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Markov Chain-Based Cost-Effectiveness Analysis of Population-Wide Osteoporosis Prevention and Control in Fenglin Community, Shanghai (Postprint)

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Abstract

Background: As the comprehensive reform of community health services gradually deepens, community-wide prevention and treatment efforts for single diseases are continuously being optimized; however, there remains a lack of appropriate methods to evaluate the effectiveness of community prevention and treatment.

Objective: To explore the preliminary effectiveness and potential problems of community-wide prevention and treatment for single diseases by analyzing the cost-effectiveness of existing community-wide osteoporosis prevention and treatment measures at Fenglin Community Health Service Center in Xuhui District, Shanghai from 2016 to 2022.

Methods: This study conducted a cost-effectiveness analysis on 4,293 community residents in Fenglin Community who received osteoporosis prevention and treatment between 2016 and 2022. Subjects were divided into three states based on bone mineral density values: healthy, low bone mass, and osteoporosis, to construct a Markov model. The study analyzed influencing factors of state transitions, calculated QALY increments based on Markov model predictions combined with quality-adjusted life years (QALY), compiled all costs invested in prevention and treatment from 2016 to 2022, evaluated prevention and treatment effectiveness using the cost/QALY increment ratio, and calculated QALY through health utility values and life expectancy determined via literature search.

Results: The total cost of osteoporosis prevention and treatment in Fenglin Community was 33,814,102.15 yuan. At the first diagnosis, the total QALY for the community osteoporosis prevention and treatment population was 77,098.2889, with a per capita mean of 17.959 and a standard deviation of 9.34; at the second diagnosis, the total QALY was 79,616.9361, with a per capita mean of 18.546 and a standard deviation of 9.342. The difference in QALY between the two diagnoses was 2,518.6472. The incremental cost-effectiveness ratio (ICER) was 2,132.9070 yuan/QALY, which is less than one times (66,965.10 yuan) the per capita GDP, indicating that the intervention program is fully cost-effective.

Conclusion: This study conducted a preliminary evaluation of the prevention and treatment effectiveness for the population in Fenglin that continuously received osteoporosis follow-up management, combining the Markov model and quality-adjusted life years (QALY). The results demonstrated that the osteoporosis prevention and treatment intervention program in Fenglin Community is worthwhile, providing a basis for subsequent precision decision-making in osteoporosis prevention and treatment.

Full Text

Cost-Effectiveness Analysis of Population-Wide Osteoporosis Prevention and Treatment in Fenglin Community, Shanghai: A Markov Chain Approach

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Abstract

Background: As comprehensive community health service reforms deepen, population-wide prevention and control programs for single diseases are continuously being optimized. However, effective methods for evaluating the outcomes of such community-based interventions remain lacking.

Objective: This study analyzes the cost-effectiveness of existing population-wide osteoporosis prevention and treatment measures implemented in Fenglin Community, Xuhui District, Shanghai from 2016 to 2022, exploring both the initial outcomes and potential challenges of community-based single-disease prevention.

Methods: A cost-effectiveness analysis was conducted on 4,293 community residents who received osteoporosis prevention and treatment services in Fenglin Community between 2016 and 2022. Based on bone mineral density (BMD) values, participants were classified into three health states: healthy, low bone mass, and osteoporosis. A Markov model was constructed to analyze factors influencing state transitions. Quality-adjusted life years (QALYs) were calculated using model predictions, and total program costs from 2016–2022 were compiled. Cost-effectiveness was evaluated using the cost per QALY gained ratio. QALYs were derived from health utility values and life expectancy data obtained through literature review.

Results: The total cost of osteoporosis prevention and treatment in Fenglin Community was ¥33,814,102.15. At baseline diagnosis, the cohort's total QALYs were 77,098.2889 (mean per capita: 17.959, SD: 9.34). At follow-up diagnosis, total QALYs were 79,616.9361 (mean per capita: 18.546, SD: 9.342), yielding a QALY gain of 2,518.6472. The incremental cost-effectiveness ratio (ICER) was ¥2,132.9070 per QALY, which is below one times the per capita GDP (¥66,965.10), indicating the intervention is highly cost-effective.

Conclusion: Using a Markov model combined with QALY analysis, this study provides a preliminary evaluation of osteoporosis prevention effectiveness in Fenglin Community. The results demonstrate that the community's osteoporosis intervention program represents a worthwhile investment and offers a foundation for future precision prevention strategies.

Keywords: Osteoporosis; Community single-disease management; Prevention and treatment; Cost-effectiveness analysis; Markov model

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Introduction

Community health centers serve as critical guardians of national health, playing a vital role in chronic disease management and prevention. Osteoporosis is a common chronic disease that seriously threatens the health of older adults. By the end of 2020, an estimated 286.6 million people in China suffered from osteoporosis [1], with osteoporotic fractures affecting over 10.0% of this population [2]. The prevalence of osteoporosis among individuals aged 65 and older reaches 32.0%. While community-based osteoporosis prevention is gradually expanding, research on disease states and future trends in community populations remains limited, necessitating effective tools to explore current prevention status and predict future outcomes.

Multi-state Markov models [3] can both describe current health states and predict future states, making them valuable for analyzing chronic disease progression with multiple states. These models can quantify total state changes resulting from interventions and convert these changes into utility or benefit measures to calculate input-output ratios. This study uses the population-wide osteoporosis prevention program naturally implemented in Fenglin Community from 2016–2022 as a case study. By constructing a Markov model for the community's osteoporosis prevention cohort, we calculated intervention costs and resulting quality-adjusted life year (QALY) [4] outcomes to conduct a cost-utility analysis. This evaluation assesses the real-world cost-effectiveness of single-disease community health services, providing a reference for current community prevention initiatives and identifying directions for improving precision osteoporosis management.

1. Methods

1.1 Study Population The study population comprised residents recorded in the Fenglin Community Health Service Center's osteoporosis database between May 2016 and August 2022, representing different BMD categories. Inclusion criteria were: (1) clinical data meeting WHO diagnostic criteria for primary osteoporosis [5]; (2) age 55–80 years; (3) normal cognitive function in both participants and primary caregivers; (4) voluntary participation with signed informed consent. Exclusion criteria included: (1) history of severe cardiovascular or respiratory disease, or acute conditions affecting heart, brain, or kidneys; (2) participation in other similar studies; (3) psychiatric disorders or inability to complete the study; (4) severe physical illness such as malignancy. Based on these criteria, 4,293 participants were selected. The study was approved by the Shanghai Clinical Research Ethics Committee (Approval No. SECCR/2021-35-01).

1.2 Data Collection and Model Development **Data Collection:** Community general practitioners and specialized physicians conducted outreach and recruitment. Participants received informed consent guidance and specialized disease management data compilation (first diagnosis), followed by continuous monitoring (second diagnosis). Data sources included: (1) Hospital Information System (HIS) records detailing services, medication names/quantities, test names/quantities, and outpatient referrals; and (2) service records from the Fenglin Community Osteoporosis Service Register (for services not captured in HIS), documenting service themes, target populations, providers, and service duration [6].

Model Construction: A retrospective study examined BMD state transitions among community osteoporosis prevention participants. Based on BMD measurements, three health states were defined: healthy (S1), low bone mass (S2), and osteoporosis (S3) [7-10]. State transition probabilities were calculated by comparing first and second diagnoses to construct frequency and probability matrices. Using the initial distribution (based on 4,293 first-diagnosis participants), the model predicted probability distributions across states over 30 years and analyzed factors influencing multi-state transitions (calculated from 362 participants with consecutive BMD measurements).

Cost Analysis: Costs were calculated using healthcare service costs [11], representing direct costs actually incurred for osteoporosis prevention from May 2016 to August 2022. Cost components included: (1) total outpatient fees (registration, prescriptions); (2) outpatient treatment fees (tests); (3) hospitalization costs; (4) laboratory fees; (5) medication costs; and (6) labor costs for the "Fenggu Club" health education program. Outpatient fees, treatment fees, hospitalization, and laboratory costs were obtained from HIS. Medication costs were estimated using the mean annual medication cost from 2016–2019 (¥612,030.3) multiplied by the study period (May 2016–August 2022). Labor costs were calculated as: annual education sessions × participants × average wage (¥3,000/person).

Effectiveness Analysis: Effectiveness was measured using QALYs, calculated as: QALY = life expectancy × health utility value [4,7,12-14]. Life expectancy data were obtained from reference [14], stratified by age groups: 20– (63.36), 25– (58.36), 30– (53.36), 40– (43.59), 45– (38.81), 50– (34.01), 55– (29.41), 60– (24.84), 65– (20.3), 70– (16.26), 75– (12.33), 80– (9.43), and 85+ (6.67). Health utility values were determined from references [15-18] as: healthy (1) [15], low bone mass (0.89) [16], osteoporosis (fracture) (0.84) [17], and death (0) [18]. For the 362 participants with continuous dual-energy X-ray absorptiometry measurements, actual values were used; for the remaining 3,931 without continuous measurements, BMD states were estimated using the Markov model constructed from the 362 participants with follow-up data.

Cost-Effectiveness Evaluation: Results were assessed using WHO's incremental cost-effectiveness ratio (ICER) criteria (2010 edition) [19], representing additional cost per unit utility gained. ICER = incremental cost / QALY gained, reflecting extra expenditure required to extend quality-adjusted survival. WHO recommends: ICER $< 1\times$ per capita GDP indicates very cost-effective; ICER $< 3\times$ per capita GDP indicates cost-effective; ICER $> 3\times$ per capita GDP suggests excessive costs requiring careful consideration.

Sensitivity Analysis: Single-variable sensitivity analysis examined five parameters to assess their impact on the incremental cost-utility ratio, with results presented in a tornado diagram. Each parameter was varied across its range while holding others constant.

1.3 Statistical Methods Baseline characteristics and diagnostic results were described using frequencies and proportions, with basic statistics performed in SPSS 25.0 and Excel 2016. Markov model construction, transition intensities/probabilities, and mean sojourn times were completed using the "msm" package in R 4.1.2. Dummy variables were created for categorical variables in influencing factor analysis, with hazard ratios (HR) and 95% confidence intervals (CI) reported. Two-sided tests were performed with α=0.05; P<0.05 was considered statistically significant.

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2. Results

2.1 Baseline Characteristics The study cohort had a mean age of 68.4$±11.8*years*, *withmostparticipants*(53.5±14.52*kgandmeanheight*157.8±16.7*cm*.*BMIwasnormalin*1, 986
years. Detailed demographic characteristics are shown in .

2.2 Markov Model Analysis **Transition Probability Matrix:** Based on BMD diagnostic results, three states were defined: healthy (S1), low bone mass (S2), and osteoporosis (S3) [7-10]. Comparing first and second diagnoses yielded transition probabilities. The frequency matrix is shown in and the probability matrix in . Within one annual cycle, the probability of transitioning from healthy to low bone mass was 8.5%; low bone mass to healthy, 16.4%; low bone mass to osteoporosis, 17.9%; and osteoporosis to low bone mass, 24.9%. Direct transitions between healthy and osteoporosis states did not occur within a single cycle. State transition probabilities are illustrated in [Figure 1: see original paper].

30-Year State Distribution Prediction: Using transition probabilities from section 2.2.1 and the initial distribution (4,293 first-diagnosis participants), we projected state probability distributions over 30 years. shows BMD state proportions across the 30-year horizon: healthy (0.527), low bone mass (0.274), and osteoporosis (0.199). Over time, the proportions of low bone mass and osteoporosis decreased while healthy status increased, eventually stabilizing. Trends are depicted in [Figure 2: see original paper].

Influencing Factors Analysis: After excluding five cases with missing BMI or medical history data, we analyzed factors affecting state transitions using BMI, age, sex, back pain/bone pain, fragility fracture history, height loss, and kyphosis as independent variables. Different state transitions (S1→S2, S2→S1, S2→S3, S3→S2) served as dependent variables. The msm model estimated hazard ratios (HR) for each transition, with female sex, no back pain, no fracture history, no height loss, and no kyphosis as reference categories. presents results for adjacent state transitions, showing BMI, age, sex, and height loss significantly influenced BMD state transitions (all $P<0.05$). Compared to low BMI, normal BMI was associated with higher transition intensity from S2→S1; older age showed lower S3→S2 transition intensity; males had higher S2→S1 transition rates than females; and participants with noticeable height loss had higher S1→S2 transition risk.

2.3 Cost-Effectiveness Analysis **Total Costs:** Total osteoporosis prevention costs in Fenglin Community were ¥33,814,102.15, comprising outpatient fees (¥14,464,180.49, 42.8%), outpatient treatment costs (¥6,681,264.20), hospitalization (¥8,485,958.69), laboratory tests (¥129,575.00), medications

(¥3,828,123.77), and labor costs (¥225,000.00). The program managed 4,293 participants, including 1,584 with osteoporosis, 2,038 with low bone mass, and 671 healthy individuals .

QALY Outcomes: QALYs were calculated for all 4,293 participants. At baseline, total QALYs were 77,098.2889 (mean: 17.959, SD: 9.34). Using the Markov model built from 362 participants with follow-up data to predict post-intervention outcomes, total QALYs at second diagnosis were 79,616.9361 (mean: 18.546, SD: 9.342), yielding a QALY gain of 2,518.6472.

Incremental Cost-Effectiveness Ratio: Annual average costs were calculated across six years (2016–2022) to ensure adequate cost estimation, yielding ¥5,372,040.308 per year. The one-year follow-up period produced a QALY gain of 2,518.6472. ICER = $\Delta C/\Delta E$ = ¥5,372,040.308 / 2,518.6472 = ¥2,132.9070 per QALY. China's average per capita GDP from 2016–2021 was ¥66,965.10. Since the ICER is below one times per capita GDP, the intervention is highly cost-effective.

Sensitivity Analysis: Single-variable sensitivity analysis results are shown in [Figure 3: see original paper]. The ICER was most sensitive to the transition probability from healthy to low bone mass, followed by low bone mass to healthy, and low bone mass to osteoporosis. CPI value showed the weakest sensitivity. Across all parameter variations, the ICER remained below one times per capita GDP (¥66,965.10), confirming the robustness of the cost-utility findings.

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3. Discussion

3.1 Current Status of Community Prevention Evaluation Tools China currently lacks appropriate tools to evaluate community-based prevention outcomes, constrained by several factors: (1) Intervention models differ from traditional approaches—community programs target entire populations and alter population-level health states, making conventional controlled trials inadequate for measuring community prevention effects; (2) Structural differences exist—community prevention encompasses broad activities including mobilization, screening, diagnosis, intervention, and follow-up, with different cost structures than traditional healthcare, and many components lack explicit fee schedules [20]; (3) Heterogeneous populations have varying initial disease states, intervention protocols, duration, and outcome measures, rendering traditional clinical efficacy analysis unsuitable for community prevention [6].

Markov models, which describe random dynamic systems without aftereffects, have been widely applied in clinical efficacy evaluation, screening assessment, and prognostic research since the 1980s. By the 1990s, they were increasingly used in health economics. Feng et al. [21] constructed a Markov economic model to analyze the cost-utility of alendronate for preventing osteoporotic fractures in postmenopausal women, while Si et al. [11] used Markov models to evaluate interventions for virtual patients at different fracture risk levels. Most community interventions employ mature technologies with established efficacy and safety. When community health organizations innovatively combine these proven technologies, effectiveness measures and evaluation metrics must be reconsidered [22] to enable precise assessment of community prevention outcomes. Markov models can dynamically and accurately evaluate disease state changes following community-based chronic disease management, predict current and future system states, and forecast future conditions at specific time points, thereby informing decision-making, guiding refined and competitive development of community health services, and avoiding reliance on excessive process-oriented performance metrics.

3.2 Analysis of Disease States and Influencing Factors Transition probability analysis indicates that healthy participants receiving osteoporosis prevention maintain high probabilities of staying healthy. Preventing deterioration in healthy and low bone mass populations is more effective at blocking long-term harm than correcting established osteoporosis (transitioning to low bone mass). Appropriate intervention for low bone mass populations effectively controls osteoporosis progression, while healthy individuals cannot directly transition to osteoporosis, highlighting low bone mass individuals as the priority target for community prevention efforts. However, healthy population management remains essential.

Our Markov model projections over 30 years show that under intervention, the community's osteoporosis and low bone mass populations decrease while healthy individuals increase, suggesting that delayed or absent intervention would consume more healthcare resources long-term. Community general practitioners and teams should therefore engage earlier and more actively in high-risk chronic disease populations.

Results demonstrate that BMI, age, sex, and height loss significantly influence BMD state transitions. Compared to low BMI individuals, those with normal BMI show higher transition intensity from low bone mass to healthy status and lower risk of transitioning to osteoporosis. Older patients have higher risk of progressing from low bone mass to osteoporosis. Females have higher risk than males of transitioning from healthy to low bone mass. Participants with noticeable height loss have lower probability of transitioning from low bone mass back to healthy status. These findings suggest community health workers should prioritize prevention efforts for thin, older female patients.

3.3 Cost-Utility Analysis The input-output ratio reveals that Fenglin Community's osteoporosis intervention produced substantial QALY gains. An investment of ¥5,372,040.308 yielded 2,518.6472 additional QALYs, with an ICER of ¥2,132.9070 per QALY—well below one times per capita GDP. This confirms the intervention is highly cost-effective and represents a worthwhile investment.

Limitations: Model construction was based on available data, but only 362 of

4,293 participants had second BMD measurements. While this subset provides representative reference value for modeling natural disease progression under continuous follow-up, the small sample affects precision in simulating the entire community population. Cost calculations aggregated total expenditures from 2016–2022 rather than annual breakdowns. Since all 4,293 participants began receiving interventions in May 2016, we calculated average annual investment using post-May data, potentially introducing inaccuracy. For utility analysis, the lack of continuous data meant calculations were limited to the second diagnostic state rather than matching the cost analysis timeframe. Consequently, we measured both inputs and outputs as annual averages. This approach may overestimate outcomes—if health utility were calculated through 2022, QALY gains might be lower than reported. Additionally, second-diagnosis age was calculated using first-diagnosis values without accounting for QALY changes during treatment. For the 3,931 participants without second measurements, health states were estimated using the Markov model from 362 participants with follow-up data, introducing some real-world error. Future work should improve data management and measure inputs and outputs over identical timeframes for more precise results to better guide osteoporosis prevention decisions.

Despite these limitations, using a Markov model with QALYs provides preliminary input-output ratios for community osteoporosis prevention. Although data precision and management require improvement, we conclude that community-based osteoporosis prevention warrants continued long-term investment and implementation.

Author Contributions

SU Jin conceptualized and designed the study, supervised implementation, and drafted the manuscript. SHOU Juan ensured manuscript quality and takes overall responsibility. GU Wenqin and YI Chuntao supervised osteoporosis prevention program implementation. XU Liping, CHENG Lili, and ZHOU Peng conducted literature review and collation. DING Hongjuan and WEI Yangyang performed statistical analysis and created figures. WU Yinghua, QIN Jie, XUE Bin, WEI Baichuan, WANG Qian, PENG Yan, CHENG Yimin, and YANG Lan implemented the study and collected data. WANG Lei, QI Jinlin, SHAO Ying, and CAI Liming cleaned the data.

Conflict of Interest Disclosure: The authors declare no conflicts of interest.

References

[1] Writing Group of "Community Guidelines for Primary Osteoporosis Diagnosis and Treatment". Community guidelines for primary osteoporosis diagnosis and treatment[J]. Chinese General Practice, 2019, 22(10): 1125-1132.

DOI:10.12114/j.issn.1007-9572.2019.00.116.

[2] HU Jun, ZHANG Hua, MU Qing. Epidemiological trends and prevention progress of osteoporosis[J]. Clinical Focus, 2011, 26(8): 729-731.

[3] LIU Xun, LING Li, WANG Cheng, et al. Application of multi-state Markov model in chronic kidney disease staging prognosis[J]. Academic Journal of Second Military Medical University, 2009, 30(7): 804-807. DOI:10.3724/SP.J.1008.2009.00804.

[4] JIANG Xinjun, JIANG Hua, LI Mingzi, et al. Cost-effectiveness analysis of diabetes patient education[J]. Chinese Journal of Diabetes, 2018, 26(11): 964-968. DOI:10.3969/j.issn.1006-6187.2018.11.018.

[5] Chinese Medical Association Osteoporosis and Bone Mineral Disease Branch. Guidelines for the diagnosis and treatment of primary osteoporosis (2017)[J]. Chinese Journal of Osteoporosis, 2019, 25(3): 281-309. DOI:10.3969/j.issn.1006-7108.2019.03.001.

[6] ZHOU Peng, YANG Lan, XUE Bin, et al. Construction of community osteoporosis prevention pathway based on two-way referral model and its significance[J]. Chinese General Practice, 2020, 23(5): 585-592. DOI:10.12114/j.issn.1007-9572.2020.00.043.

[7] LI Ge, ZHANG Chunlin, CAI Chenghua, et al. Cost-benefit study of osteoporosis drug and health education intervention strategies[J]. Chinese Journal of Osteoporosis, 2006, 12(3): 310-312, 217. DOI:10.3969/j.issn.1006-7108.2006.03.030.

[8] FENG Xin, GAO Ying, PAN Xuemei, et al. Cost-utility analysis of alendronate sodium for preventing osteoporotic fractures in postmenopausal women[J]. China Pharmacy, 2017, 28(17): 2313-2318. DOI:10.6039/j.issn.1001-0408.2017.17.03.

[9] SU Xiaoqing, HUANG Lesong, YANG Zhou, et al. Cost-effectiveness analysis of alendronate sodium[J]. Chinese Journal of Gerontology, 2013, 33(15): 3625-3628. DOI:10.3969/j.issn.1005-9202.2013.15.035.

[10] IGLESIAS C P, TORGERSON D J, BEARNE A, et al. The cost-utility of bisphosphonate treatment in established osteoporosis[J]. QJM, 2002, 95(5): 305-311. DOI:10.1093/qjmed/95.5.305.

[11] SI L, WINZENBERG T M, JIANG Q, et al. Screening for and treatment of osteoporosis: construction and validation of a state-transition microsimulation cost-effectiveness model[J]. Osteoporosis International, 2015, 26(5): 1477-1489. DOI:10.1007/s00198-014-2999-4.

[12] YANG Danhong, ZHANG Weidong. Study on quality-adjusted life years and influencing factors in community hypertensive patients in Shanghai suburbs[J]. Chinese General Practice, 2014, 17(10): 1158-1160. DOI:10.3969/j.issn.1007-9572.2014.10.019.

[13] XU Xun, LI Fan, ZHU Yunxia, et al. Impact of community standardized management on quality-adjusted life years in chronic obstructive pulmonary disease patients[J]. Chinese General Practice, 2013, 16(9): 798-801. DOI:10.3969/j.issn.1007-9572.2013.07.026.

[14] BIAN Hongyi, ZHENG Yingjie, CAO Jiayan. Life table and cause-eliminated life table analysis of Tangqiao community residents in Shanghai, 2013[J]. Health Education and Health Promotion, 2016, 11(1): 52-57. DOI:10.16117/j.cnki.31-1974/r.201601017.

[15] GUAN Haijing, XU Fei, LIU Guoen. Discussion on calculation methods for quality-adjusted life years based on EQ-5D scale[J]. Chinese Health Economics, 2015, 34(10): 5-8. DOI:10.7664/CHE20151001.

[16] WANG Jun. Economic evaluation of behavioral interventions in diabetes patients based on Markov model[D]. Hefei: Anhui Medical University, 2018.

[17] ZHOU Ting, GUAN Haijing, LIU Guoen, et al. Systematic review of health-related quality of life in Chinese general population[J]. Chinese Health Service Management, 2016, 33(8): 621-623, 630.

[18] BRAZIER J E, GREEN C, KANIS J A, et al. A systematic review of health state utility values for osteoporosis-related conditions[J]. Osteoporosis International, 2002, 13(10): 768-776. DOI:10.1007/s001980200107.

[19] World Health Organization. The CHOICE (Choosing Interventions that are Cost-Effective) project is a WHO initiative developed in 1998[J]. 2014.

[20] ZHANG Lifang, LIU Zhongyuan, LIN Chunmei, et al. Current status and development strategies of specialized services in Chinese community health centers[J]. Chinese General Practice, 2019, 22(16): 1900-1903. DOI:10.12114/j.issn.1007-9572.2019.00.284.

[21] FENG Xin, GAO Ying, PAN Xuemei, et al. Cost-utility analysis of alendronate sodium for preventing osteoporotic fractures in postmenopausal women[J]. China Pharmacy, 2017, 28(17): 2313-2318. DOI:10.6039/j.issn.1001-0408.2017.17.03.

[22] SHEN Fulai, CAI Yuyang, WU Jianping, et al. Analysis of community medical service product attributes and exploration of product development pathways[J]. Chinese Journal of General Practitioners, 2017, 16(3): 174-178. DOI:10.3760/cma.j.issn.1671-7368.2017.03.002.

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