# Predicting fracture using bone mineral density from abdominal CT scans

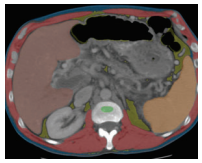
**Alexandra Wong, Benjamin Rush, Yunju Ha, Perry J. Pickhardt, John W. Garrett**

*Department of Radiology, University of Wisconsin-Madison School of Medicine & Public Health*

## Background

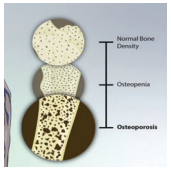
- Low **bone mineral density (BMD)** contributes to increased **fracture** risk.
- BMD typically declines **after age 50.**
- Osteoporosis is often undiagnosed until fractures occur, but early BMD loss detection through **value-added CT scans** can facilitate effective prevention strategies.
- **Goal: Examine biomarkers derived from CT scans to predict fracture risk using survival analysis.**

A. 

B. 

*(A) CT scanner. (B) OSCAR L1 abdominal CT scan slice with AI body composition tools.*

## Methods

A. 


Adapted Photo byhttps://www.myupchar.com/en. wikimedia.org

B. 


Ranges from:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7237579/#:~:text=In%20these%20studies%2C%20while%20bone,density%20(19%E2%80%9322).

**Dataset**: Patients from OSCAR (136,109 adults)

**Data Preparation:** removed non-physiological values and tool failures, 80/20 split (training: 108,887, testing: 27,222), analysis done on training.

*Statistics*

- Kaplan-Meier survival plot for risk of fracture predicted by BMD and muscle density
- Choropleth maps
- Cox proportional-hazards model

## Results

### Descriptive Statistics

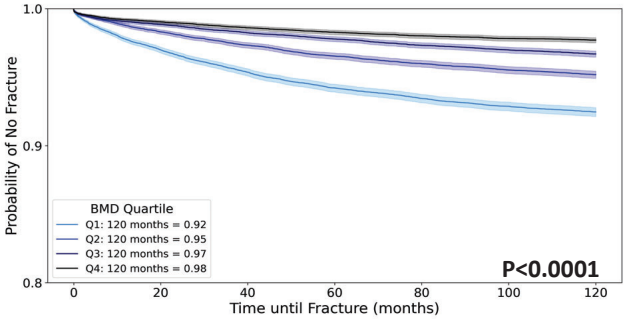
| | Training (n=108,887) | Fracture (n=12,624) | No Fracture (n=96,263) |
|---|---|---|---|
| Age at CT | 53.3 ± 17.6 years | 58.9 ± 18.4 years | 52.6 ± 17.3 years |
| BMD | 167 ± 48.5 HU | 153.7 ± 53.1 HU | 168.8 ± 47.5 HU |
| Muscle density | 30.3 ± 17.3 HU | 25.7 ± 18.5 HU | 30.9 ± 17.1 HU |

*Descriptive statistics presented as mean ± standard deviation*

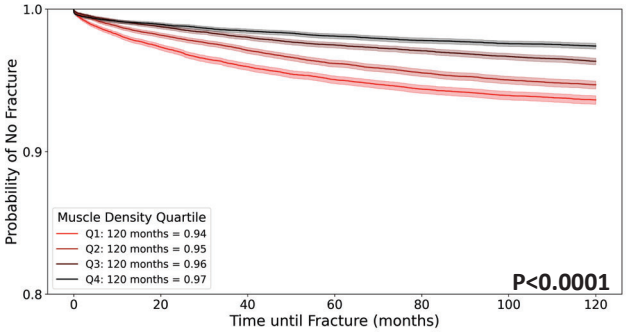
### Median BMD by Age Group and Fracture Status

| No Fractures <50 | No Fractures ≥ 50 | Fractures < 50 | Fractures ≥ 50 |
|---|---|---|---|
| 190.5 HU | 147.1 HU | 182.2 HU | 135.4 HU |

### Kaplan-Meier Survival (No Fracture) Curves by BMD Quartiles (10 years)




### Kaplan-Meier Survival (No Fracture) Curves by Muscle Density Quartiles (10 years)



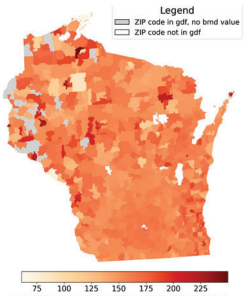

### Cox Proportional-Hazards Model

| | 10-year fracture risk coefficient (β) | p-value |
|---|---|---|
| BMD* | -0.11 | < 0.005 |
| Age at CT | 0.02 | < 0.005 |

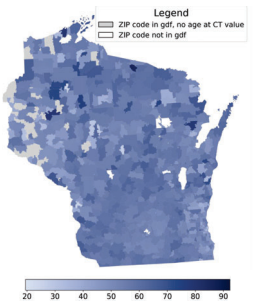
**Concordance Index: Train set** = 0.64, **Test set** = 0.63

*Biomarker with asterisk indicates scaled value (BMD divided by 20)*

### BMD by ZIP Code




### Age at CT by ZIP Code




## Conclusions and Future Directions

- **Kaplan-Meier survival analysis** shows increased risk of fracture in lower quartiles for BMD and muscle density.
- **Cox proportional-hazards model** indicates that higher BMD and lower age is associated with decreased fracture risk.
- Future research will focus on femoral neck fracture, cox proportional-hazards models with additional biomarkers and demographics, as well as on plotting these findings across the state of Wisconsin by ZIP code.

## Acknowledgements

Department of Radiology
UNIVERSITY OF WISCONSIN
SCHOOL OF MEDICINE AND PUBLIC HEALTH

NIH
National Institutes of Health