Addressing Healthcare Disparities and Improving Osteoporosis Management in Rural Communities: A Randomized Control Trial

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Abstract

Background: Rural communities face unique challenges including limited healthcare access, financial constraints, and health disparities. These challenges result in shortages of healthcare professionals, insufficient health literacy, socio-cultural dynamics, geographical isolation, transportation difficulties, economic constraints, and inconsistent doctor-patient relationships, collectively contributing to barriers to accessing healthcare in rural areas. However, interventional research focused on overcoming barriers to access healthcare services in rural areas remains limited.

Objective: This study assessed the effectiveness of a multicomponent intervention in increasing the hospital arrival and treatment rate of anti-osteoporosis medication (AOM), and the risk factors leading to the refusal of therapy in a rural community.

Methods: Overall, 567 patients were randomly assigned to three groups: multicomponent integrated care (MIC), osteoporosis care only (OC), and usual care (UC). Five interventions were implemented in the MIC and OC groups: medical professionals and specialists, enhancing disease knowledge, overcoming geographic barriers, peer support, and dedicated case managers. However, only medical professionals and specialists, enhancing disease knowledge and a portion of overcoming geographic barriers were included in the UC group.

Results: In the MIC group, 116 patients were admitted to hospital, with 85 (73.3%) visiting and 68 (58.6%) receiving AOM after interventions. In the OC group, 153 patients were referred to the hospital, of whom 124 (81 %) visited and 106 (69.3%) received AOM after intervention. However, in the UC group, only six (4.1%) visited and received AOM, of the 146 participants recommended for hospital after our screening. Significant differences were found between the MIC and UC groups regarding the proportion of patients who visited the hospital (P<.001) and those who received AOM (P<.001). Significant differences were also observed between the OC and UC groups (P<.001, P<.001, respectively). Multivariable logistic modeling identified risk factors hindering hospital visits, including male sex (odds ratio (OR) 3.54; 95% CI 1.46–8.59; P=.005), low education (OR 2.46; 95% CI 1.14–5.32; P=.02), multiple disabilities (OR 2.18; 95% CI 1.05–4.51; P=.04), and osteopenia diagnosis (OR 2.3; 95% CI 1.15–4.61; P=.02).

Conclusions: Our findings underscore the importance of supporting patients in accessing rural healthcare services, in addition to

integrating professionals and specialists, and improving disease knowledge. We emphasize the need for multiple interventions to enhance osteoporosis treatment rates in rural communities. Clinical Trial: ClinicalTrials.gov NCT05104034

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Conclusions: Our findings underscore the importance of supporting patients in accessing rural healthcare services, in addition to integrating professionals and specialists, and improving disease knowledge. We emphasize the need for multiple interventions to enhance osteoporosis treatment rates in rural communities.

Trial Registration: ClinicalTrials.gov NCT05104034

Keywords: rural healthcare access; healthcare disparities; multicomponent intervention; osteoporosis intervention.

Introduction

Rural regions face unique challenges that negatively impact health outcomes, including limited access to medical care, lower income, and a higher prevalence of medical conditions such as diabetes, end-stage renal disease, and cancer [1]. These challenges often result in poorer health outcomes for rural residents compared to their urban or suburban counterparts [2]. Despite ongoing efforts to improve healthcare accessibility in rural areas, issues such as financial constraints and substandard healthcare quality persist [3], exacerbating health disparities. Consequently, addressing healthcare access in rural areas has garnered significant attention in recent decades, with extensive research and discussions focused on finding solutions [3,4].

Several barriers impede access to healthcare in rural communities. These include shortages of healthcare professionals [4-7], insufficient health literacy [6,8], socio-cultural dynamics [4,6], geographical remoteness [6-9], transportation difficulties [4,6,9,10], economic constraints [4,8], and inconsistent doctor-patient rapport [6,11]. The lack of healthcare professionals in rural areas is a major challenge, with a shortage of physicians, pharmacists, and nurse practitioners [12,13].

Therefore, strategies for recruiting and retaining professionals in rural areas are imperative. Moreover, health literacy deficits are prevalent in these regions [14-16], often leading to compromised health management. From a positive perspective, this barrier can be ameliorated through appropriate education, as reported by Fernandez et al. [17].

The vast geographical span of rural settings make transportation a pivotal concern. Extended travel durations coupled with limited public transportation availability hinder healthcare access, resulting in delays, rescheduling, and lapses in medication adherence [10]. As highlighted by Brundisini et al., geographical factors increase health risks for rural residents [6]. Furthermore, to address transportation barriers affecting rural communities, a previous review article emphasized that achieving equal access to high-quality chronic disease care and reducing geographic disparities necessitates the design and implementation of customized, multilevel interventions [18].

Both the National Academy of Medicine in the United States and the Council of Science and Technology in the United Kingdom have underscored the crucial role of community-based health promotion and disease prevention initiatives [19, 20]. These programs aim to alleviate health challenges and social burdens associated with an aging population within healthcare systems constrained by limited resources. However, there remains a requirement for further interventional research focused on overcoming barriers to access healthcare services in rural areas.

Therefore, this study aimed to assess the effectiveness of a multicomponent intervention in increasing the hospital arrival and treatment rate of anti-osteoporosis medication (AOM). We used osteoporosis as a case study, given its increasing prevalence [21] as a result of the aging population, which is representative of other common chronic conditions. Concurrently, we endeavored to explore the barriers preventing older individuals from pursuing medical care, even after comprehensive intervention and support.

Methods

Design and setting:

The Healthy Longevity and Aging in Place (HOPE) study is a two-year, open-label, three-armed cluster randomized controlled trial conducted in a rural community. The study commenced in November 2021 and is scheduled for completion by the end of 2023. The HOPE study aims to provide community-based integrated care, with the goal of improving quality-adjusted life years and preventing disability. Our interdisciplinary team comprised orthopedic and rehabilitation doctors, pharmacists, physical therapists, dietitians, research nurses, and other professionals. We delivered integrated, multifaceted healthcare services; addressed issues such as osteoporosis, sarcopenia, and polypharmacy. Additionally, we provided support for exercise and nutrition to enhance the overall well-being of rural residents, both physically and mentally. This article reports the one-year outcomes of the osteoporosis intervention within the HOPE study (Supplement figure 1.). This article adheres to the Consolidated Standards of Reporting Trials (CONSORT)-Outcomes 2022 Extension [22].

Recruitment

The trial was conducted in Yunlin County, a rural area in Taiwan known for being one of the most aged counties, with residents mainly engaged in agriculture and holding a relatively lower average incomes [23, 24]. Our participants were sourced from community-dwelling elderly individuals participating in activities at congregated meal service (CMS) centers. Established by the Yunlin government, CMS centers are typically conveniently located near participants' residences compared to hospitals, and they serve dual functions of providing affordable lunches for the elderly and fostering their community involvement. As of April 2020, 110 CMS centers had been set up in

Yunlin, catering to approximately 7,232 seniors daily, 5 days a week. The supportive environment and well-established infrastructure make CMS centers suitable venues for healthcare delivery programs and social engagement, including those in our trial.

Inclusion criteria

Rural residents aged 50 years or older who participated in the CMS were eligible to participate in the trial. Our recruitment strategy was all-encompassing, aiming not only to target high-risk elderly individuals, but also to include those in the low- and medium-risk strata. The overarching goal was to prevent the onset of disabilities and age-associated ailments across diverse subsets of elderly individuals.

Exclusion criteria

Elderly individuals with severe cognitive dysfunction, rendering them incapable of lucid self-expression, or those identified as terminally ill with a life expectancy of three months or less were excluded. Life expectancy was estimated by two of the authors, a cardiologist and a geriatrician, respectively.

Ethical consideration

The design and execution of the study adhered to the ethical principles of the Declaration of Helsinki. This trial was approved by the Institutional Review Board of the National Taiwan University Hospital (protocol ID: 202106076RIND) and registered at ClinicalTrials.gov (NCT05104034). Informed consent was obtained from all participants before starting the trial.

Randomization

Cluster randomization was employed to allocate CMS centers into three randomized groups: multicomponent Integrated care (MIC), osteoporosis care only (OC), and usual care (UC), using a computer-generated random allocation sequence to achieve an allocation ratio at the individual level of 1:1:1. The MIC group benefited from the holistic program targeting osteoporosis, sarcopenia, and polypharmacy. The OC group underwent osteoporosis care mirroring that of the MIC group but was devoid of additional interventions. Participants in the UC group underwent data collection with minimal intervention, a step taken to uphold ethical standards. Following randomization, inclusion and exclusion criteria were applied to identify suitable individuals, and informed consent was obtained.

Blinding

While statistical analyses were performed by a blinded statistician, logistical constraints necessitated that the participants, investigators, and study nurses remain unblinded.

Baseline characteristics collection and comprehensive assessment

Sociodemographic information, including age, sex, comorbidities (Charlson comorbidity index was also utilized [25]), educational attainment, employment status, income, and marital status, was documented at the beginning of the study. Data pertaining to the participants' lifestyles, including smoking patterns, alcohol consumption, Activities of Daily Living (ADL) [26], and Instrumental Activities of Daily Living (IADL) [27], were also gathered. Fracture risk was assessed employing the Fracture Risk Assessment Tool (FRAX) [28]. The FRAX utilizes 11 clinical factors, including age, sex, and fracture history, to estimate the 10-year probability of major osteoporotic fractures (such as those in the spine, hip, forearm, and humerus) or hip fractures. A high fracture risk, as defined by the FRAX, occurs when the 10-year hip fracture risk is equal to or greater than 3% or the major osteoporosis risk is equal to or greater than 20%. FRAX is versatile and can be used with or without

a bone mineral density (BMD) scan, providing guidance for further Dual-energy X-ray Absorptiometry (DEXA) or AOM treatment. The guideline also defines osteoporosis as a T-score of ≤-2.5 at the lumbar spine, total hip, or femoral neck, and osteopenia as a T-score between -2.5 and -1. This information aids in determining the need for additional AOM [29].

Interventions

The interventions were designed to optimize participant engagement and encourage active participation in seeking treatment. In both the MIC and OC groups, five interventions were implemented: medical professionals and specialists, enhancing disease knowledge, overcoming geographic barriers, peer support, and dedicated case managers. However, only the first two interventions and mobile DEXA units were implemented in the UC group. Table 1 presents the details of the five interventions used in our study.

Table 1. Specific interventions implemented in the three groups (MIC, OC, UC).

	Multicomponent integrated care	Osteoporosis care only	Usual care
Medical Professionals and Specialists: Osteoporosis care experts offered their medical insights. For instance, these professionals assessed whether further evaluation and treatment were necessary based on fracture risk or BMD results [30].	✓	✓	✓
Enhancing Disease Knowledge: Educational initiatives, such as a concise 15-min lecture on osteoporosis by Dr. Fu, were conducted to enhance participants' understanding of their condition and improve their health literacy.	✓	✓	✓
Overcoming Geographic Barriers: **a.** A mobile DEXA[a] unit was utilized to obtain accurate bone health results for the participants. **b.** To overcome geographical limitations, we provided facilitated transportation to a hospital for individuals requiring further examinations and treatment.	✓	✓	✓[c]
Peer Support: Anonymized presentation of BMD and fracture risk data within CMS[b] centers encouraged participants to engage with their results and fostered peer discussions.	✓	✓	
Dedicated Case Managers: Assigned case managers offered valuable guidance and support, ensuring participants had seamless access to hospital examinations and necessary treatments.	✓	✓	

[a]DEXA: Dual-energy X-ray Absorptiometry

[b]CMS: Congregated Meal Services

[c] Mobile DEXA services were also provided to the participants in the usual care group.

Individuals assigned to the UC group underwent comprehensive data collection encompassing baseline characteristics and FRAX calculations. Furthermore, owing to ethical considerations, a detailed assessment of osteoporosis status was provided, accompanied by an identical, concise osteoporosis lecture. No additional intervention was administered.

Outcome ascertainment

The primary outcomes of this study were the proportion of participants who visited the outpatient clinic and received definitive AOM treatment within the first year after screening. The differences in these proportions among the three groups were analyzed.

We also explored several secondary outcomes. Our aim was to gauge the residents' receptiveness to treatment under diverse circumstances.

1. The immediate disclosure of fracture risk, as determined by the FRAX following screening, was intended to evaluate the comprehension of future fracture risk concepts among elderly rural residents.
2. Delayed communication of BMD results by one month post screening aimed at assessing the comprehension and significance attributed to the concept of osteoporosis within this demographic.

Additionally, we sought to identify factors impeding hospital arrival among individuals recommended for hospitalization.

Statistical analysis

We used the chi-square test to compare differences among the three groups regarding the proportion of visits to the outpatient clinic and the proportion of patients who received AOM (MIC vs. UC, OC vs. UC, and MIC vs. OC).

For our secondary outcome, we focused on factors influencing the participants' hospital arrivals within the MIC and OC groups. The UC group was excluded from the analysis due to incomplete intervention. Overall, 269 individuals (116 in the MIC group and 153 in the OC group) were recommended to the hospital for further management, while 60 individuals did not achieve this even after our robust interventions (Table 3). A multivariate logistic regression model was employed to assess the risk factors hindering the elderly from receiving AOM therapy when deemed necessary. Older individuals in the MIC and OC groups were included in this analysis, and their baseline characteristics were evaluated (Table 2).

All statistical analyses were conducted using SAS software, Version 9.4 (SAS Institute, Cary, NC, USA), and two-sided statistical testing was performed with an α-significance level of 0.05.

Results

The 31 CMS centers were randomized into one of three groups: 1. MIC (11 CMS centers), and 2. OC (10 CMS centers), and 3. UC (10 CMS centers). One CMS in MIC group closed shortly after randomization because of the COVID-19 pandemic and a lack of financial support (Supplement figure 2.). Of the remaining participants in 30 CMS, 48 were excluded, and 70 refused to participate.

Baseline characteristics

Among the 567 individuals included in the study (Table 2), 178, 201, and 188 were included in the MIC, OC, and 188 in UC group, respectively. The participants had an average age 74.8 (SD 8.7), and 460 (81.1%) were female. Additionally, 157 (27.7%) participants were illiterate, 212 (37.4%) had completed only elementary school, 116 (20.5%) were living alone, 355 (62.6%) were retired, and 383 (67.5%) had a monthly disposable budget of less than 10,000 NTD (320 USD). As for comorbidity, the participants had 1.4 (SD 1.2) comorbidities in average, and they had an average 3.9 (SD 1.3) points of Charlson comorbidity index. Of the total participants, only 11 (1.9%) were current smokers and 41 (7.3%) consumed alcohol. The average ADL score among the participants was 98.6 (SD 4.8), with males averaging a score of 4.9 (SD 0.3) and females averaging a score of 7.6 (SD 1.0). Regarding osteoporosis, 129 (22.8%) participants had been screened for osteoporosis before this study, 17 (3.0%) had been treated in the past, 18 (3.2%) had been diagnosed with

osteoporosis but not treated, and 43 (7.6%) had received current osteoporosis treatment. According to the FRAX, 447 (78.8%) patients had a high-risk of fracture. After the DEXA scan, 204 (36 %) of the 567 study patients had osteopenia, and 314 (55.4%) had osteoporosis.

Table 2. Baseline characteristics

	Multicomponent integrated care (n=178)	Osteoporosis care only (n=201)	Usual care (n=188)	Total (N=567)
Sex (Female, %)	134 (75.3%)	173 (86.1%)	153 (81.4%)	460 (81.1%)
Age (mean, SD)	74.3 (SD 8.8)	74.4 (SD 8.6)	75.6 (SD 8.7)	74.8 (SD 8.7)
BMI (mean, SD)	24.7 (SD 3.3)	25.1 (SD 3.9)	24.3 (SD 3.8)	24.7 (SD 3.7)
Education				
Illiteracy (n, %)	42 (23.6%)	51 (25.4%)	64 (34.0%)	157 (27.7%)
elementary school (n, %)	66 (37.1%)	74 (36.8%)	72 (38.3%)	212 (37.4%)
Living alone (n, %)	34 (19.1%)	40 (19.9%)	42 (22.3%)	116 (20.5%)
Retired (n, %)	116 (65.2%)	123 (61.2%)	116 (61.7%)	355 (62.6%)
Disposable budget < NTD[a] $10,000 (US $320)[b] (n, %)	112 (62.9%)	135 (67.2%)	136 (72.3%)	383 (67.5%)
Comorbidity No. (mean, SD)	1.4 (SD 1.1)	1.4 (SD 1.2)	1.4 (SD 1.2)	1.4 (SD 1.2)
Fracture history (yes, %)	23 (12.9%)	35 (17.4%)	30 (16%)	88 (15.5%)
Charlson comorbidity index (mean, SD)	3.9 (SD 1.3)	3.9 (SD 1.3)	4.0 (SD 1.3)	3.9 (SD 1.3)
Current smoker (n, %)	3 (1.7%)	2 (1.0%)	6 (3.2%)	11 (1.9%)
Alcohol drinking (n, %)	18 (10.1%)	12 (6.0%)	11 (5.9%)	41 (7.3%)
ADL[c] (mean, SD)	98.5 (SD 5.3)	98.7 (SD 4.3)	98.7 (SD 5.0)	98.6 (SD 4.8)
IADL[d] (mean, SD)	M[e]: 5.0 (SD 0.2) F[f]: 7.7 (SD 0.8)	M: 4.9 (SD 0.4) F: 7.6 (SD 1.1)	M: 4.9 (SD 0.3) F: 7.6 (SD 1.1)	M: 4.9 (SD 0.3) F: 7.6 (SD 1.0)
Have been screened for osteoporosis (n, %)	42 (23.6%)	44 (21.9%)	43 (22.9%)	129 (22.8%)
Diagnosed osteoporosis but not treated (n, %)	8 (4.5%)	6 (3.0%)	4 (2.1%)	18 (3.2%)
Have been treated in the past (n, %)	2 (1.1%)	8 (4.0%)	7 (3.7%)	17 (3.0%)
Current osteoporosis treatment (n, %)	12 (6.7%)	12 (6.0%)	19 (10.1%)	43 (7.6%)
FRAX[g] high fracture risk (n, %)	134 (75.3%)	152 (75.6%)	161 (85.6%)	447 (78.8%)
Osteopenia (n, %)	66 (37.3%)	76 (38%)	62 (33%)	204 (36%)
Osteoporosis (n, %)	87 (48.9%)	115 (57.2%)	112 (59.6%)	314 (55.4%)

[a]NTD: New Taiwan Dollar.

[b]A currency exchange rate of NTD $1=US $0.032 is applicable.
[c]ADL: Activities of Daily Living.
[d]IADL: Instrumental Activities of Daily Living.
[e]M: male.
[f]F: female.
[g]FRAX: Fracture Risk Assessment Tool.

Evaluation outcomes

As shown in Table 3, a higher percentage of participants in the MIC and OC groups (66.4% (77/116) and 84.3% (129/153), respectively) were willing to receive further management after being informed of their BMD results and receiving a short talk than those who only received their FRAX results (65.6% (76/116) and 77.1% (118/201), respectively). The UC group had the highest initial willingness to receive further management in the hospital (91.8% (134/153)), but the proportion of participants who visited the outpatient clinic and received AOM was significantly lower than that in the MIC group and OC group without the aid of interventions including "facilitated transportation," "peer support," and "dedicated case managers."

In the MIC group (Table 3, Figure 1), 116 participants were recommended further medical management in hospitals. Of these, 73.3% (85/116) visited the outpatient clinic after all interventions and 58.6% (68/116) received AOM. In the UC group, 146 participants were recommended further medical management in hospitals after receiving the FRAX results; however, only 4.1% (6/146) visited the outpatient clinic and received AOM. A significant difference was found between the MIC and UC groups in terms of both the proportion of participants who visited the outpatient clinic (P<.001) and the proportion of those who received AOM (P<.001). Comparable results were observed for the OC and UC groups. In the OC group, 153 participants were recommended to the hospital, and 81% (124/153) visited the outpatient clinic after our intervention. Of these, 69.3% (106/153) received AOM. The results remained significant when comparing the OC group with the UC group (P<.001, P<.001, respectively). However, no significant differences were found between the MIC and OC groups, regardless of whether the participants visited the outpatient clinic or received AOM.

Figure 2 illustrates the most common reasons for participants not visiting hospitals after being informed of the FRAX results. The top two reasons were disbelief in having osteoporosis and the belief that osteoporosis does not necessitate treatment.

Table 3. Willing to be surveyed in hospital and receive treatment after different interventions.

		Multicomponent integrated care (n=178)	Osteoporosis care only (n=201)	Usual care (n=188)
Recommended to the hospital[a]		116	153	146
Willing to receive further management in hospitals				
	After FRAX reported	76/116 (65.6%)	118/153 (77.1%)	134/146 (91.8%)
	After BMD & short talk	77/116 (66.4%)	129/153 (84.3%)	Not asked
Final disposition				
	Visits to the outpatient clinic	85/116 (73.3%)	124/153 (81.0%)	6/146 (4.1%)
	Received AOM	68/116 (58.6%)	106/153 (69.3%)	6/146 (4.1%)

[a]Recommended to the hospital: meeting the criteria for osteoporosis or FRAX fracture risk.

[b]FRAX: Fracture Risk Assessment Tool

[c]BMD: bone mineral density

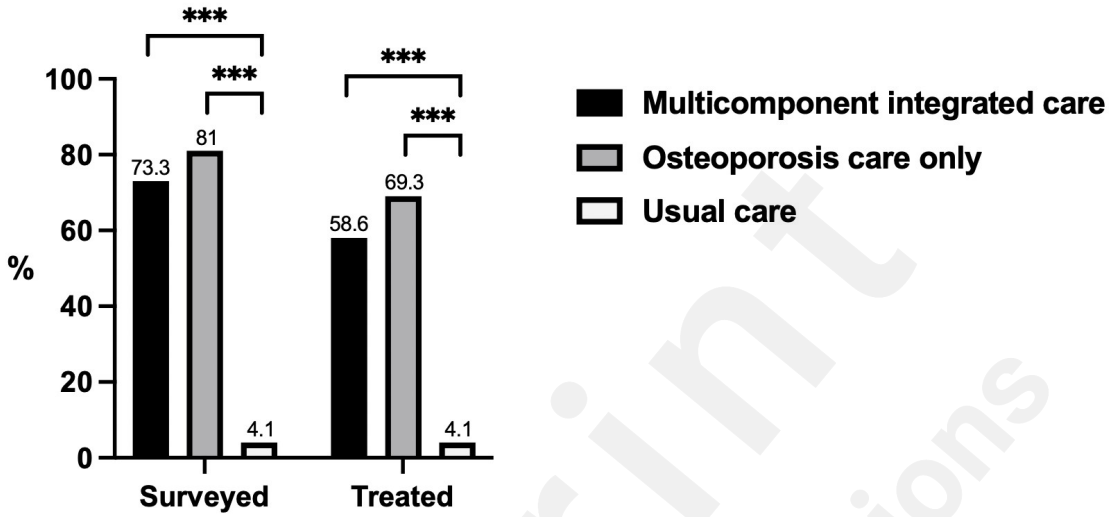

Figure 1. Comparison of proportion of participants visit the outpatient clinic and received treatment in three groups.
*** *P* <.001

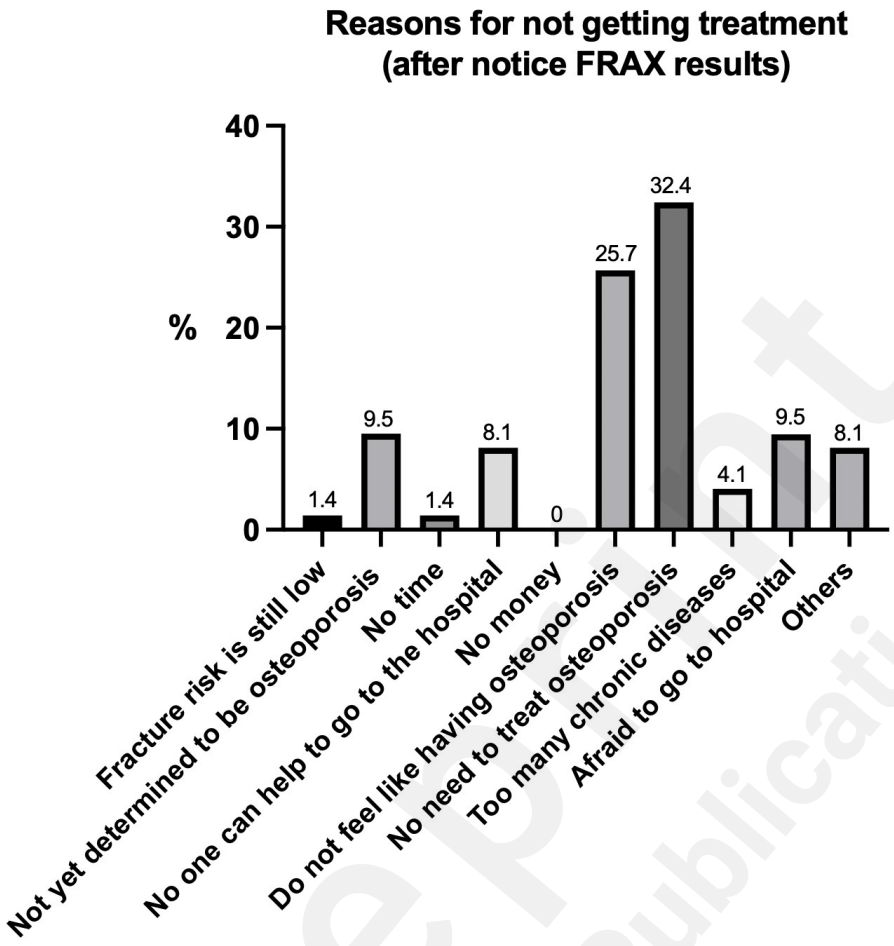

Figure 2: Reasons for participants' unwillingness to receive further management in hospitals.

Table 4. Factors that prevent participants from going to the hospital.

	Univariate	P-value	Multivariate	P-value
	OR[a] (95% CI)		OR (95% CI)	
Sex (male vs female)	3 (1.4, 6.42)	.005	3.54 (1.46, 8.59)	.005
Age (≥65 vs <65)	2.28 (0.51, 10.25)	.28		
Age (≥80 vs<80)	1.66 (0.92, 3)	.09		
BMI (18.5≦BMI□24 vs ≥24)	0.78 (0.44, 1.40)	.41		
Education				
illiterate vs others	1.25 (0.67, 2.31)	.48		
elementary or below vs others	1.92 (0.99, 3.72)	.05	2.46 (1.14, 5.32)	.02
Living alone vs not living alone	0.82 (0.40, 1.67)	.59		
Retired vs employed	1.27 (0.68, 2.40)	.45		
Disposable budget <10,000 NTD[b] vs ≥10,000	1.41 (0.67, 2.96)	.36		
Comorbidity No. (≥3 vs <3)	0.5 (0.21, 1.18)	.11	0.44 (0.18, 1.09)	.08
Fracture history (yes vs no)	1.04 (0.5, 2.18)	.92		
Charlson comorbidity index (≥4 vs <4)	1.04 (0.56, 1.95)	.90		

Current smoker (yes vs no)	1.73 (0.15, 19.4)	.66		
Alcohol drinking (yes vs no)	0 (0, 0)	.99		
ADL[c] (<100 vs 100)	1.79 (0.82, 3.92)	.15		
IADL[d] more than one disability	1.76 (0.93, 3.33)	.08	2.18 (1.05, 4.51)	.04
Have been screened for osteoporosis (no vs yes)	0.89 (0.45, 1.77)	.75		
Previous osteoporosis diagnosis (no vs yes (+/- treated))	0.79 (0.27, 2.29)	.66		
FRAX[e] moderate vs high fracture risk	1.70 (0.7, 4.18)	.24		
Osteopenia vs Osteoporosis	2.3 (1.25, 4.25)	.007	2.30 (1.15, 4.61)	.02

[a]OR: odds ratio.
[b]NTD: New Taiwan Dollar. A currency exchange rate of NTD $1=US $0.032 is applicable.
[c]ADL: Activities of Daily Living.
[d]IADL: Instrumental Activities of Daily Living.
[e]FRAX: Fracture Risk Assessment Tool.

Based on the statistics provided in Table 4, male participants exhibit less willingness to receive further hospital management compared to females (OR 3.54; 95% CI 1.46 to 8.59; *P*=.005). Similarly, participants with an elementary educational level or below display reluctance toward hospital management compared to their counterparts with higher educational degrees (OR 2.46; 95% CI 1.14–5.32; *P*=.02). Additionally, individuals grappling with one or more disabilities in the IADL questionnaire demonstrate disinclination toward hospital management compared to those without IADL disabilities (OR 2.18; 95% CI 1.05–4.51; *P*=.04). Moreover, participants diagnosed with osteopenia show hesitancy toward hospital management compared to those with osteoporosis (OR 2.3; 95% CI 1.15–4.61; *P*=.02).

Discussion

Principal findings

Rural communities face unique challenges, such as limited access to healthcare, financial constraints, and health disparities [1-4]. These challenges results in shortages of healthcare professionals [4-7], insufficient health literacy [6,8], socio-cultural dynamics [4,6], geographical remoteness [6-9], transportation difficulties [4,6,9,10], economic constraints [4,8], and inconsistent doctor-patient relationships [6,11], collectively contributing to barriers to accessing healthcare in rural areas.

Our study highlights the positive impact of a multi-intervention approach in increasing treatment willingness for chronic diseases such as osteoporosis within rural communities. We found that a comprehensive strategy that encompasses a spectrum of interventions, including incorporating medical professionals and specialists, heightened disease awareness, surmounting geographical obstacles, peer support networks, and dedicated case management, is effective in addressing healthcare disparities. Our study results underscore the importance of each intervention component, as the absence of any could compromise the efficacy of rural healthcare approaches and potentially lead to the failure

of other intervention components. These findings align seamlessly with the core objective of our study, robustly affirming the necessity for multifaceted interventions to improve treatment adherence rates for chronic ailments such as osteoporosis in rural settings.

Our findings demonstrate that with solely three interventions, encompassing “medical professionals and specialists,” “enhancing disease knowledge,” and “mobile DEXA unit,” implemented in the UC group, have minimal impact. Despite providing FRAX results, BMD scores, and osteoporosis information, only 4.1% of patients in the UC group sought follow-up treatment. Incorporating interventions such as, “facilitated transportation,” “peer support,” and “dedicated case manager” enhanced outcomes. Transportation interventions address rural health challenges and provide access to care. In the MIC and OC groups, displaying BMD score rankings in the CMS centers fostered peer support and motivated participants to pursue treatment. Case managers ensured streamlined appointments and treatment. Notably, interventions “medical professionals and specialists” and “enhancing disease knowledge” remain pivotal irrespective of other measures. The analysis revealed that osteopenia was a risk factor for reduced hospital visits compared with patients diagnosed with osteoporosis (osteopenia vs. osteoporosis: OR=2.3). Misconceptions about osteoporosis could have prevented participants from seeking medical treatment, as illustrated in Figure 2. Awareness improved after the BMD scores and health discussions in the MIC and OC groups. Importantly, some individuals needing treatment due to higher fracture risk hesitate due to “osteopenia” instead of “osteoporosis” BMD scores. The term “osteoporosis” holds more weight than “hip fracture>3% in 10 years,” increasing care-seeking behavior. Unlike the abstract notion of fracture risk, the public familiarity with “osteoporosis” encourages action. Multiple interventions are crucial to boost the treatment of osteoporosis in rural areas.

Comparison with prior work

The suitability of large-scale community fracture risk screening RCTs, commonly employed in developed nations, for rural areas is hindered for several key reasons [31-33]. First, the use of the FRAX questionnaire requires participants, particularly the elderly, to be literate. However, approximately 27.7% of rural residents are illiterate, and even those with a basic education (37.4%) struggle to understand the questionnaire. Second, participant engagement is crucial; however, previous trials have faced challenges. In the SOS study, 24% dropped out before undergoing DEXA scans [32], and the ROSE study observed a lack of interest in DEXA scans among 12%, with 17% not attending [34]. Even in the SCOOP study [31], renowned for reducing hip fracture incidence, the experimental group saw treatment rates of approximately 15% within the first year and approximately 24% within 5 years, still demonstrating relatively low proportions. Third, previous trials required a strong network of general practitioners or family physicians for health education and consultation, which were absent in rural areas. Fourth, to apply these methods in other studies, we must address challenges related to transportation and clinical registration obstacles. These issues are effectively tackled by our interventions “facilitated transportation” and “dedicated case manager.” Through the interventions introduced in our study, we increased the treatment proportions to 60–70% in both the MIC and OC groups. This ratio significantly surpasses that of previous studies [31-33], signifying a potentially enduring enhancement of bone health among elderly residents.

Identifying hindering risk factors

We revealed that participants who are male, have an educational level of elementary school or below, experience one or more IADL disabilities, or have osteopenia are less willing to engage in hospital management.

Male sex emerged as the strongest risk factor hindering rural residents from arriving at outpatient clinics for osteoporosis treatment. Several studies have highlighted the lower disease screening rates among men compared to women [35-37]. Borkhoff et al. found that men have lower screening rates for both cancer and chronic diseases, such as diabetes and high cholesterol [35]. Lo et al. demonstrated that men had a lower participation rate in three consecutive years of screening invitations compared to women. However, our study specifically highlights how a lower educational level, particularly below elementary education, hinders hospital attendance. Hansen et al. discovered that individuals with secondary education (>10 years) exhibited better treatment persistence than those with primary education (> 10 years) [38]. Patients with limited education demonstrated lower health literacy, thereby reducing their inclination to seek hospital treatment [39]. Moreover, patients with multiple IADL disabilities are less inclined to visit hospitals. Although few studies have addressed the link between IADL and osteoporosis treatment, some have associated physical and mental activity with medication compliance [40,41]. Tomioka et al. pointed out the association between IADL and social participation [42], and some studies emphasized the interaction between IADL and physical and leisure activities [43,44], thus emphasizing the multifaceted role of IADL. Furthermore, the term "osteopenia" diminishes participants' health consciousness and willingness to seek medical care. Contrasting "osteopenia" with "osteoporosis," we posit, weakens health awareness, thereby reducing hospital visits. McHorney et al. reported that patients diagnosed with osteopenia exhibited lower AOM adherence rates than those with osteoporosis [45]. Considering these insights, we propose that interventions aimed at increasing AOM adherence should prioritize male sex, individuals with limited education (elementary or lower), those with multiple IADL disabilities, and those diagnosed with osteopenia.

Limitations

It is challenging to ascertain the impact of each component, such as whether medical professionals and specialists are more crucial than geographical barriers or dedicated case managers. The UC group exhibited a lower proportion of individuals seeking medical care without the latter three interventions. However, in the absence of the former two interventions—medical professionals and specialists or Enhancing Disease Knowledge—rural community residents may have a limited understanding of osteoporosis, thus reducing their likelihood of prioritizing and complying with treatment. Therefore, all intervention measures are indispensable.

Both MIC and OC groups underwent the same osteoporosis intervention. However, the MIC group incorporated additional measures such as exercise or nutrition, potentially influencing their willingness to engage in osteoporosis interventions. Nevertheless, since our osteoporosis interventions under multicomponent integrated care (MIC) commenced earlier than the other measures, patients were less likely to be impacted by these

additional interventions. The comparable proportion of the OC group receiving osteoporosis treatment suggests that subsequent interventions in the MIC did not significantly affect osteoporosis interventions.

Conclusions

Our intervention significantly increased hospital arrival and treatment rates for the MIC and OC groups compared to the UC group. This underscores the necessity of implementing multiple interventions to enhance osteoporosis treatment rates in rural areas. Identified risk factors hindering hospital visits include male sex, low education level, multiple disabilities, and osteopenia diagnosis. Future studies should prioritize investigating these factors to develop targeted strategies aimed at improving access to osteoporosis treatments in rural communities. Effectively addressing healthcare access in rural areas requires diverse solutions, such as bolstering the healthcare workforce, improving health literacy, fostering strong doctor-patient relationships, and enhancing transportation options. Through collaborative efforts, we can ensure equitable access to medical care regardless of the location.

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Conflicts of Interest

none declared.

Abbreviations

AOM: anti-osteoporosis medication
MIC: Multicomponent Integrated care
OC: Osteoporosis care only
UC: Usual care

HOPE: Healthy Longevity and Aging in Place
CMS: Congregated Meal Services
ADL: Activities of Daily Living
IADL: Instrumental Activities of Daily Living
FRAX: Fracture Risk Assessment Tool
BMD: bone mineral density
DEXA: Dual-energy X-ray Absorptiometry
NTD: New Taiwan Dollar
USD: US Dollar
M: male
F: female
OR: odds ratio

References

1. Smith KB, Humphreys JS, Wilson MG. Addressing the health disadvantage of rural populations: how does epidemiological evidence inform rural health policies and research?. Aust J Rural Health. 2008;16(2):56-66. doi:10.1111/j.1440-1584.2008.00953.x
2. Meit MB, Knudson A, Gilbert TA, Yu AT, Tanenbaum E, Ormson E. (2014). The 2014 Update of the Rural-Urban Chartbook. URL: https://www.ruralhealthresearch.org/webinars/rural-urban-chartbook
3. Harris JK, Beatty K, Leider JP, Knudson A, Anderson BL, Meit M. The Double Disparity Facing Rural Local Health Departments. Annu Rev Public Health. 2016;37:167-184. doi:10.1146/annurev-publhealth-031914-122755
4. Douthit N, Kiv S, Dwolatzky T, Biswas S. Exposing some important barriers to health care access in the rural USA. Public Health. 2015;129(6):611-620. doi:10.1016/j.puhe.2015.04.001
5. Peterson LE, Bazemore A, Bragg EJ, Xierali I, Warshaw GA. Rural-urban distribution of the U.S. Geriatrics physician workforce. J Am Geriatr Soc. 2011;59(4):699-703. doi:10.1111/j.1532-5415.2011.03335.x
6. Brundisini F, Giacomini M, DeJean D, Vanstone M, Winsor S, Smith A. Chronic disease patients' experiences with accessing health care in rural and remote areas: a systematic review and qualitative meta-synthesis. Ont Health Technol Assess Ser. 2013;13(15):1-33. PMID: 24228078; PMCID: PMC3817950.
7. Ford DM. Four persistent rural healthcare challenges. Healthc Manage Forum. 2016;29(6):243-246. doi:10.1177/0840470416658903
8. Hay-McCutcheon MJ, Yuk MC, Yang X. Accessibility to Hearing Healthcare in Rural and Urban Populations of Alabama: Perspectives and A Preliminary Roadmap for Addressing Inequalities. J Community Health. 2021;46(4):719-727. doi:10.1007/s10900-020-00943-4
9. Chan L, Hart LG, Goodman DC. Geographic access to health care for rural Medicare beneficiaries. J Rural Health. 2006;22(2):140-146. doi:10.1111/j.1748-0361.2006.00022.x
10. Syed ST, Gerber BS, Sharp LK. Traveling towards disease: transportation barriers to health care access. J Community Health. 2013;38(5):976-993. doi:10.1007/s10900-013-9681-1

11. Gjessing K, Faresjö T. Exploring factors that affect hospital referral in rural settings: a case study from Norway. Rural Remote Health. 2009;9(1):975. PMID: 19199374.
12. Tan AC, Emmerton L, Hattingh HL. A review of the medication pathway in rural Queensland, Australia. Int J Pharm Pract. 2012;20(5):324-339. doi:10.1111/j.2042-7174.2012.00193.x
13. Koebisch SH, Rix J, Holmes MM. Recruitment and retention of healthcare professionals in rural Canada: A systematic review. Can J Rural Med. 2020;25(2):67-78. doi:10.4103/CJRM.CJRM_43_19
14. Mohammed KA, Subramaniam DS, Geneus CJ, et al. Rural-urban differences in human papillomavirus knowledge and awareness among US adults. Prev Med. 2018;109:39-43. doi:10.1016/j.ypmed.2018.01.016
15. Pugh A, Castleden H, Giesbrecht M, Davison C, Crooks V. Awareness as a dimension of health care access: exploring the case of rural palliative care provision in Canada. J Health Serv Res Policy. 2019;24(2):108-115. doi:10.1177/1355819619829782
16. Yuan F, Qian D, Huang C, et al. Analysis of awareness of health knowledge among rural residents in Western China. BMC Public Health. 2015;15:55. doi:10.1186/s12889-015-1393-2
17. Pérez Fernández MR, Almazán Ortega R, Martínez Portela JM, Alves Pérez MT, Segura Iglesias MC, Pérez Fernández R. Intervención educativa para la prevención de osteoporosis en un servicio de Atención Primaria rural [Educational intervention for the prevention of osteoporosis in a rural primary healthcare service]. Med Clin (Barc). 2013;141(12):519-521. doi:10.1016/j.medcli.2013.02.041
18. Wercholuk AN, Parikh AA, Snyder RA. The Road Less Traveled: Transportation Barriers to Cancer Care Delivery in the Rural Patient Population. JCO Oncol Pract. 2022;18(9):652-662. doi:10.1200/OP.22.00122
19. Council for Science and Technology (2021) Correspondence. Harnessing technology for the long-term sustainability of the UK's healthcare system: report. URL: https://www.gov.uk/government/publications/harnessing-technology-for-the-long-term-sustainability-of-the-uks-healthcare-system/harnessing-technology-for-the-long-term-sustainability-of-the-uks-healthcare-system-report#contents
20. Dzau VJ, McClellan MB, McGinnis JM, et al. Vital Directions for Health and Health Care: Priorities From a National Academy of Medicine Initiative. JAMA. 2017;317(14):1461-1470. doi:10.1001/jama.2017.1964
21. Lee MT, Fu SH, Hsu CC, et al. Epidemiology and clinical impact of osteoporosis in Taiwan: A 12-year trend of a nationwide population-based study. J Formos Med Assoc. 2023;122 Suppl 1:S21-S35. doi:10.1016/j.jfma.2023.05.001
22. Butcher NJ, Monsour A, Mew EJ, et al. Guidelines for Reporting Outcomes in Trial Reports: The CONSORT-Outcomes 2022 Extension. JAMA. 2022;328(22):2252-2264. doi:10.1001/jama.2022.21022
23. Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C.(Taiwan). URL: https://eng.dgbas.gov.tw/Default.aspx
24. Dept. of Household Registration, Ministry of the Interior. Republic of

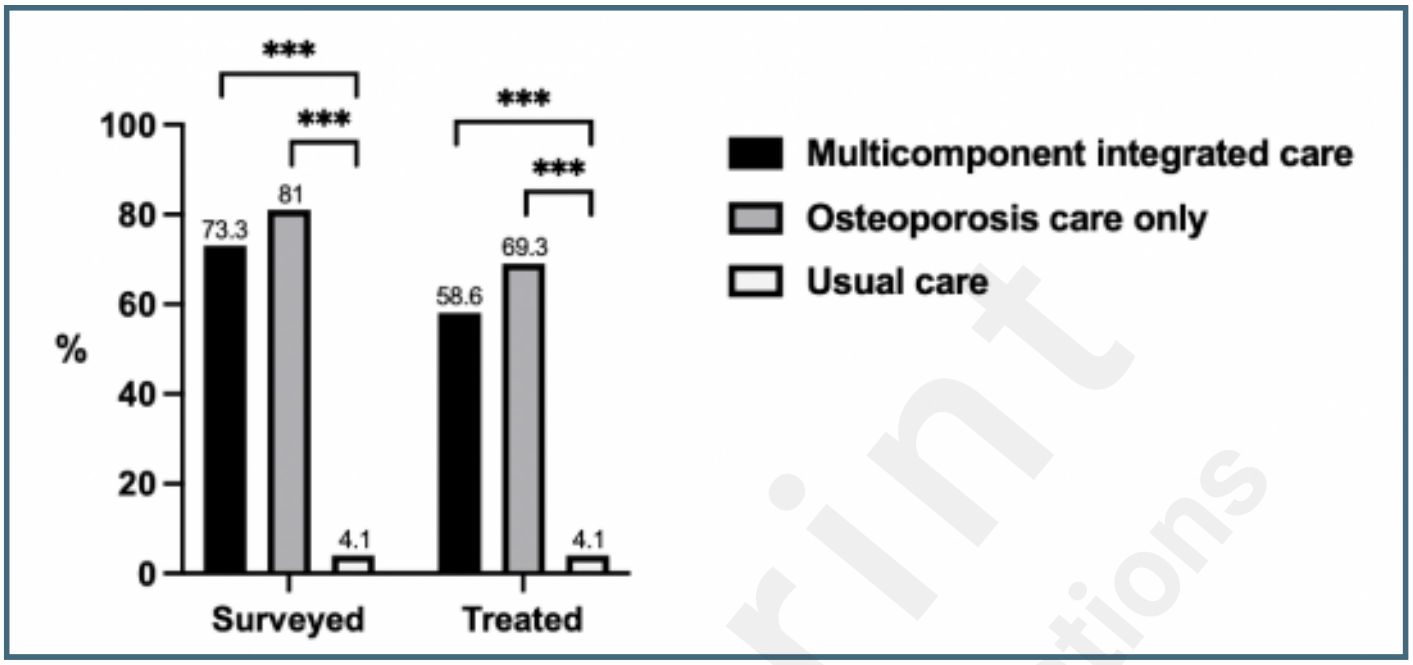
China(Taiwan). URL: https://www.ris.gov.tw/app/en
25. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373-383. doi:10.1016/0021-9681(87)90171-8
26. KATZ S, FORD AB, MOSKOWITZ RW, JACKSON BA, JAFFE MW. STUDIES OF ILLNESS IN THE AGED. THE INDEX OF ADL: A STANDARDIZED MEASURE OF BIOLOGICAL AND PSYCHOSOCIAL FUNCTION. JAMA. 1963;185:914-919. doi:10.1001/jama.1963.03060120024016
27. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9(3):179-186.
28. Kanis JA, Johnell O, Oden A, Johansson H, McCloskey E. FRAX and the assessment of fracture probability in men and women from the UK. Osteoporos Int. 2008;19(4):385-397. doi:10.1007/s00198-007-0543-5
29. Tai TW, Huang CF, Huang HK, et al. Clinical practice guidelines for the prevention and treatment of osteoporosis in Taiwan: 2022 update. J Formos Med Assoc. 2023;122 Suppl 1:S4-S13. doi:10.1016/j.jfma.2023.01.007
30. LeBoff MS, Greenspan SL, Insogna KL, et al. The clinician's guide to prevention and treatment of osteoporosis [published correction appears in Osteoporos Int. 2022 Jul 28;:]. Osteoporos Int. 2022;33(10):2049-2102. doi:10.1007/s00198-021-05900-y
31. Shepstone L, Lenaghan E, Cooper C, et al. Screening in the community to reduce fractures in older women (SCOOP): a randomised controlled trial. Lancet. 2018;391(10122):741-747. doi:10.1016/S0140-6736(17)32640-5
32. Merlijn T, Swart KM, van Schoor NM, et al. The Effect of a Screening and Treatment Program for the Prevention of Fractures in Older Women: A Randomized Pragmatic Trial. J Bone Miner Res. 2019;34(11):1993-2000. doi:10.1002/jbmr.3815
33. Rubin KH, Rothmann MJ, Holmberg T, et al. Effectiveness of a two-step population-based osteoporosis screening program using FRAX: the randomized Risk-stratified Osteoporosis Strategy Evaluation (ROSE) study. Osteoporos Int. 2018;29(3):567-578. doi:10.1007/s00198-017-4326-3
34. Rothmann MJ, Möller S, Holmberg T, et al. Non-participation in systematic screening for osteoporosis-the ROSE trial. Osteoporos Int. 2017;28(12):3389-3399. doi:10.1007/s00198-017-4205-y
35. Borkhoff CM, Saskin R, Rabeneck L, et al. Disparities in receipt of screening tests for cancer, diabetes and high cholesterol in Ontario, Canada: a population-based study using area-based methods. Can J Public Health. 2013;104(4):e284-e290. Published 2013 Jun 21. doi:10.17269/cjph.104.3699
36. Dryden R, Williams B, McCowan C, Themessl-Huber M. What do we know about who does and does not attend general health checks? Findings from a narrative scoping review. BMC Public Health. 2012;12:723. Published 2012 Aug 31. doi:10.1186/1471-2458-12-723
37. Lo SH, Halloran S, Snowball J, Seaman H, Wardle J, von Wagner C. Colorectal cancer screening uptake over three biennial invitation rounds in the English bowel cancer screening programme. Gut. 2015;64(2):282-291.

doi:10.1136/gutjnl-2013-306144
38. Hansen C, Pedersen BD, Konradsen H, Abrahamsen B. Anti-osteoporotic therapy in Denmark--predictors and demographics of poor refill compliance and poor persistence. Osteoporos Int. 2013;24(7):2079-2097. doi:10.1007/s00198-012-2221-5
39. Roh YH, Koh YD, Noh JH, Gong HS, Baek GH. Effect of health literacy on adherence to osteoporosis treatment among patients with distal radius fracture. Arch Osteoporos. 2017;12(1):42. doi:10.1007/s11657-017-0337-0
40. Huas D, Debiais F, Blotman F, et al. Compliance and treatment satisfaction of post menopausal women treated for osteoporosis. Compliance with osteoporosis treatment. BMC Womens Health. 2010;10:26. Published 2010 Aug 20. doi:10.1186/1472-6874-10-26
41. Berecki-Gisolf J, Hockey R, Dobson A. Adherence to bisphosphonate treatment by elderly women. Menopause. 2008;15(5):984-990. doi:10.1097/gme.0b013e31816be98a
42. Tomioka K, Kurumatani N, Hosoi H. Association Between Social Participation and Instrumental Activities of Daily Living Among Community-Dwelling Older Adults. J Epidemiol. 2016;26(10):553-561. doi:10.2188/jea.JE20150253
43. Komatsu M, Obayashi K, Tomioka K, et al. The interaction effect between physical and cultural leisure activities on the subsequent decline of instrumental ADL: the Fujiwara-kyo study. Environ Health Prev Med. 2019;24(1):71. Published 2019 Dec 1. doi:10.1186/s12199-019-0826-4
44. Ukawa S, Tamakoshi A, Tani Y, et al. Leisure activities and instrumental activities of daily living: A 3-year cohort study from the Japan Gerontological Evaluation Study. Geriatr Gerontol Int. 2022;22(2):152-159. doi:10.1111/ggi.14334
45. McHorney CA, Schousboe JT, Cline RR, Weiss TW. The impact of osteoporosis medication beliefs and side-effect experiences on non-adherence to oral bisphosphonates [published correction appears in Curr Med Res Opin. 2008 Mar;24(3):707]. Curr Med Res Opin. 2007;23(12):3137-3152. doi:10.1185/030079907X242890

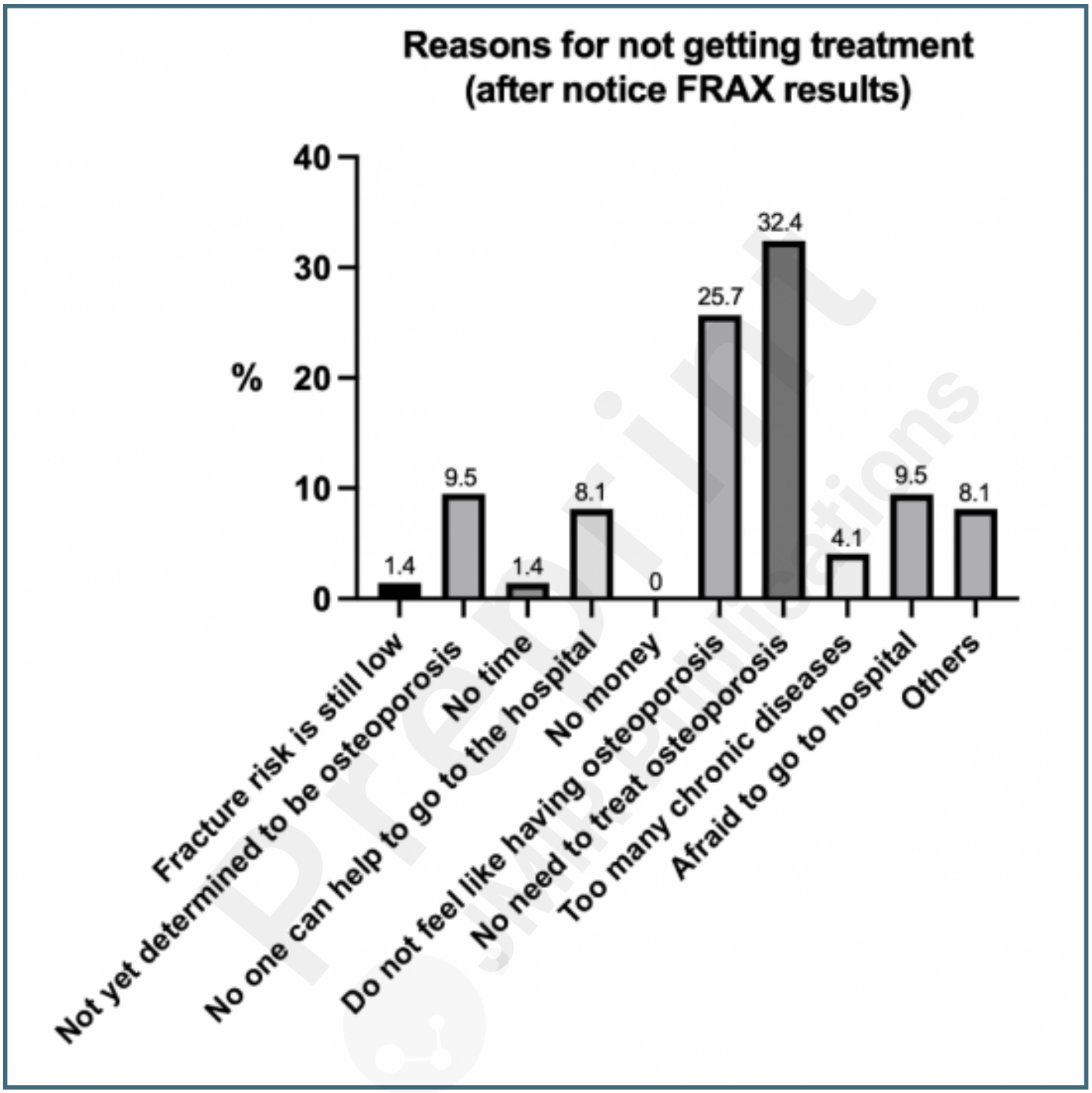
Supplementary Files

Figures

Comparison of proportion of participants visit the outpatient clinic and received treatment in three groups.



Reasons for participants' unwillingness to receive further management in hospitals.



Multimedia Appendixes

Supplement figure 1. Study flow chart. Supplement figure 2. Participant flow.
URL: http://asset.jmir.pub/assets/9bd3dd31e131c92efecf7c902d8c1abf.docx

CONSORT (or other) checklists

the CONSORT-Outcomes 2022 extension.
URL: http://asset.jmir.pub/assets/7212ca75808d83319cdd5de5ad9afb40.pdf