

Ageing and BMI in focus: rethinking risk assessment for vertebral fragility and pedicle screw loosening in older adults

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Introduction

Introduction: Pathological vertebral fragility (path-VF) increases the risk of osteoporotic fractures and pedicle screw loosening (PSL) after posterior instrumented spinal fusion (PISF). While WHO Body Mass Index (BMI) categories broadly identify risks related to underweight and obesity, fixed thresholds may inadequately reflect vertebral fragility risks among elderly patients, especially within the normal-weight range. This study investigates whether current BMI classifications sufficiently capture the risk of path-VF in older adults.

Materials and Methods

Methods: This retrospective study included 225 patients who underwent kyphoplasty or PISF (2022-2023). Path-VF was defined by non-tumorous fractures, screw reinforcement, or PSL within six months without prior reinforcement. Patients were grouped into the path-VF (n = 94) and control (n = 131) groups. HU and BMI values, BMI-related ORs, age trends, and logistic regression were analysed.

Results

Results: Mean HU values were significantly lower in the path-VF group (71.37 ± 30.50) than in controls (130.35 ± 52.53 , $p < 0.001$). Path-VF females (26.26 ± 5.38) had lower BMI than control females (29.33 ± 5.98 , $p = 0.002$); no difference was found in males. Normal-weight females showed a borderline risk for path-VF (OR 2.03, $p = 0.0495$). Obesity (ORmale 0.31 / ORfemale 0.37) and male overweight (OR 0.21) were protective (all $p < 0.05$). BMI declined with age in path-VF males ($p = 0.001$) but increased in controls ($p = 0.023$). Logistic regression identified BMI $< 22.5\text{kg/m}^2$ and age > 67.5 years as significant risk thresholds. Notably, 20.2% of path-VF patients over 67.5 had a normal weight, suggesting a potentially overlooked subgroup.

Conclusion

Conclusions: The current WHO lower limit for normal BMI (18.5 kg/m^2) may underestimate the risk of path-VF in patients older than 67.5 years, potentially overlooking 24.7% of cases. The results offer a new approach for clinicians to interpret BMI values at the lower end of the normal range ($<22.5\text{ kg/m}^2$) with caution in elderly patients undergoing spinal surgery.

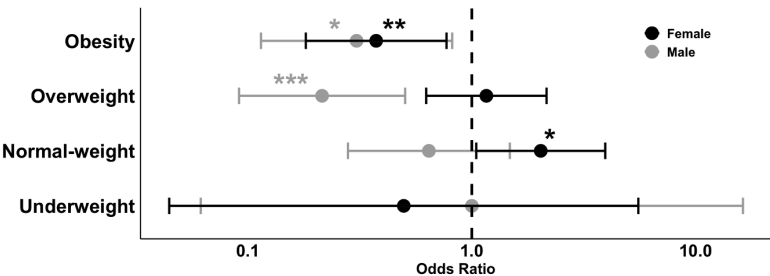


Figure 1. OR of BMI categories for the risk of path-V. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Obese males showed a significantly reduced risk of developing path-VF, with an OR of 0.31 (95% CI [0.11–0.82], $p = 0.024$). Being obese and female also demonstrated a protective effect, with an OR of 0.37 (95% CI [0.18–0.77], $p = 0.009$). In addition, overweight males had an even lower risk, with an OR of 0.21 (95% CI [0.09–0.50], $p < 0.001$). In contrast, normal-weight females were at significantly higher risk of path-VF, with an OR of 2.03 (95% CI [1.05–3.94], $p = 0.0495$).

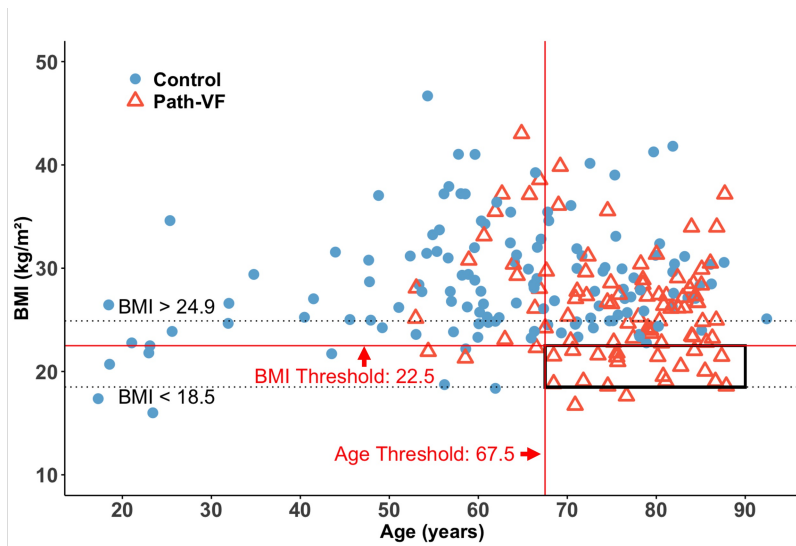


Figure 2. Age and BMI distribution highlighting the 'overlook zone' for the risk of path-VF. The area between the horizontal dashed lines represents the WHO-defined normal BMI range (18.5–24.9 kg/m²). The solid red line represents the BMI threshold of 22.5 kg/m², and the solid vertical line indicates the age threshold of 67.5 years. The black frame marks the 'Overlook Zone', in which all patients over 67.5 years with a BMI of 18.5–24.9 kg/m² showed path-VF.