# In Older Individuals There Is Greater Variance In Low Mean Bone Material Strength Index Values Obtained With The OsteoProbe

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## Introduction

Bone Material Strength Index (BMSi) quantifies bone resistance to indentation *in vivo* at the mid tibia using impact microindentation[1]. This score has the potential to be used in conjunction with other measures of bone to better understand bone health and fracture risk[2]. Anecdotal evidence suggests that within-participant variance in BMSi may be associated with individual level mean BMSi. This study aimed to investigate associations between mean and variance of BMSi in a population-based study.

## Material and Methods

- Participants (n=475) included men (n=420) and women (n=55) from the Geelong Osteoporosis Study[3], a cohort study in south-eastern Australia.
- Participants underwent the OsteoProbe procedure during the most recent follow-up phases (2016-2022 for men, 2022-2023 for women) following international published guidelines[4].
- BMSi standard deviation was skewed and therefore log transformed (referred to as log-SD).
- Linear regression was performed considering log-SD the dependent variable, and mean BMSi the independent variable, adjusting for sex, age, and body mass index (weight/height$^2$).
- To explore interactions with age, a dichotomous age variable was created using median age of the sample as a cut-point.

## Results

**Descriptive characteristics**

- The Table shows the descriptive statistics for the participants included in this study.

**Linear regression modelling**

- In unadjusted models, greater BMSi was associated with lower log-SD (β=-1.58, p=0.04).
- This association was sustained after adjustment (p=0.013). An interaction between logSD and age was observed (p=0.004). Sex and BMI were not identified as effect modifiers.
- Stratifying the models at median age showed that in those aged 63.7 and over, BMSi was inversely associated with log-SD (β=-2.83, p=0.009). In younger participants, no BMSi-log-SD association was observed (p=0.550).
- The linear fit for this trend can be seen in the Figure.

## Acknowledgements

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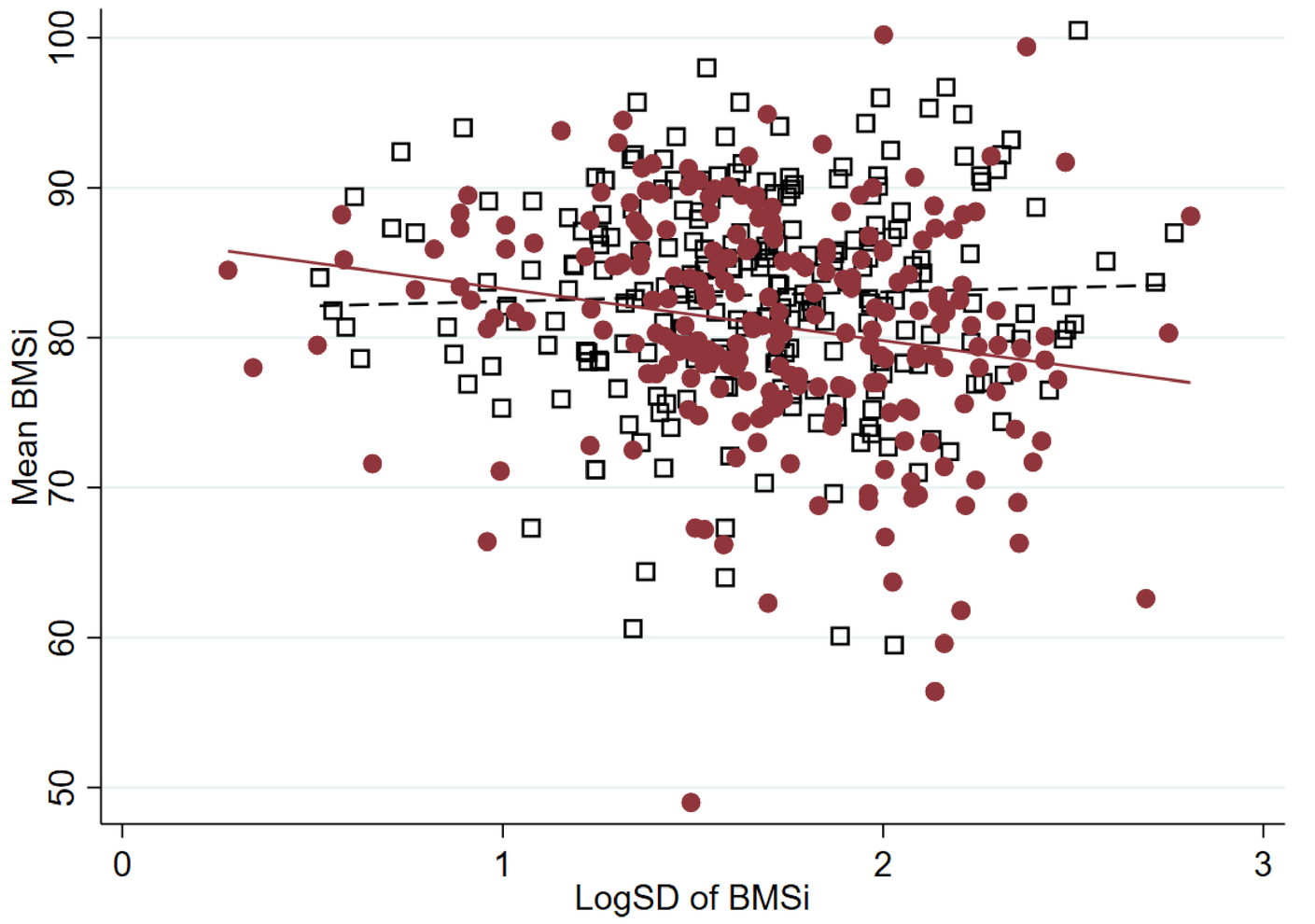


**SUMMARY: Variance in Bone Material Strength Index was higher for older individuals with lower mean values.**

Table: Participant characteristics (n=475). Data presented as mean±SD, n(%) or median(IQR), as appropriate.

| Participant characteristics | |
|---|---|
| **Sex (Female)** | 55 (11.6) |
| **Age (yr)** | 63.7 (53.0-71.8) |
| **Weight (kg)** | 80.7±12.2 |
| **Height (cm)** | 173.1±8.1 |
| **Body Mass Index (kg/m$^2$)** | 26.9±3.4 |
| **Mean BMSi** | 81.8±7.3 |

Figure: Mean Bone Material Strength index vs log-SD, stratified by age (cut-off 63.7yr). Data for participants in the older age category are marked in red, with the line indicating the linear fit. The black squares and dashed line indicate the data and linear fit of participants in the younger age category.

## Conclusion

In older men and women, there is greater variance observed in individuals with low BMSi values. One potential reason for this association may be the presence of an increased number of resorption pits in the cortical bone of older individuals. These data support a heightened fracture risk for men and women with low BMSi and poorer bone structure.

## References

[1] Randall et al. *Applications of a New Handheld Reference Point Indentation Instrument Measuring Bone Material Strength.* J Med Device. 2013; 7(4):410051-410056.

[2] Rufus-Membere et al. *Associations between bone impact microindentation and clinical risk factors for fracture.* Endocrinology. 2019; 160(9):2143-2150.

[3] Pasco et al. *Cohort Profile: Geelong Osteoporosis Study.* Int. J. Epidemiol. 2012; 41:1565–1575.

[4] Diez-Perez et al. *Technical note: Recommendations for a standard procedure to assess cortical bone at the tissue-level in vivo using impact microindentation.* Bone Reports. 2016; 5:181–185.