थान
 तिरुवनन्तपुरम का पत्र क्रमांक 67/2024 दिनांक 28/10/2024

उपरोक्त विषयान्तर्गत एवं संदर्भित पत्र के कम मे लेख है कि श्री चित्रा तिरुनाल आयुर्विज्ञान ओर प्रोद्योगिकी संस्थान तिरुवनन्तपुरम के द्वारा प्राप्त पत्र मे वर्णित एम०पी०एच० कोर्स के लिए Estimation of prevalence of osteoporosis risk among post menopausal women in Udaipur distt. rajasthan की स्टेडी के लिए जिले मे 45 वर्ष से अधिक उम्र की महिलाओ का सर्वे एवं साक्षात्कार के लिए आपको निम्न शर्तों के साथ दिनांक 1 जनवरी 2025 से दिनांक 28 फरवरी 2025 तक स्वीकृती प्रदान की जाती है ।

1. आप द्वारा 45 वर्ष से अधिक उम्र की महिलाओ के सर्वे के कम मे किसी भी महिला से किसी भी प्रकार का शुल्क प्राप्त नहीं करेगी एवं नहीं किसी प्रकार की सलाह प्रदान करेगी एवं नहीं आप किसी चिकित्सा संस्थान अथवा चिकित्सक का प्रचार -प्रसार करेगी ।
2. आप द्वारा 45 वर्ष से अधिक उम्र की महिलाओ के सर्वे के कम मे किसी भी महिला से वार्ता करने पर यदि वह स्वेच्छा से अपना साक्षात्कार देना चाहे तभी आप ले पायगे किसी भी महिला को साक्षात्कार देने हेतु आप बाध्य नहीं करेगे ।
3. आप द्वारा 45 वर्ष से अधिक उम्र की महिलाओ के सर्वे के कम मे किसी भी महिला से वार्ता करते समय किसी भी प्रकार की पारिवारिक निजी जानकारी प्राप्त नहीं करेगी जेसे बैंक खाता संख्या /आधार सख्यां या पारिवारिक निजी जानकारी ।
4. उपरोक्त सर्वे हेतु आपको किसी भी प्रकार का मानदेय इस कार्यालय से देय नहीं होगा
5. उपरोक्त सर्वे की किसी भी प्रकार का प्रमाणीकरण अधो-हस्ताक्षर कर्ता द्वारा नहीं किया जावेगा ।

NO 6206
 11-11-24

मुख्य चिकित्सा एवं स्वास्थ्य अधिकारी
 उदयपुर राजः

प्रतिलिपि सूचनार्थ एवं आवश्यक कार्यवाही हेतु।

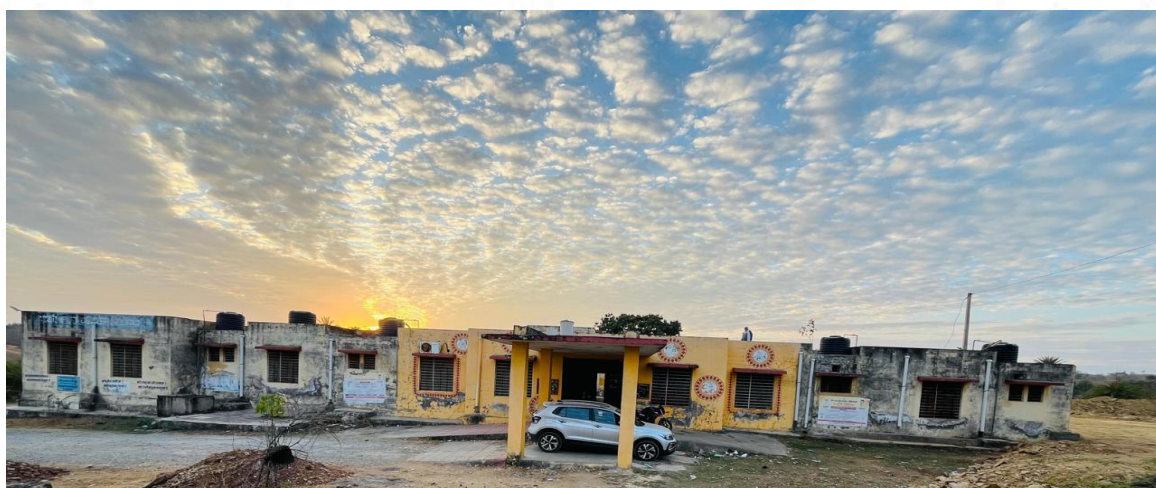
1. प्रोफेसर एवं विभागाध्यक्ष श्री चित्रा तिरुनाल आयुर्विज्ञान ओर प्रोद्योगिकी संस्थान तिरुवनन्तपुरम
2. समस्त खण्ड मुख्य चिकित्सा अधिकारी उदयपुर

मुख्य चिकित्सा एवं स्वास्थ्य अधिकारी
 उदयपुर राजः

Annexure XI

Photographs





Annexure XII

Plagiarism report

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