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ORIGINAL ARTICLE

# Assessing Fracture Risk (FRAX) and Falls Risk among the Elderly in a Specialist Primary Care Clinic in Klang Valley, Malaysia

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## ABSTRACT

**Introduction:** The fracture risk assessment (FRAX) is a tool to assess the fracture risk among the elderly. However, FRAX does not include other domains of fall risk and this can be assessed using the falls risk assessment tool (FRAT). The study looks to compare the FRAX and FRAT tools, as well as the prevalence of fall risk and fracture risk and factors associated with high risk of fracture. **Methods:** This was a cross-sectional study among elderly patients aged 60 years and above who attended a specialist primary care clinic. The study tool included the sociodemographic and clinical characteristics details of the participants and the FRAX and FRAT assessment. Data were entered and analysed using SPSS version 23. **Results:** A total of 307 participants were analysed with a mean age of 68.1 (SD=6.1). The prevalence for high fracture risk and high fall risk was 23.5% (95% CI: 18.7, 28.2) and 26.7% (95% CI: 21.7, 31.7) respectively. Six factors were found to be associated with high fracture risk. These six factors were higher age group ($P$<0.001), non-Malay ethnicity ($P$=0.004), patients on calcium supplements ($P$=0.003), medical history of gout ($P$=0.048), lower BMI categories ($P$<0.001) and history of previous fracture ($P$<0.001). The study also found that there was no correlation between FRAX and FRAT calculation [κ = 0.10 (95%CI: -0.02, 0.21), $P$=0.079]. **Conclusion:** FRAX calculation predicts fracture risk but does not include all of the domains of fall risk. Clinicians need to assess fall risk (FRAT) on top of the FRAX among the elderly for a more accurate fracture risk assessment.

**KEYWORDS: Osteoporosis, fracture risk, FRAX, FRAT, elderly**

## INTRODUCTION

Osteoporosis is asymptomatic until a fracture occurs, often following a fall, and this results in complications that pose a significant economic and psychosocial burden upon the patient and society [1]. It is estimated that the prevalence of suboptimal bone health among elderly dwellers in Klang Valley is as high as 12.3 to 28% for osteoporosis and osteopenia respectively [2]. For this reason, it is important to identify suboptimal bone health for early prevention of falls and fractures.

The fracture risk assessment tool (FRAX) was developed in 2008 and has since been used worldwide and provides country-specific calculations to estimate the individualized 10-year probability of hip and osteoporotic fracture with or without the bone mineral density [3][4]. Although bone mineral density (BMD) measurement using the DEXA scan is still the gold standard for diagnosing osteoporosis, this is often unrealistic in low-resource settings [4]. Therefore, FRAX without BMD is often used to evaluate fracture risk and incorporated within guidelines worldwide. In Malaysia, the estimation of fracture risk recommends using FRAX with ethnic-specific algorithms from Singapore [5][6].

The FRAX model is not without its deficiencies and one of its critiques is the lack of fall risk assessment within its calculation of fracture risk [7]. In the elderly with a risk of falls, the fracture probability may be underestimated by FRAX [8]. However, one study suggested that although fall risk was not included within the FRAX calculation, high fall risk is dependent on some clinical risk factors incorporated in FRAX [8]. Therefore, there is a possibility that FRAX calculation may also be predictive of fall risk. This critique of FRAX requires further evaluation.

Scrutinizing the FRAX tool, the clinical risk factors included in FRAX are age, sex, body mass index (BMI), personal history of fracture, parental history of hip fracture, current smoking, glucocorticoid use, rheumatoid arthritis (RA), alcohol intake, and secondary osteoporosis [9]. These clinical factors do not directly measure all domains of falls risk. On the other hand, the falls risk assessment tool (FRAT) is a known tool to assess an older person's risk of falling that is easily applied in primary care. It is developed by primary care researchers for primary care use. It has a low sensitivity (42%), but high specificity (92%) [10]. The five items included in this tool are history of falls in the previous year, 4 or more prescribed medications, diagnosis of stroke or Parkinson's disease, reported problems with balance, and inability to rise from a chair without using arms. These factors are not included in the FRAX tool.

The gap is in determining whether FRAX alone indirectly includes fall risk assessment and is enough to predict fracture risk without including FRAT. The outcome will determine the clinical practice of measuring fracture risk using FRAX alone or whether is there a need to measure fall risk simultaneously. The objective of this study is to compare fall risk using FRAT and fracture risk using FRAX, the prevalence of fracture risk and fall risk, and the factors associated with fracture risk among the elderly attending a specialist primary care clinic in Selangor.

## MATERIALS AND METHODS

### Study Design

A cross-sectional study was conducted among elderly 60 years and above attending a specialist primary care clinic in Selangor. The data collection period was from December 2019 to December 2020. The sampling population was all elderly 60 years and above attending the specialist primary care clinic within the data collection period. The definition of elderly is based on the United Nations and adopted by the National Registration Department, Malaysia (11). The exclusion criteria were the following: Those previously diagnosed with chronic diseases such as chronic kidney disease stage 4 and above, underlying history of liver cirrhosis, underlying history of malabsorption, asthma, and rheumatoid arthritis, previously diagnosed with endocrine diseases such as Cushing's syndrome, hypogonadism, hypoparathyroidism, thyrotoxicosis and premature menopause, taking drugs that induced osteoporosis such as glucocorticoid, heparin, anticonvulsant, immunosuppressant, aromatase inhibitor, thiazolidinedione and hormone replacement therapy, diagnosed with osteogenesis imperfecta, underlying malignancy and underlying history of cognitive impairments which will affect the ability to answer the questions.

### Sample Size Determination

The highest sample size calculation was based on a one-year prevalence of falls among elderly Malaysians [12], which was 27%. Using the Raosoft sample size calculator, the sample size required was 299 participants with a 20% consideration of non-responders, the sample needed was 359 participants.

### Data Collection and Conduct of the Study

After receiving the registration numbers from the registration counter at the clinic, patients over 60 years old who attended the primary care clinic during the data collection days were approached by the researcher in the waiting area. A Patient Information Leaflet regarding the study was presented to them in Malay or English, and for those who agreed to participate, written informed consent was obtained. Patients who accepted were screened for eligibility criteria. Those who were eligible were invited to participate in the study.

### Materials and Study Tools

The study tool contained sociodemographic and clinical



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characteristics details of the participants including anthropometry measurements and the FRAX and FRAT calculations. The sociodemographic characteristics included age, ethnicity, gender, and education level. The clinical characteristics included a history of previous fracture, parent hip fracture, medication history such as statin and calcium use, and self-declared lifestyle information such as smoking status, alcohol consumption, tea intake, and sleep pattern. Anthropometry measurements such as height and weight were performed as per clinic protocol by the regularly trained staff. Height was recorded in meters (m) and weight in kilogram (kg) and measured using a Charder Adult scale model MS4900. The Body Mass Index (BMI) was calculated manually. After completing the anthropometric measurements, the researcher stratified the participants for their FRAX score using the FRAX online calculator and for FRAT score manually.

High fracture risk means there is an increased likelihood of fracture. For this study, high fracture risk was defined as FRAX score without BMD of a 10-year fracture probability of more than 3% for the hip or a 10-year fracture probability of more than 20% for major osteoporosis-related fractures. High fall risk means that there is an increased likelihood that a person will fall. For this study, high fall risk was defined as Fall Risk Assessment Tool (FRAT) in primary care score of ≥3.

### Data and Statistical Analysis

All the collected data were entered and analysed using Statistical Package for Social Sciences (SPSS) version 23 (SPSS, Inc., Chicago, IL, USA). Categorical variables were described in numbers and percentages whereas continuous variables were expressed as mean with standard deviation (SD). Inferential analysis was conducted to compare the sociodemographic and clinical characteristics of participants. Simple logistic regression (SLogR) was used as a preliminary analysis to identify the significant factors for high fracture risk. Variables with $p < 0.25$ were included in the Multiple Logistic Regression (MLogR) to determine the independent associated factors for high fracture risk after adjusting for the confounders. A p-value of $< 0.05$ was considered significant. The comparison between the FRAX and FRAT assessments was tested using Cohen's κ [13]. Cohen's κ. coefficient is a statistical analysis within the SPSS that looks at the inter-tool agreement or correlation, a score of 1 indicates strong agreement or correlation, and a score less than 1 shows lower agreement or correlation.

### Data and Statistical Analysis

The ethical approval for this study was obtained from the Research Ethics Committee of Universiti Teknologi MARA (600-IRMI (5/1/6)) (REC/363/19 before the conduct of the study. The authors obtained informed consent from all participants involved in the study.

## RESULTS

A total of 359 potential participants were approached and 52 patients did not fulfil eligibility criteria or refused to participate in the study. The response rate was 85.5%. The final sample of 307 participants was analysed with a mean age of 68.1 (SD =6.05). This study found that the prevalence of high fracture risk (high FRAX score) among elderly participants was 23.5% (95% CI: 18.7,28.2). The overall prevalence of high fall risk (FRAT score ≥3) was reported as 26.7% (95% CI: 21.7, 31.7).

Table 1 highlights the sociodemographic and clinical characteristics (including medication and lifestyle) of the participants. There were more male participants (57.0%), married (78.8%), Malay ethnicity (75.9%), and completed their education up to the secondary level (44.6%). The majority were obese (49.2%) with a mean BMI ± SD of 28.10 ±5.13, hypertensive (77.2%), and had Type-2 Diabetes Mellitus (53.4%). For medication history, the majority were on a statin (81.4%) and had no calcium supplementation (80.1%). In terms of lifestyle, most of the participants never smoked (65.1%), consumed no alcoholic beverages (91.5%), had no regular exercise (77.5%), and slept for less than 6 hours per day (53.1%). 50.5% of participants drank coffee more than once in 2 days.



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**Table 1** The sociodemographic and clinic characteristics, medication, lifestyle and fall risk of the participants stratified by the fracture risk status

| Variables | Fracture risk | | |
|---|---|---|---|
| | High (*n* =72) *n* (%) | Low (*n* =235) *n* (%) | Total *n* (%) |
| **Sociodemographic** | | | |
| **Age (years)**[a] | 73.8 (5.8) | 66.3 (5.0) | 68.1 (6.1) |
| **Age Classification** | | | |
| 60 to 69 | 16 (22.2) | 172 (73.2) | 188 (61.2) |
| 70 to 79 | 45 (62.5) | 60 (25.5) | 105 (34.2) |
| ≥ 80 | 11 (15.3) | 3 (1.3) | 14 (4.6) |
| **Gender** | | | |
| Male | 38 (52.8) | 137 (58.3) | 175 (57.0) |
| Female | 34 (47.2) | 98 (41.7) | 132 (43.0) |
| **Marital status** | | | |
| Single | 1 (1.4) | 3 (1.3) | 4 (1.3) |
| Married | 49 (68.1) | 193 (82.1) | 242 (78.8) |
| Widowed/Divorced | 22 (30.6) | 39 (16.6) | 61 (19.9) |
| **Ethnicity** | | | |
| Malay | 36 (50.0) | 197 (83.8) | 233 (75.9) |
| Non-Malay | 36 (50.0) | 38 (16.2) | 74 (24.1) |
| **Education level** | | | |
| No formal education | 3 (4.3) | 5 (2.1) | 8 (2.6) |
| Primary level | 24 (33.3) | 40 (17.0) | 64 (20.8) |
| Secondary level | 33 (45.8) | 104 (44.3) | 137 (44.6) |
| Tertiary level | 12 (16.7) | 86 (36.6) | 98 (31.9) |
| **BMI (kg/m$^2$)** [a] | 25.0 (4.4) | 29.1 (5.0) | 28.1 (5.1) |
| **BMI category** | | | |
| Not obese (BMI <23) | 25 (34.7) | 16 (6.8) | 41 (13.4) |
| Pre-obese (BMI 23 to 27.5) | 29 (40.3) | 86 (36.6) | 115 (37.5) |
| Obese (BMI ≥27.5) | 18 (25.0) | 133 (56.6) | 151 (49.2) |
| **Past medical history** | | | |
| **Hypertension** | | | |
| Present | 60 (83.3) | 177 (75.5) | 237 (77.2) |
| Absent | 12 (16.7) | 58 (24.7) | 70 (22.8) |
| **T2DM** | | | |
| Present | 32 (44.4) | 132 (56.2) | 164 (53.4) |
| Absent | 40 (55.6) | 103 (43.8) | 143 (46.6) |
| **CAD** | | | |
| Present | 16 (22.2) | 64 (27.2) | 80 (26.1) |
| Absent | 56 (77.8) | 171 (72.8) | 227 (73.9) |
| **Previous fracture** | | | |
| Present | 39 (54.2) | 26 (11.1) | 65 (21.2) |
| Absent | 33 (45.8) | 209 (88.9) | 242 (78.8) |
| **Parent hip fracture** | | | |
| Present | 7 (9.7) | 14 (6.0) | 21 (6.8) |
| Absent | 65 (90.3) | 221 (94.0) | 286 (93.2) |
| **Gout** | | | |



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| | | | |
|---|---|---|---|
| Present | 3 (4.2) | 36 (15.2) | 39 (12.7) |
| Absent | 69 (95.8) | 199 (84.7) | 268 (87.3) |
| **Medication history** | | | |
| **Statin** | | | |
| Present | 56 (77.8) | 194 (82.6) | 250 (81.4) |
| Absent | 16 (22.2) | 41 (17.4) | 57 (18.6) |
| **Calcium supplement** | | | |
| Present | 21 (29.2) | 40 (17.0) | 61 (19.9) |
| Absent | 51 (70.8) | 195 (83.0) | 246 (80.1) |
| **Lifestyle** | | | |
| **Smoking** | | | |
| Never | 50 (69.4) | 150 (63.8) | 200 (65.1) |
| Stop | 16 (22.2) | 64 (27.2) | 80 (26.1) |
| Active | 6 (8.3) | 21 (8.9) | 27 (8.8) |
| **Alcohol** | | | |
| Non-drinker | 55 (76.4) | 226 (96.2) | 281 (91.5) |
| Drinker | 17 (23.6) | 9 (3.8) | 26 (8.5) |
| **Daily tea** | | | |
| Yes | 35 (48.6) | 120 (51.1) | 155 (50.5) |
| No | 37 (51.4) | 115 (48.9) | 152 (49.5) |
| **Sleep (hours per day)** | | | |
| <6 | 33 (47.2) | 129 (54.9) | 163 (53.1) |
| 6 to 8 | 21 (29.2) | 79 (33.6) | 100 (32.6) |
| ≥8 | 17 (23.6) | 27 (11.5) | 44 (14.3) |
| **Frequency of coffee intake** | | | |
| Seldom | 31 (43.1) | 90 (38.3) | 121 (39.4) |
| Once per week | 4 (5.6) | 25 (10.6) | 29 (9.4) |
| >once in 2 days | 37 (51.4) | 120 (51.1) | 157 (51.1) |
| **Exercise** | | | |
| Yes | 17 (23.6) | 52 (22.1) | 69 (22.5) |
| No | 55 (76.4) | 183 (77.9) | 238 (77.5) |
| **Fall risk** | | | |
| High | 25 (34.7) | 57 (24.3) | 82 (26.7) |
| Low | 47 (65.3) | 178 (75.7) | 225 (73.3) |

[a.] Mean (SD)

Table 2 shows the factors associated with high fracture risk, using simple logistic regression for the univariate analysis of the variables interested. In this table, there were several significant factors. These were age group (p<0.001), ethnicity (p<0.001), BMI category (p<0.001), history of previous fracture (p<0.001), medical history of gout (p=0.021), patient on calcium supplement (p=0.026), alcohol drinker (p<0.001) and duration of sleep (p=0.017). Variables with a p-value < 0.05 in the univariate analysis were further analysed in the multivariable analysis using multiple logistic regression (MLogR).

Table 3 presents the factors associated with high fracture risk from the multivariable analysis. The result identified that there were six factors associated with high fracture risk. These six factors were higher age group (<0.001), non-Malay ethnicity (0.004), patients on calcium supplements (0.003), medical history of gout (0.048), lower BMI categories (<0.001), and history of previous fracture (<0.001). The model fitness was assessed using the Hosmer-Lemeshow goodness-of-fit (GOF) test and the receiver operating characteristic (ROC). The Hosmer-Lemeshow GOF model was not significant (*P*=0.372), indicating that the



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model fits well. The regression model explained 47.8% (Cox & Snell $R^2$) of the variance in high fracture risk with 73.6% sensitivity and 93.2% specificity of the cases. The ROC curve gave an area under the curve (AUC) of 0.953 which indicated that the model discriminated 95.3% of the cases (95% CI 92.7,97.9) of the patients with high fracture risk. There were no significant interactions or multicollinearity problems.

Table 4 shows the comparison between FRAT and FRAX assessments. A Cohen's κ was run to determine the possible inter-tool correlation between FRAT and FRAX on the 307 individuals. A kappa value of 1 indicates high correlation and a value less than 1 shows low inter-tool correlation. The results show that there was no significant correlation between these two assessments (fracture risk and fall risk), [κ = 0.10 (95%CI: -0.02, 0.21), p=0.079].

**Table 2** The univariate analysis of the sociodemographic, clinical characteristics, medication, lifestyle and fall risk stratified by the fracture risk status

| Variables | Fracture risk | | | | |
|---|---|---|---|---|---|
| | High *n* (%) | Low *n* (%) | *n* | $x^2$-statistic[a] (df) | *P*-value[a] |
| **Sociodemographic** | | | | | |
| **Age category** | | | | | |
| 60 to 69 | 16 (8.5) | 172 (91.5) | 188 | 69.095(2) | ref |
| 70 to 79 | 45 (42.9) | 60 (57.1) | 105 | | **0.001*** |
| ≥80 | 11 (78.6) | 3 (21.4) | 14 | | **<0.001*** |
| **Gender** | | | | | |
| Male | 38 (21.7) | 137 (78.3) | 175 | 0.685 (1) | ref |
| Female | 34 (25.8) | 98 (74.2) | 132 | | 0.408 |
| **Marital status** | | | | | |
| Single | 1 (25.0) | 3 (75.0) | 4 | 6.795 (2) | ref |
| Married | 49 (20.2) | 193 (79.8) | 242 | | 0.815 |
| Widowed/Divorced | 22 (36.1) | 39 (63.9) | 61 | | 0.591 |
| **Ethnicity** | | | | | |
| Malay | 36 (15.5) | 197 (84.5) | 233 | 34.479 (1) | ref |
| Non-Malay | 36 (48.6) | 38 (51.4) | 74 | | **<0.001*** |
| **Education level** | | | | | |
| No formal education | 3 (37.5) | 5 (62.5) | 8 | 14.802 (3) | ref |
| Primary level | 24 (37.5) | 40 (62.5) | 64 | | 1.000 |
| Secondary level | 33 (24.1) | 104 (75.9) | 137 | | 0.400 |
| Tertiary level | 12 (12.2) | 86 (87.8) | 98 | | 0.066 |
| **BMI category** | | | | | |
| Not Obese (BMI <23) | 25 (61.0) | 16 (39.0) | 41 | 43.541 (1) | **<0.001*** |
| Pre-obese(BMI 23 to 27.5) | 29 (25.2) | 86 (74.8) | 115 | | **0.006** |
| Obese (BMI ≥27.5) | 19 (11.9) | 133 (88.1) | 151 | | ref |
| **Past medical history** | | | | | |
| **Hypertension** | | | | | |
| Present | 60 (25.3) | 177 (74.7) | 237 | 2.011 (1) | 0.159 |
| Absent | 12 (17.1) | 58 (82.9) | 70 | | ref |
| **T2DM** | | | | | |
| Present | 32 (19.5) | 132 (80.5) | 164 | 2.045 (1) | 0.082 |
| Absent | 40 (28.0) | 103 (72.0) | 143 | | ref |
| **CAD** | | | | | |
| Present | 16 (20.0) | 64 (80.0) | 80 | 0.718 (1) | 0.398 |



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| | | | | | |
|---|---|---|---|---|---|
| Absent | 56 (24.7) | 171 (75.3) | 227 | | ref |
| **Previous fracture** | | | | | |
| Present | 39 (60.0) | 26 (40.0) | 65 | 61.351 (1) | **<0.001*** |
| Absent | 33 (13.6) | 209 (86.4) | 242 | | ref |
| **Parent hip fracture** | | | | | |
| Present | 7 (33.3) | 14 (66.7) | 21 | 1.226 (1) | 0.273 |
| Absent | 65 (22.7) | 221 (77.3) | 286 | | ref |
| **Gout** | | | | | |
| Present | 3 (7.7) | 36 (92.3) | 39 | 6.181 (1) | **0.021*** |
| Absent | 69 (25.7) | 199 (74.3) | 268 | | ref |
| **Medication history** | | | | | |
| **Statin** | | | | | |
| Present | 56 (22.4) | 194 (77.6) | 250 | 0.831 (1) | 0.363 |
| Absent | 16 (28.1) | 41 (71.9) | 57 | | ref |
| **Calcium supplement** | | | | | |
| Present | 21 (34.4) | 40 (65.6) | 61 | 5.106 (1) | **0.026*** |
| Absent | 51 (20.7) | 195 (79.3) | 246 | | ref |
| **Lifestyle:** | | | | | |
| **Smoking** | | | | | |
| Never | 50 (25.0) | 150 (75.0) | 200 | 0.821 (1) | ref |
| Stop | 16 (20.0) | 64 (80.0) | 80 | | 0.374 |
| Active | 6 (22.2) | 21 (77.8) | 27 | | 0.753 |
| **Alcohol** | | | | | |
| Non-drinker | 55 (19.6) | 226 (80.4) | 281 | 27.821 (1) | ref |
| Drinker | 17 (65.4) | 9 (34.6) | 26 | | **<0.001*** |
| **Daily tea** | | | | | |
| Yes | 35 (22.6) | 120 (77.4) | 155 | 0.133 (1) | 0.716 |
| No | 37 (24.3) | 115 (75.7) | 152 | | ref |
| **Sleep duration, hours:** | | | | | |
| <6 | 34 (20.9) | 129 (79.1) | 163 | 6.596 (2) | 0.978 |
| 6 to 8 | 21 (21.0) | 79 (79.0) | 100 | | **0.017*** |
| ≥8 | 17 (28.6) | 27 (61.4) | 44 | | ref |
| **Coffee intake** | | | | | |
| Seldom | 31 (25.6) | 90 (74.4) | 121 | 1.825 (2) | ref |
| Once per week | 4 (13.8) | 25 (86.2) | 29 | | 0.184 |
| >once in 2 days | 37 (23.6) | 120 (76.4) | 157 | | 0.693 |
| **Exercise** | | | | | |
| Yes | 17 (24.6) | 52 (75.4) | 69 | 0.070 (1) | 0.792 |
| No | 55 (23.1) | 183 (76.9) | 238 | | ref |
| **Fall risk** | | | | | |
| Yes | 25 (30.5) | 57 (69.5) | 82 | 3.084 (1) | 0.79 |
| No | 47 (20.9) | 178 (79.1) | 225 | | ref |

* Statistically significant at P =0.05

a Chi-square test for independence



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**Table 3** The adjusted analysis to determine the factor associated with high fracture risk (n =307)

| Variables | Adj. Beta (SE) | Wald (df)[a] | Adj. OR (95% Cl) | *P*-value[b] |
|---|---|---|---|---|
| **Age Group** | | | | |
| 60 to 69 years old | | 40.730 (2) | 1 | ref |
| 70 to79 years old | 3.14 (0.56) | 31.455 (1) | 23.19 (7.73, 69.55) | <0.001* |
| ≥ 80 years old | 6.51 (1.18) | 30.499 (1) | 73.92 (66.79, 99.38) | <0.001* |
| **Ethnicity** | | | | |
| Malay | | | 1 | ref |
| Non-Malay | 1.38 (0.48) | 8.369 (1) | 3.97 (1.56, 10.12) | 0.004* |
| **Calcium supplement** | | | | |
| Present | 1.59 (0.54) | 8.822 (1) | 4.90 (1.72, 13.99) | 0.003 |
| Absent | | | 1 | ref |
| **Gout** | | | | |
| Yes | | | 1 | ref |
| No | 1.96 (1.07) | 3.321 (1) | 7.10 (1.86, 58.44) | 0.048* |
| **BMI category** | | | | |
| Not Obese (BMI <23) | 4.42 (0.78) | 31.819 (1) | 3.33 (1.92, 28.42) | <0.001* |
| Pre-obese (BMI 23 to 27.5) | 2.345 (0.63) | 13.792 (1) | 1.43 (3.03, 35.97) | <0.001* |
| Obese (BMI ≥27.5) | | 31.820 (2) | 1 | ref |
| **History of previous fracture** | | | | |
| Yes | 4.00 (0.65) | 37.801 (1) | 54.71 (15.28, 95.93) | <0.001* |
| No | | | 1 | ref |

Adj. OR: Adjusted Odds Ratio
[a.] Likelihood Ratio (LR) test: [b] Wald test
Sensitivity: 73.6%, Specificity: 93.2%: Cox & Snell $R^2$: 47.8%
Hosmer Lemeshow test: 0.372, no multicollinearity and interaction problems.
Statistical analysis: multiple logistic regression

**Table 4** The adjusted analysis to determine the factor associated with high fracture risk (n =307)

| | | Fall Risk | | Total, *n*(%) | Kappa (95% CI) | *P*-value |
|---|---|---|---|---|---|---|
| | | High, *n* (%) | Low, *n* (%) | | | |
| **Fracture risk** | **High** | 25 (8.1) | 47 (15.3) | 72 (23.5) | 0.10 (-0.02, 0.21) | 0.079 |
| | **Low** | 57 (18.6) | 178 (58.0) | 235 (76.5) | | |
| **Total** | | 82 (26.7) | 225 (73.3) | 307 (100.0) | | |

## DISCUSSION

It is difficult to compare the prevalence findings in this study with other studies done in Malaysia since most studies do not report fracture or fall risk. The prevalence of fracture risk from this study is comparable to a study on the prevalence of osteoporosis that is 24.1% [14]. With regards to fall risk, the prevalence is 26.7% and a study reports a fall prevalence of 27% [2] and another found 19.1% [15]. However, there is a difference between the prevalence of those who fall and those who are at risk of falls. Therefore, this study has provided the first known prevalence for both, fall risk and fracture risks in Malaysia. It is worth noting that the study location is also important in the prevalence of falls, studies found those in the community have a lower prevalence of falls (4.07 – 22.6%) compared to those who are institutionalized (22.8%) and those who are in



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a medical institution (12- 74%) [16].

Higher age is associated with a higher risk of fracture among those above 80 years old having higher risk than those between 60 – 79 years old. The process of aging is known to be positively associated with the occurrence of osteoporosis [17]. With increasing age, there is accelerated bone loss due to increased bone resorption and decreased bone formation. This is explained by testosterone deficiency in men and oestrogen deficiency in women [18]. Fracture assessment in clinical practice is important in the elderly and even more so, as the patient's age increases.

Non-Malays were almost four times more likely to fracture compared to Malays This had to be interpreted with caution due to the ethnic grouping in this study. The study looked at majority Malays compared to non-Malays. The non-Malays consist of Chinese, Indians, and others. Studies have consistently found that the Chinese tend to have a higher risk of suboptimal bone health compared to the other races [2]. There have been studies looking specifically at osteoporosis among Malaysian Chinese to identify factors associated with suboptimal bone health. A study found that older age, low monthly income, and low body weight are factors for suboptimal bone health among the Chinese population [19]. Therefore, this result does reflect this pattern within the population.

Those who had previous fracture is known to be at high risk of another fracture and this finding is worldwide [20] In fact, the complications of mortality and morbidity in this population are well known [17]. Therefore, it is not surprising that this study echoed findings from previous studies. There have been calls to include the recency of a fracture in the FRAX score [7].

This study identified that Lower BMI was strongly associated with high fracture risk. Underweight/normal BMI has almost 3 times the odds of fracture risk compared to obese and those who are overweight have 1.43 times the odds of fracture risk compared to obese. Similar findings were observed in the study of the Chinese population in Malaysia [19] and an older study which reported that each one-unit increase in BMI was associated with a significant 12% decrease in risk for osteoporosis [21]. It is postulated that increasing mechanical loading on the bone encourages it to undertake adaptive changes to support the increased load [22].

This study found that those without gout had an increased risk of having fractures compared to those with gout. It is interesting because it contradicts the common belief that chronic inflammation such as gout would harm the bones due to the stimulation of the inflammatory cascade and the production of proinflammatory cytokines. Gout was thought to be associated with a high risk of fractures [23]. However, numerous studies debated this association between gout and the risk of fractures, and the result remains inconclusive. Other studies found that gout was not associated with an increased risk of fractures and that gout patients on urate-lowering therapy have lower fracture risk [24]. However, in this study, there was no assessment of the treatment of gout or uric acid levels among the participants. Therefore, this is inconclusive.

Adequate dietary calcium intake through dairy sources is a well-recognized osteoprotective behavior [25]. Sufficient calcium intake (1000–1200 mg/day) through diet or supplements has been recommended for older individuals to prevent osteoporosis[28]. Increasing calcium intake from dietary sources increased BMD by 0.6-1.0% at the total hip and total body at one year [26]. However, this study found that those with calcium supplement has almost five times the odds of fracture risk compared to those not taking calcium supplement. Doctors tend to prescribe calcium supplements for those with suboptimal bone health and, therefore, these are already high-risk patients.

There is no correlation or inter-tool agreement between FRAX and FRAT. This means that FRAX does not include the fall risk assessment included in FRAT. Scrutinizing the two tools, it is evident that the factors included in FRAT such as the previous fall, prescribed medications, diagnosis of stroke or Parkinson's disease, problems with balance, and inability to rise from a chair without using arms (10) aren't present in the FRAX tool, and that the clinical factors within the FRAX tool do not include all other domains of fall risk (9). Therefore, FRAX calculation alone is not predictive of fall risk, and for those with high fall risk, their risk of fracture may be underestimated by FRAX. There have been several criticisms of the FRAX calculation and discussion to improve and update the FRAX score [27] and to incorporate the falls risk assessment [7]. The



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incorporation of falls risk assessment can improve the fracture risk prediction [27]. Therefore, it is advisable to include another assessment such as FRAT in assessing fracture risk among the elderly.

This study focused on elderly patients and is a homogenous sample. Its novelty is in its comparison between FRAX and FRAT, to determine once and for all, the need for falls assessment alongside FRAX. The limitation of the study includes the sampling method, and the participants are from one specialist primary care clinic, thus not representing the whole of the country.

## CONCLUSION

This study concludes the need to modify the FRAX calculation, to incorporate fall risk assessment in clinical practice to more accurately predict the risk of fracture among elderly patients. It is important to identify the factors that are associated with a higher risk of fracture among elderly patients to provide better fall prevention advice to the patient and their family members.

### Conflict of interest

Authors declare none.

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### Authors' Contribution

Mohd Yusri MY was the student of this study. Ariffin F, Isa MR and Mat Nasir N were the supervisors for this study. Mohd Yusri MY formulated and conceptualized the study, collected data, analysed and interpreted the data and wrote the manuscript. Ariffin F, Isa MR and Mat Nasir N supervised in the conception of the study, analysed and interpreted the data and contributed to the critical revisions of the results and manuscript. Ariffin F reviewed and finalized the manuscript. All authors read and approved the final manuscript. All authors agreed to be accountable for the accuracy and integrity of any part of this manuscript.

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