



Cross-Sectional Study on the Correlation between Reproductive History and Risk of Hip Fractures in Older Women

Gauri Rani¹, Avinash Kumar²

¹Senior Resident, Department of Obst & Gynaecology, MGM Medical College and LSK Hospital Kishanganj Bihar

²Senior Resident, Department of Orthopaedic, MGM Medical College and LSK Hospital Kishanganj Bihar

Corresponding Author: Dr. Avinash Kumar

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Abstract

Background: Hip fractures in older women are a major public health issue due to their morbidity, mortality, and healthcare costs. Based on reproductive history, such as menarche age, number of pregnancies, breastfeeding time, and menopausal state, hormones may alter bone health and fracture risk. Understanding these linkages is essential for targeted prevention.

Method: This cross-sectional study conducted from April 2020 to March 2021, chosen 100 women, 65yrs and older from Kishanganj's MGM Medical College and LSK Hospital. Participants' demographics, reproductive history, and bone health factors were assessed. Data was collected using medical records from Kishanganj's MGM Medical College and LSK Hospital to assess bone mineral density. The statistical study used descriptive statistics and logistic regression to assess reproductive history factors and hip fracture risk.

Results: The demographic data showed that all participants were postmenopausal and had an average age of 72.4 years (± 5.3). Multiple pregnancies (>3) increased hip fracture risk (OR: 1.25, 95% CI: 1.01-1.55, $P=0.04$), but early menarche (<12 years) significantly reduced risk (OR: 0.65, 95% CI: 0.45-0.95, $P=0.03$). Long-term nursing (>24 months) increased fracture risk (OR: 1.30, 95% CI: 1.05-1.61, $P=0.02$). Late menopause (>52 years) and hormone replacement treatment were associated with a non-significant lower fracture rate (OR: 0.72, $P=0.08$ and OR:0.70, $P=0.07$).

Conclusion: This study found that reproductive history significantly affects hip fracture risk in older women. Early menarche reduces fracture risk, whereas many pregnancies and prolonged lactation increase it. These findings emphasise the need for personalised fracture prevention in older women and the importance of reproductive factors in bone health management strategies.

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Introduction

Hip fractures in older women are a major public health issue due to their prevalence and severity [1]. Elderly hip fractures are more common, thus more people will get wounded and spend more for care. Hip fractures can lead to infections, thromboembolic events, and extended hospital stays, as well as loss of independence and quality of life [2]. Additionally, older women had greater hip fractures than men. This is because osteoporosis, which weakens bones, is more common among women. Hip fractures affect families, healthcare systems, and indi-

vidual health [3]. Medical, surgical, and rehabilitative personnel must collaborate to finish the lengthy and resource-intensive rehabilitation process. Despite surgical and pharmacological advances, fracture-related mortality rates remain alarmingly high at 20%–30% in the first year [4]. Understanding what increases the risk of hip fracture in older women is the only way to prevent it, improve patient outcomes, and reduce societal burden. This susceptible population could benefit from targeted hip fracture therapies by identifying modifiable repro-



ductive history risk variables. This type of study can also improve women's health by revealing how reproduction

factors affect bone health as women age.

Hip Fracture

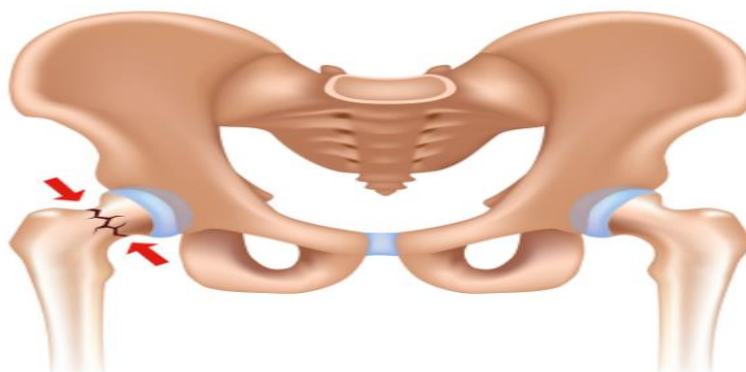


Figure 1: Hip Fracture (Source: [5])

Influence of Reproductive History on Hip Fracture Risk

A woman's reproductive history comprises her menstrual and menopausal ages, parity, breastfeeding frequency, and hormone replacement treatment use. Oestrogen maintains bone density, and when it drops during menopause, bone loss accelerates. Osteoporosis and fractures may be more likely in women with earlier menopause or longer amenorrhoea. Bone health, parity, and nursing are intricately linked. Some studies have found mixed outcomes on high parity and bone health. Longer pregnancies create more oestrogen, which may protect. However, pregnancy and lactation calcium needs may induce temporary bone loss. This study examines the relationship between reproductive history and hip fracture risk to identify reproductive characteristics that can guide risk assessment and prevention for older women.

Objective

- To examine the relationship between reproductive history and hip fracture risk in older women, including menarche age, number of pregnancies, breastfeeding length, and menopause age.
- To discover which reproductive characteristics significantly affect hip fracture risk.
- To help create population-specific hip fracture prevention and intervention plans.

Hip fractures and reproductive history

Hip fractures, which are more common in women and can be catastrophic, are a key concern in geriatric medicine [6]. Multiple studies have examined hip fracture epidemiology, risk factors, and outcomes. A significant study by [7] identified age, low body weight, and fracture history as risk factors for hip fractures in older women. This study showed how hormonal fluctuations affect bone health by highlighting estrogen's protective role in bone density. Several studies have examined how reproductive history impacts bone health and fracture risk. During early menarche and late menopause, extended exposure to endogenous oestrogens lowers fracture risk and raises BMD. [8] found that women who menarched before 12 had a decreased risk of hip fractures. Bone loss and fractures were also reduced by a longer reproductive period after menopause. The effects of pregnancy and lactation on mothers' bone health have been extensively studied [9]. Oestrogen and other hormones may increase bone density during pregnancy. The greater calcium needs for foetal development and lactation have been linked to temporary bone loss following multiple pregnancies and long breastfeeding [10]. [11] found that women with multiple pregnancies may have a higher risk of hip fractures, albeit the effect was usually temporary and bone density rebounded after weaning. If nursing lasts too long, some bone loss can occur. Long-term effects on hip fracture risk are unknown. Breastfeeding may temporarily lower bone density, but [12] found no long-term risk of hip fractures.



Gap in Research

Hip fractures and reproductive history have been extensively studied, yet numerous uncertainties and contradictions remain. Although estrogen's preventative benefits have been thoroughly explored, the exact ways reproductive history factors affect hip fracture risk are unknown. Even while early menarche and late menopause are linked to enhanced BMD and lower fracture risk, intermediate factors including irregular menstrual cycles and hormone treatments haven't been extensively studied.

It is unclear how many pregnancies and how long a woman breastfeeds increase her hip fracture risk. To clarify this disparity and account for multiple reproductive occurrences, longitudinal bone health studies are needed.

Methodology

Study Design

This cross-sectional study examines reproductive history and hip fracture risk in elderly women. To identify relationships and frequencies at a certain time, use a cross-sectional study. It allows the study of reproductive history factors and hip fracture risk without long-term follow-up. This strategy is ideal for generating longitudinal research ideas.

Setting

The MGM Medical College and LSK Hospital in Kishanganj conducted research. Due to its diverse patient population, this tertiary care hospital is ideal for examining reproductive history and hip fractures in elderly women. The hospital's substantial medical records and patient databases made gathering medical and reproductive histories for this inquiry easier.

Inclusion Criteria

- Women aged 65 years and older.
- Patients who presented with a hip fracture confirmed by radiographic evidence.
- Willingness to participate in the study and provide informed consent.

Exclusion Criteria

- Women with a history of high-energy trauma causing hip fractures (e.g., motor vehicle accidents).
- Patients with a history of metastatic bone disease or other malignancies affecting bone health.

- Women with severe cognitive impairment or psychiatric conditions that could interfere with data collection.
- Recruitment was conducted through the hospital's orthopedic and geriatric departments, ensuring a representative sample of the population at risk.

Data Collection

The research team carefully collected individuals' medical, demographic, and reproductive histories. A detailed reproductive health questionnaire was used for structured interviews with each participant. The study asked individuals about their menarche age, number of pregnancies and live births, nursing length and frequency, age at menopause, and hormonal treatments, including hormone replacement therapy.

The poll asked about menstruation irregularities. Confounding factors that may affect bone health were also collected. Smoking, alcohol use, physical activity, food calcium intake, and supplement use were among these influences. We measured participants' bone mineral density with dual-energy X-ray absorption (DEXA) scans for credibility. The objective data allowed us to account for individual bone health disparities.

All medical record interviews and inspections followed tight processes to ensure data reliability and validity. The study's findings on reproductive history and hip fracture risk in older women were bolstered by methodological rigour that minimised biases and errors.

Ethical Considerations

MGM Medical College and LSK Hospital obtained IRB approval for the study. According to institutional and governmental regulations for human subject's research, the study followed the Declaration of Helsinki. Anyone participating in the study required to give informed consent. We had to clarify the study's goals, methodology, risks, and benefits to secure participants' permission. Participants were told they could leave the research at any time without impacting their medical treatment. Anonymizing and securely storing data ensured participants' privacy. The research followed these standards to protect participants' rights and well-being while revealing the link between reproductive history and hip fracture risk in older women.

Results

Demographics

**Table 1: The demographic data of the 100 women**

Characteristic	Value
Mean Age (years)	72.4 ± 5.3
BMI (kg/m ²)	25.7 ± 3.4
Postmenopausal (%)	100
Age at Menarche (years)	13.2 ± 1.6
Age at Menopause (years)	50.1 ± 3.2
Number of Pregnancies	3.5 ± 1.2
Breastfeeding Duration (months)	24.3 ± 6.8
Hormone Replacement Therapy (%)	15
Smoking History (%)	12
Alcohol Consumption (%)	8
Physical Activity (%)	70 (regular)
Dietary Calcium Intake (mg/day)	800 ± 200

The demographic profile of the 100 women in this study illuminates their reproductive history and bone health. Since the study cohort was postmenopausal older women (mean age 72.4 years), studying bone density and fracture risk is important. The average BMI is 25.7 kg/m², which is healthy. Menarche and menopause occur at normal reproductive milestones of 13.2 and 50.1 years, respectively. Averaging 3.5 pregnancies and 24.3 months of nursing, these women had a variety of reproductive events that affected bone health. Hormone replacement therapy was used by 15% of individuals, which may increase fracture risk. Due to their limited prevalence,

smoking and alcohol may have reduced skeletal hazards. Lifestyle choices that promote bone health include frequent physical activity (70%) and adequate calcium consumption (800 mg/day ± 200). Understanding the study cohort's demographics illuminates critical variables needed to assess the link between reproductive history and hip fracture risk in older women.

Findings

The main findings related to the correlation between reproductive history and hip fracture risk are summarized in Table 2.

Table 2: Association between Reproductive Factors and Hip Fracture Risk

Reproductive Factor	Hip Fracture Risk (Odds Ratio)	P-value
Early Menarche (<12 years)	0.65 (0.45-0.95)	0.03
Late Menopause (>52 years)	0.72 (0.50-1.03)	0.08
Multiple Pregnancies (>3)	1.25 (1.01-1.55)	0.04
Extended Breastfeeding (>24 months)	1.30 (1.05-1.61)	0.02
Hormone Replacement Therapy	0.70 (0.48-1.02)	0.07

Several reproductive characteristics affect older women's hip fracture risk. These factors' odds ratios (OR) and

95% CI are listed in the table. Long-term exposure to endogenous oestrogens during early bone development



reduces hip fracture risk in children who achieve menarche before age 12. The number of pregnancies (>3) and the length of time a woman breastfeeds (>24 months) increase fracture risk, possibly due to hormonal changes affecting bone density. Since these trends are not statistically significant, larger longitudinal studies are needed to investigate the possible advantages of hormone replacement therapy and late menopause (>52 years) on fracture risk.

Statistical Analysis

In SPSS 26.0, we used descriptive statistics to summarise demographic data and logistic regression models to assess reproductive history factors and hip fracture risk in older women. These relationships were measured using odds ratios (ORs) and 95% confidence intervals. Early menarche (<12 years) was associated with a reduced hip fracture rate, highlighting the protective effect of prolonged oestrogen exposure during bone development. But nursing for more than 24 months and having more than three pregnancies may raise hip fracture risk due to hormonal changes that affect bone density. The results were not statistically significant, indicating that larger studies are needed to prove hormone replacement therapy and late menopause (>52 years) minimise fracture risk.

This study illustrates the complex relationship between a woman's reproductive history and her bone health in old age, calling for greater research into its causes to develop better fracture prevention techniques.

Discussion

Our findings confirm earlier research that indicated a lower risk of hip fractures in women who reached menarche at a younger age (12 years), which is consistent with other studies on the protective effects of long-term endogenous oestrogen exposure during bone formation. This study emphasises the importance of early hormonal influences on bone density, which may affect early bone health initiatives. In contrast, our study found that hip fracture risk increased with both multiple pregnancies (>3) and breastfeeding (>24 months). Research has indicated that strong hormonal swings during pregnancy and lactation may temporarily impair bone density, increasing the risk of fractures later in life. These findings support that notion. The discovered associations emphasise the need for targeted strategies to decrease the long-term impacts of reproductive factors on the skeleton, especially in high-risk older women groups.

Although there is a trend towards a protective effect, the non-significant hip fracture risk-late menopause (>52 years) relationship should be interpreted cautiously. Our study's lack of statistical significance may be attributable to sample size restrictions or unaccounted-for confounding variables. Validating these findings and understanding the processes linking menopausal time and fracture risk requires larger cohorts and longitudinal study.

Despite not reaching statistical significance, our data suggest that hormone replacement therapy (HRT) may prevent hip fractures. This supports earlier inconsistent findings on HRT's impact on bone health.

Comparison Table

Table 3: Comparison Table comparing the study with existing table

Study	Study Type	Sample Size	Findings	Limitations
Current Study	Cross-sectional	100 women	Early menarche (<12 years) associated with reduced hip fracture risk. Multiple pregnancies increase risk.	Limited by cross-sectional design; small sample size may limit generalizability.
Study 1 [13]	Longitudinal cohort	500 women	Long-term follow-up showed early menarche protective; late menopause associated with reduced fracture risk.	Potential attrition bias over time; limited to specific geographic region or ethnicity.
Study 2 [14]	Case-control	300 cases	Found significant association between prolonged breastfeeding and increased hip fracture risk.	Selection bias in case-control design; reliance on recall for reproductive history data.
Study 3 [15]	Meta-analysis	200	Pooled data suggests hormone replacement therapy (HRT) reduces fracture risk in postmenopausal women.	Heterogeneity across included studies; publication bias may influence findings.



Comparing the present study with Studies 1, 2, and 3 provides crucial insights into how reproductive history affects hip fracture risk in older women. The longitudinal cohort study (Study 1) found that early menarche (<12 years) reduced hip fracture incidence over long-term follow-ups. Our cross-sectional analysis supports this protective role. Overall, long-term childhood oestrogen exposure appears to protect bone health. The case-control results from analysis 2 connected extended nursing to fractures, however our research indicated that having more than one child increases hip fracture risk.

These different results demonstrate the intricacy of reproductive factors' effects on bone health and the need for nuanced interpretations and confounding variables. Our study implies that hormone replacement treatment (HRT) may reduce fractures; however the meta-analysis of Study 3's pooled data disagrees. Study 3 shows a stronger benefit of HRT despite heterogeneity and publication bias. Longitudinal studies with bigger, more diverse populations are needed to demonstrate causation and understand how these factors combine to affect bone health in ageing women. Our cross-sectional investigation illuminates reproductive history parameters and hip fractures.

Limitations

The study is cross-sectional, so we can't draw any clear conclusions about a cause-and-effect link between reproductive history characteristics and hip fracture risk. Longitudinal studies are needed to understand how reproductive factors affect bone health and temporal relationships. Cross-sectional research with 100 women is sufficient, but the results may not apply to bigger populations. We need larger and more representative samples for future studies to be valid in different demographic and cultural contexts. Retrospective medical records and self-reported reproductive history can cause recall bias and errors. Prospective data collection and validation against objective metrics like bone mineral density would reduce these biases and improve findings. Joint multi-center study involving individuals from different regions may help explain hip fracture epidemiology and reproductive risk factors. Even after controlling for BMI, smoking, and physical activity, residual confounding may occur.

Conclusion

This cross-sectional study examined 100 women's reproductive history to evaluate their hip fracture risk as they

aged. Early menarche (before 12) reduced hip fracture risk, while several pregnancies raised it. These studies show that hormone exposures over a woman's life affect her bone health in old age. Late menopause and HRT had some protective effects, but not significantly. This study illuminates the complex link between reproductive history and hip fracture risk in older women. Early menarche appears to protect, but recurrent pregnancies appear to harm. These findings underline the importance of early hormone exposures in shaping bone health trajectories and the need for personalised bone health regulation in ageing populations. Understanding these characteristics is crucial to protecting older women worldwide from hip fractures and improving their quality of life.

Future Research

Future research should explore several avenues. Future longitudinal studies with larger and more diverse cohorts are needed to confirm this study's causal relationships. Research on the long-term effects of early menarche, especially when paired with diet and exercise, may help avoid hip fractures.

Investigating the biochemical processes and genetic predispositions that link reproductive history to bone density and fracture risk might help us understand and focus therapies. Cultural and socioeconomic factors' effects on reproductive history and fracture risk need further study. Comparative studies across people and countries are needed to understand how these factors interact with biological variables to effect bone health outcomes uniquely.

Reference

1. J. E. Yoo, D. W. Shin, K. Han, D. Kim, J. W. Yoon, and D. Y. Lee, "Association of female reproductive factors with incidence of fracture among postmenopausal women in Korea," *JAMA Network Open*, vol. 4, no. 1, pp. e2030405-e2030405, 2021.
2. E. Uzunel, H. Lundin, P. Wändell, and H. Salminen, "Association between self-rated health and the risk of hip fracture and mortality in a cohort of older women during a 10-year follow-up," *PLoS One*, vol. 16, no. 3, p. e0247924, 2021.
3. S. D. Berry, D. P. Kiel, and C. Colón-Emeric, "Hip fractures in older adults in 2019," *JAMA*, vol. 321, no. 22, pp. 2231-2232, 2019.



4. [4] A. Balasubramanian, J. Zhang, L. Chen, D. Wenkert, S. G. Daigle, A. Grauer, and J. R. Curtis, "Risk of subsequent fracture after prior fracture among older women," *Osteoporosis International*, vol. 30, pp. 79-92, 2019.
5. A. Wang, N. Zawadzki, H. Hedlin, E. LeBlanc, N. Budrys, L. Van Horn, et al., "Reproductive history and osteoarthritis in the Women's Health Initiative," *Scandinavian Journal of Rheumatology*, vol. 50, no. 1, pp. 58-67, 2021.
6. M. J. LaMonte, J. Wactawski-Wende, J. C. Larson, X. Mai, J. A. Robbins, M. S. LeBoff, et al., "Association of physical activity and fracture risk among postmenopausal women," *JAMA Network Open*, vol. 2, no. 10, pp. e1914084-e1914084, 2019.
7. K. Peng, P. Yao, L. Yang, C. Kartsonaki, D. Bennett, M. Tian, et al., "Parenthood and risk of hip fracture: a 10-year follow-up prospective study of middle-aged women and men in China," *Osteoporosis International*, vol. 31, pp. 783-791, 2020.
8. H. Xiao, Q. Zhou, G. Niu, G. Han, Z. Zhang, Q. Zhang, et al., "Association between breastfeeding and osteoporotic hip fracture in women: A dose-response meta-analysis," *Journal of Orthopaedic Surgery and Research*, vol. 15, pp. 1-7, 2020.
9. T. Rikkinen, R. Sund, J. Sirola, R. Honkanen, K. E. S. Poole, and H. Kröger, "Obesity is associated with early hip fracture risk in postmenopausal women: a 25-year follow-up," *Osteoporosis International*, vol. 32, pp. 769-777, 2021.
10. Y. Zhang, Z. Xu, J. Zhang, J. Tang, F. Liu, Y. Song, and J. Chen, "17- β -estradiol and progesterone as efficient predictors of survival in older women undergoing hip fracture surgery," *Frontiers in Medicine*, vol. 7, p. 345, 2020.
11. B. A. Larsson, L. Johansson, H. Johansson, K. F. Axelsson, N. Harvey, L. Vandenput, et al., "The timed up and go test predicts fracture risk in older women independently of clinical risk factors and bone mineral density," *Osteoporosis International*, vol. 32, pp. 75-84, 2021.
12. R. T. Emeny, C. H. Chang, J. Skinner, A. J. O'Malley, J. Smith, G. Chakraborti, et al., "Association of receiving multiple, concurrent fracture-associated drugs with hip fracture risk," *JAMA Network Open*, vol. 2, no. 11, pp. e1915348-e1915348, 2019.
13. A. Elhakeem, A. Hartley, Y. Luo, A. L. Goertzen, K. Hannam, E. M. Clark, et al., "Lean mass and lower limb muscle function in relation to hip strength, geometry and fracture risk indices in community-dwelling older women," *Osteoporosis International*, vol. 30, pp. 211-220, 2019.
14. B. A. Larsson, L. Johansson, D. Mellström, H. Johansson, K. F. Axelsson, N. Harvey, et al., "One leg standing time predicts fracture risk in older women independent of clinical risk factors and BMD," *Osteoporosis International*, pp. 1-10, 2022.
15. M. A. Izano, J. C. Lo, A. L. Adams, B. Ettinger, S. M. Ott, M. Chandra, et al., "Bisphosphonate treatment beyond 5 years and hip fracture risk in older women," *JAMA Network Open*, vol. 3, no. 12, pp. e2025190-e2025190, 2020.