

# Self-reported bone fracture among Malaysian adults: Baseline findings of PURE Malaysia cohort study

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## ABSTRACT

**Introduction:** In Malaysia, studies on self-reported bone fractures are scarce. Due to the fact that bone fractures may serve as an indicator of osteoporosis in the community, this study aimed to identify the factors associated with their occurrence among adults in Malaysia.

**Materials and Methods:** Epidemiological data for self-reported bone fractures were obtained through direct interviews using a validated questionnaire from the Prospective Urban and Rural Epidemiology (PURE) study.

**Results:** Of 15,378 respondents, 6.63% (n=1019) reported bone fractures, with a higher proportion of men (65.8%, n=671) than women (34.2%, n=348). Higher odds of self-reporting bone fractures were seen in males (aOR, 2.12; 95%CI: 1.69, 2.65), those with a history of injury (aOR 5.01; 95%CI: 3.10, 6.32) and those who were obese (aOR: 1.46; 95% CI: 1.13, 1.89), highly active (aOR 1.25; 95%CI: 1.02, 1.53), smokers (aOR 1.35; 95%CI: 1.11, 1.65) and alcohol consumers (aOR 1.67; 95%CI: 1.20,2.32).

**Conclusion:** Adopting a healthier lifestyle that includes a balanced diet and moderate physical activity is critical for weight loss, increased muscle and bone mass and better stability, which reduces the likelihood of fractures following a fall.

## KEYWORDS:

*Bone health, fractures, fragility, incidence, self-reported, osteoporosis*

## INTRODUCTION

A fracture occurs when bones cannot withstand the pressure applied to them, resulting in a crack or break. Studies have shown that fractures cause substantial functional deficits and are a significant cause of disability and disease load across all world regions.<sup>1,2</sup> In Malaysia, the most comprehensive study on bone fractures to date was conducted to identify the incidence of hip fractures between 1996 and 1997.<sup>3</sup> This study reported an incidence of hip fractures of 88 per 100,000 and 218 per 100,000 in males and females, respectively. These numbers were predicted to escalate by 3.55 times by 2050,

constituting the largest increase in the Asian region. The report also projected an increase in reported fracture cases from 6,000 to 21,000 per year, costing nearly USD125 million (MYR540 million) in healthcare expenditures.<sup>4</sup>

The occurrence of bone fractures has been commonly associated with gender and age, as well as modifiable risk factors such as BMI, history of previous fractures, smoking and insufficient dietary calcium and vitamin D intake.<sup>5-9</sup> Although Malaysia is predicted to be an ageing nation by 2030 when 15% of its population is aged 60 and above,<sup>10</sup> little is known regarding the factors associated with self-reported bone fractures. As bone fractures may act as an indicator for the severity of osteoporosis, this study aimed to determine the prevalence of self-reported bone fractures and identify its associated factors in Malaysia's adult population.

## MATERIALS AND METHODS

The Prospective Urban Rural Epidemiology (PURE) study is an ongoing investigator-led study involving 27 countries, including Malaysia, which aims to determine the impact of societal influences on the prevalence of select non-communicable diseases. Data were collected using established and validated questionnaires designated by the local researchers involved in the PURE study. The comprehensive methodology of the overall study has been detailed in previous studies.<sup>11,12</sup>

A total of 15,378 Malaysian adults between 35 and 70 years of age were recruited from select urban and rural areas. The potential respondents were purposively sampled through the community leaders of the sampling regions. Health screening and health promotion booths were set up in the communities' assembly halls, and attendees who were interested in participating were briefed on the study. Prior to a basic physical examination, eligible respondents were asked to sign a consent form and provide information on their medical history. Only respondents who intend to continue living in their current home for a further 4 years were selected to join this study to ensure the feasibility of long-term follow-up. All data were gathered through face-to-face interviews conducted by well-trained research assistants.

This article was accepted: 18 October 2023

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**Table I: Socio-demographic, lifestyle characteristics and events reported among Malaysian adults' population with and without bone fracture (N = 15,378)**

Variables	Categories	Fractured bone/s		p-value
		Yes n (%)	No n (%)	
Age	<50	495 (7.2)	6379 (92.8)	0.010*
	≥50	524 (6.2)	7980 (93.8)	
Gender	♀Female	348 (4.03)	8277 (96.0)	<0.001**
	♂Male	671 (9.94)	6082 (90.1)	
Education level (n=15,367)	Low	353 (5.47)	6099 (94.5)	<0.001**
	High	666 (7.47)	8249 (92.5)	
Employment status (n=13,080)	No	315 (5.2)	5742 (94.8)	<0.001**
	Yes	624 (8.9)	6399 (91.1)	
Socioeconomic status (n=15,378)	Low	394 (6.24)	5918 (93.8)	0.009*
	Middle	521 (6.63)	7341 (93.4)	
	High	104 (8.64)	1100 (91.4)	
Marital status (n=15,329)	Currently unmarried	92 (6.01)	1440 (94)	0.292
	Currently married	926 (6.71)	12871 (93.3)	
BMI (n=15,378)	Normal	300 (6.1)	4596 (93.9)	0.115
	Overweight	521 (6.7)	7269 (93.3)	
	Obese	198 (7.4)	2494 (92.6)	
IPAQ (n=14,142)	Inactive	311 (6.0)	4859 (94.0)	0.003*
	Minimally active	281 (6.1)	4307 (93.9)	
	Highly active	333 (7.6)	4051 (92.4)	
Smoking status (n=15,213)	No	606 (5.18)	11091 (94.8)	<0.001**
	Yes	404 (11.5)	3112 (88.5)	
Alcohol consumption (n=15,334)	No	934 (6.36)	13745 (93.6)	<0.001**
	Yes	81 (12.4)	574 (87.6)	
Asthma (n=15,349)	No	952 (6.5)	13745 (93.5)	<0.001**
	Yes	67 (10.3)	585 (89.7)	
COPD (n=15,345)	No	1015 (6.6)	14286 (93.4)	0.513
	Yes	4 (9.1)	40 (90.9)	
Diabetes (n=15,353)	No	867 (6.5)	12404 (93.5)	0.191
	Yes	152 (7.3)	1930 (92.7)	
Hypertension (n=15,359)	No	767 (6.7)	10682 (93.3)	0.544
	Yes	251 (6.4)	3659 (93.6)	
Injuries	No	85 (7.5)	1052 (92.5)	<0.001**
	Yes	180 (30.9)	403 (69.1)	
Injury (machinery)	No	258 (15.3)	1423 (84.7)	0.032*
	Yes	4 (40.0)	6 (60.0)	
Injury (crash)	No	259 (15.4)	1426 (84.6)	0.019*
	Yes	3 (50)	3 (50)	
Injury (fall)	No	195 (13.6)	1242 (86.4)	<0.001**
	Yes	66 (25.7)	191 (74.3)	
Injury (motor vehicle accident)	No	161 (11.4)	1253 (88.6)	<0.001**
	Yes	104 (34.3)	199 (65.7)	
Injury (struck by object)	No	226 (14)	1383 (86)	<0.001**
	Yes	36 (39.6)	55 (60.4)	
Calcium intake (n=11,064)	<RNI	588 (6.6)	8307 (93.4)	0.133
	≥RNI	163 (7.5)	2006 (92.5)	

\*significant at p-value <0.05, \*\*significant at p-value <0.001, IPAQ = International Physical Activity Questionnaire, RNI = Recommended Nutrient Intake

## Study Instruments

### Questionnaires

The questionnaire consisted of three sections, a) Adult Questionnaire, b) International Physical Activity Questionnaire (IPAQ) and c) Food Frequency Questionnaire (FFQ). Information on socio-demographic characteristics, medical history and injuries was gathered using the Adult Questionnaire, while the IPAQ collected data on the respondents' metabolic rates (METs) in min/week. Based on MET, participants' physical activity level was categorised as inactive, minimally active or highly active. Daily calcium intake data were obtained through the semi-quantitative FFQ and were then categorised according to the recommended

daily calcium intake of 1000 mg/day per the recommended nutrient intakes (RNI) for Malaysia.<sup>13</sup> Each questionnaire was validated and pretested as part of the study protocol prior to the start of the study. Data on bone fractures were derived from respondents' self-reporting of bone fracture incidents. They were asked if they have had a bone fracture in their lifetime and to specify the body parts that were involved.

### Physical Examination

A basic physical examination was conducted to obtain each respondent's height, weight, blood pressure and blood glucose level. Height and weight were measured using the calibrated SECA 213 stadiometer (Hammer Steindamm,

Table II: Associated factors for self-reported bone fracture among Malaysian adults' population (N=8,555)

Variables	Categories	B	S.E.	OR (95% CI)	p-value
Age (years old)	<50	0.154	0.098	1.166 (0.962,1.413)	0.117
	≥50			1.0	
Gender	Female	0.750	0.114	1.0	<0.001**
	Male			2.117 (1.693,2.647)	
Education level	Low	0.164	0.106	1.0	0.122
	High			1.179 (0.957,1.452)	
Employment status	No	0.142	0.101	1.0	0.160
	Yes			1.152 (0.946,1.405)	
Socioeconomic status	Low	-0.029	0.101	1.0	0.124
	Middle			0.971 (0.797,1.184)	0.774
	High			1.371 (0.963,1.954)	0.080
BMI	Normal	0.178	0.103	1.0	0.013
	Overweight			1.194 (0.975,1.463)	0.086
	Obese			1.462 (1.133,1.885)	0.003*
IPAQ	Inactive	0.056	0.109	1.0	0.089
	Minimally active			1.058 (0.854,1.31)	0.606
	Highly active			1.247 (1.018,1.529)	0.033*
Smoking status	No	0.303	0.101	1.0	0.003*
	Yes			1.354 (1.111,1.651)	
Alcohol consumption	No	0.510	0.169	1.0	0.003*
	Yes			1.666 (1.195,2.321)	
Asthma	No	0.227	0.191	1.0	0.237
	Yes			1.254 (0.862,1.825)	
Self-reported injuries	No	1.612	0.118	1.0	<0.001**
	Yes			5.013 (3.975,6.322)	
Calcium Intake (mg/day)	<RNI	0.038	0.108	1.039 (0.84,1.284)	0.726
	≥RNI			1.0	

\*significant at p-value <0.05, \*\*significant at p-value <0.001, classification table (overall correctly classified percentage – 92.8%), Hosmer Lemeshow test = 0.066 and model fitness, R<sup>2</sup> = 9.6%, IPAQ = International Physical Activity Questionnaire, RNI = Recommended Nutrient Intake

Hamburg, Germany) and TANITA BC-558 IRONMAN Segmental Body Composition Analyzer (Arlington Heights, Illinois, United States), respectively. Blood pressure was taken twice after 5 minutes of rest in a seated position using the OMRON automatic blood pressure monitor (HEM-7111; OMRON Healthcare, Tokyo, Japan). The measurements were taken two times, and the average were recorded. Blood glucose readings were taken using the GlucoSure Auto Code glucometer (GlucoSure S70009; Medical Taiwan, Hsinchu, Taiwan).

#### Statistical Analysis

Descriptive analysis was performed for the socio-demographic characteristics of all the 15,378 adults who participated in the study. Factors associated with self-reported bone fractures were determined using multiple regression analysis. This was conducted for 8,555 respondents with the most complete data for all independent variables investigated in this study.

#### Ethical Approval

The protocol of this study was approved by the Hamilton Health Sciences Research Ethics Board (grant no. 101414). Local ethics approval was obtained from the Research and Ethics Committee of Universiti Kebangsaan Malaysia (UKM) Medical Center and the Research Ethics Committee of Universiti Teknologi Mara (UiTM) (project code: PHUM-2012-01).

## RESULTS

Of the 15,387 respondents who participated in the study, 1,019 respondents (6.63%) self-reported a bone fracture. As presented in Table I, they were predominantly male, were less than 50 years old, had a high level of education, were currently employed and had a high socioeconomic status. Self-reported bone fractures were also more prevalent among those who were highly physically active, were smokers, consumed alcohol, had asthma and had previous injuries.

Table II displays the factors associated with self-reported bone fractures. Male respondents (adjusted odds ratio (aOR), 2.12; 95% confidence interval (95%CI): 1.69, 2.65) had two times higher odds of self-reporting a bone fracture than female respondents. Respondents who had previously sustained an injury (aOR: 5.01; 95%CI: 3.10, 6.32) had five times higher odds of self-reporting bone fractures than those who had not previously sustained an injury. Obese individuals (aOR: 1.46; 95%CI: 1.13, 1.89), smokers (aOR: 1.35; 95%CI: 1.11, 1.65) and alcohol drinkers (aOR: 1.67; 95%CI: 1.20, 2.32) were 1.5, 1.4 and 1.7 times higher odds to self-report bone fractures, respectively. In addition, respondents who reported being highly active (aOR, 1.25; 95% CI, 1.02, 1.53) were 1.2 times higher odds to have self-reported bone fractures than those who reported being inactive.

## DISCUSSION

This study reveals several important findings pertaining to the factors associated with self-reported bone fractures in Malaysian adults. Male respondents and those who reported

previous injuries were more likely to self-report bone fractures. Further descriptive analysis of the respondents' previous injuries revealed that motor vehicle accidents (48.8%), falls (31.0%) and being struck by objects (16.9%) were the three most common causes of injuries resulting in self-reported fractures. This can be explained by the modes of transport used in Malaysia to commute to and from work. Men often prefer to ride motorcycles, particularly in urban areas, in order to avoid heavy traffic, whereas women typically opt to drive cars or take public transportation.<sup>14,15</sup> In rural areas, motorcycles are preferred due to their mobility and narrower road conditions. Studies have shown that more than 50% of road accident fatalities in Malaysia involved motorcyclists and the risk of motorcyclists suffering bone fractures is higher compared to occupants of other vehicles.<sup>15,16</sup>

Compared to individuals with normal BMI, this study found that obese individuals were more likely to experience self-reported bone fractures. In general, obesity has been reported to increase the risk of fractures at certain body sites while being protective against fractures at others.<sup>17,18</sup> Individuals with obesity have been found to be more likely to sustain fractures in the ankle, upper and lower leg regions while having a decreased risk of hip and pelvis fractures. The hip and pelvic region may be protected by the fat surrounding it, which absorbs the impact of the fall and thus reduces the risk of fracture. On the other hand, excessive stresses associated with introversion or extroversion of the ankle, as well as bending or torsion of the legs, may increase the risk of fracture following a fall in obese individuals.

Individuals who were highly active and engaged in higher frequencies of physical activity had higher odds of self-reporting bone fractures. Physical activities, which generally require intense mobility and movement that includes challenging the body's centre of gravity and balance, may increase the risk of falls and cause bone fractures.<sup>19,20</sup> One study found that 5-10% of all falls result in fractures, with more than 90% of hip fractures occurring as a result of a fall.<sup>21</sup> Additionally, it is essential to consider that highly active individuals, already acclimated to rigorous exercise routines, often allocate extended periods in their training regimens to higher-intensity activities. This prolonged engagement in high-intensity exercises can exert excessive strain on specific muscle groups, potentially leading to symptoms such as muscle fatigue, cramping, or an increased susceptibility to falls that may ultimately culminate in fractures.<sup>22,23</sup> Simultaneously, participating in high-impact activities and exercises, characterised by their demanding physical nature and frequent contact, further elevates the risk of fractures.

This study also revealed that smokers were more likely to self-report bone fractures compared to non-smokers. Several experimental studies on rats found that both the structure and strength of rats' femurs were lower in the group exposed to tobacco smoke.<sup>24,25</sup> These studies suggest that the content of tobacco smoke, particularly nicotine and polycyclic aromatic hydrocarbons, may significantly lower bone mass density, thus increasing the risk of bone fragility and fracture. These chemicals may cause changes in bone's collagen fibre

composition and cross-linking, thereby altering its structure and apparent material strength properties. Any interference with the cross-linking process of bone causes poor mineralisation, leading to compromised bone-strength properties.<sup>26,27</sup> Thus, any injuries or falls are more likely to cause a fracture.

Alcohol consumption among this study's respondents was found to increase the odds of self-reported bone fractures. Alcohol affects bone metabolism, as it displaces the intake of other critical nutrients, particularly in long-term heavy drinkers, resulting in reduced bone mineral density. In this scenario, thinning of the bones occurs, increasing the risk of fractures due to a fall.<sup>28,29</sup> Another possible explanation is that drinking is often associated with altered gait and balance and the sensation known as the 'spins', which is likely caused by either alcohol's effect on inner ear function<sup>30</sup> or the presence of ethyl alcohol in the central nervous system, which may impair the transmission of nerve impulses at the synapse, causing deleterious effects on both the sensory and motor systems.<sup>31</sup> These side effects of alcohol consumption may contribute to an increased risk of fractures following a fall among those who consume alcohol.

Although inadequate calcium intake is a well-known risk factor for bone fractures, this study did not share this result, as a majority (80.4%) of the studied population reported consuming less than the 1000mg of calcium per day recommended by the RNI from the Ministry of Health (MOH).<sup>32</sup> The findings of this study are consistent with the reported mean daily calcium intake among the Malaysian population of 357mg/day, which is only 35.7% of the RNI.<sup>33</sup> Aside from the typical Asian diet, which includes the diet of Malaysia, containing fewer calcium-rich foods such as milk and cheese, these types of food are quite expensive, particularly for those with lower household incomes. According to a nutrition-based study involving 187 countries conducted by Singh and colleagues, across the 21 world regions, people living in East Asia and Oceania countries had the lowest daily milk intake, less than a quarter of a serving per day.<sup>34</sup> Calcium deficiency may also be attributed to the high sodium and carbohydrate content of the majority of local delicacies that are preferred and familiar to local palates, which may cause Malaysians to be less likely to choose naturally calcium-rich foods such as milk and cheese.

The main limitation in this study was the analysis based on self-reported fractures provided by study participants. Access to medical records or radiographic imaging for independent verification of the anatomical location of these fractures is not available. While self-reporting represents a useful approach for data collection in large-scale epidemiological studies, it does introduce a potential source of variability in research. The accuracy of self-reported fractures may vary, and there may be instances where fractures are either over-reported or unreported. In the study conducted by Baleanu et al.,<sup>35</sup> it was observed that only 14.4% of all self-reported fractures turned out to be false positives. Furthermore, despite annual follow-up, 21.3% of fractures were not reported.<sup>36</sup> It is worth noting that such false reporting of fractures by individuals is relatively uncommon. Another limitation that should be noted is the nature of cross-sectional study, which

limits the understanding of causal relationships between bone fractures and risk factors, especially dietary intake of calcium. Thus, future research should consider follow-up study with the utilisation of radiological methods, such as bone mineral density measurement, to ascertain the risk factors related to bone fractures.

## CONCLUSION

The prevalence of self-reported bone fractures among this study's respondents was 6.63%. Among other factors, males, those who reported previous injuries and those who were obese were more likely to suffer self-reported bone fractures. Thus, based on the findings of this study, a healthier lifestyle that includes weight loss, a balanced diet, moderate physical activity, smoking cessation and reduced alcohol consumption is recommended to reduce the risk of fracture. Healthy weight loss accompanied by increased muscle and bone mass may aid in lowering the risk of fractures caused by falls.

## ACKNOWLEDGEMENTS

The authors would like to thank all PURE staff members at Population Health Research Institute (PHRI) for continuous staff training and data management support. The authors are also grateful for the dedication and commitment of fellow research assistants from UKM and UiTM who have been involved in the data collection process of the PURE study. The voluntary participation of all respondents is greatly appreciated.

## FUNDING

The PURE study is an investigator-initiated study that is funded by the Population Health Research Institute, the Canadian Institutes of Health Research, Heart and Stroke Foundation of Ontario and through unrestricted grants from several pharmaceutical companies (with major contributions from AstraZeneca (Canada), Sanofi-Aventis (France and Canada), Boehringer Ingelheim (Germany and Canada), Servier and GSK) and additional contributions from Novartis and King Pharma and various national or local organisations in participating countries.

This work was supported and funded by PHRI, the Canadian Institutes of Health Research, Heart and Stroke Foundation of Ontario and through unrestricted grants from several pharmaceutical companies. It was also supported by local grants from Ministry of Science, Technology and Innovation of Malaysia Grant Nbr 100 - IRDC/BIOTEK 16/6/21 (13/2007), Grant Number 07-05-IFN-BPH 010, Ministry of Higher Education of Malaysia Grant Nbr 600 - RMI/LRGS/5/3 (2/2011), UiTM and UKM (PHUM-2012-01).

## CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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