Association Between Daily Impact Score in Free-living Conditions and Fracture Risk in Middle Life

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INTRODUCTION: High-impact exercise is shown to be beneficial for bone health [1,2]. The magnitude of individual impacts can be quantified using accelerometry. Daily Impact Score (DIS) has been suggested as an indicator of the overall osteogenic impact of daily physical activities, combining the contribution of the activities over the entire spectrum of acceleration peak magnitudes [3]. DIS is a tool to estimate the osteogenic index [4] from daily accelerometer-based data. Previously DIS has been used in intervention studies. This study examined the association between accelerometer-estimated DIS and 10-year osteoporotic fracture risk in a large population-based cohort.

METHODS: The study population was participants of the Northern Finland Birth Cohort 1966 (n=3165) [5] with valid accelerometer data (Hookie AM20, Traxmeet, 14-day recording) in the age of 46 years. Impact magnitude peaks were extracted, divided into 32 acceleration intensity bands, and DIS was calculated as

$$DIS = \sum_{j=1}^{32} a_j \ln(N_j + 1),$$

where a_j is the lower limit of the impact intensity band at index j, and N is the count of peaks at band j [3]. FRAX score (without DXA) was used as an estimate of the 10-year risk of hip fracture and all major osteoporotic fractures. Partial correlation, partial least square (PLS) multivariate correlation and multiple linear regression were applied to examine the associations between FRAX and the daily impact counts at different intensities and DIS. All analyses were adjusted for age, sex, marital status, household income, education level, employment status and health-related quality of life. This study was approved by an institutional Ethics Committee.

RESULTS: Partial correlation coefficient demonstrated that physical activities at low and moderate intensity bands had a positive correlation with FRAX score, whereas high impacts had a trend for decreased probability for osteoporotic fractures (Figure 1). PLS indicated a significantly decreased estimated fracture risk in high impact intensities (Figure 2). Multiple linear regression analysis showed that a higher DIS was associated with a lower probability of future hip fractures (β = -0.053, 95% CI -0.087 to -0.020) and all major osteoporotic fractures (β = -0.024, 95% CI -0.042 to -0.005).

DISCUSSION: This study examined the association of the intensity profile of daily physical activities with the 10-year probability of osteoporotic fractures in a large population-based sample of middle-aged adults. We found that high intensity impacts are associated with a decreased FRAX score and DIS is a relevant single metric of the overall osteogenic potential of daily physical activities even at population level. This study also has limitations. Including DXA-based BMD in FRAX could potentially lead to more accurate fracture probability estimation, but DXA was not available for this cohort. In addition, the age-range of the study population was narrow, the study had an observational and cross-sectional design, and causality could not be determined. A long-term follow-up of the cohort population may confirm the findings in future.

SIGNIFICANCE: The current study demonstrates that the osteogenic potential of daily physical activities can be estimated using accelerometer-based physical activity monitoring. Even if any physical activity may be beneficial for health, including high impacts in the daily activities should be promoted for decreasing the risk of osteoporotic fractures.

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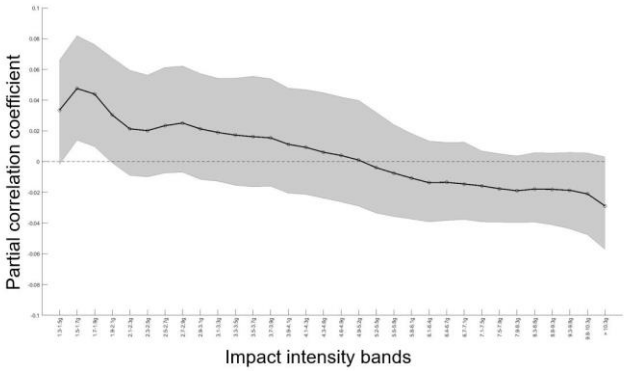

Figure 1. Partial correlation coefficient between FRAX (all major osteoporotic fractures) and log-transformed daily impact counts at different impact intensity bands. Partial correlation coefficients with 95% confidence intervals (shaded area).

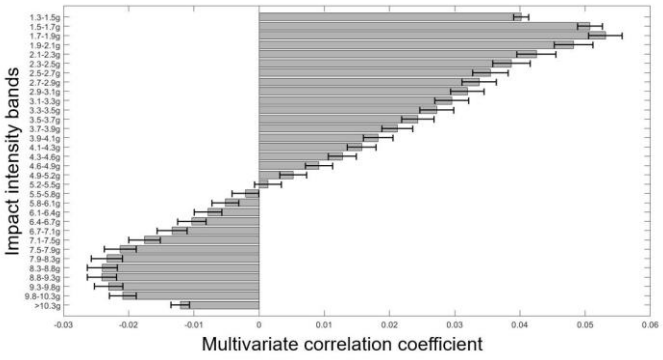

Figure 2. PLS multivariate correlation coefficients with 95% confidence intervals between FRAX (all major osteoporotic fractures) and daily impacts at different impact intensity bands. Normalized data was applied in PLS analysis.