The Incorporation of Support Vector Machines and Hip Geometric Structure Assessments in the Development of Hip Fracture Risk Prediction Model

Zhaoh Chen1, Peng Jiang2, Chengcheng Hu1, Leslie Arendell1, Skye Nicholas1, John Robbins3 and Sammy Missoum2

1Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ. 2Aerospace and Mechanical Engineering Department, University of Arizona, Tucson, AZ. 3University of California at Davis School of Medicine, Sacramento, CA.

Introduction

Hep fracture prediction models, such as FRAX, have been developed and widely used. Robbins and colleagues (2007) have shown that in the Women’s Health Initiative (WHI), collectively, 11 predictors may generate a prediction with area under the curve (AUC) being 80% for 5-year hip fracture risk. The prediction property of this model was less accurate (AUC% = 71%) in the participants of the WHI bone mineral density (BMD) cohort, but when BMD was added into the model, AUC% reached 80%.

Methods

Study Participants:
- Participants in the clinical trial (CT) arm (n=5,016) and observational study (OS) arm (n=6,224) from the WHI BMD sub-cohort were selected for this analysis.

Hip Fracture and other covariate assessment:
- All hip fractures were adjudicated.
- Weight and height were measured in the clinic.
- Other covariates, including age, race/ethnicity, health status, fractured after age 55, physical activity, smoking status, a parent broke a hip, corticosteroid use, and diabetes treatment, were self-reported.

HSA (T Beck method):
- Hip structural analysis (HSA) program was applied to archived DXA scans to estimate BMD and structural parameters (BMD [g/cm^2], cross-sectional area [cm^2], outer diameter [cm], section modulus [cm^3], cortical thickness [cm], buckling ratio) at 3 femur cross-sections (narrow neck; intertrochanter; shaft)

Support Vector Machines (SVMs):
- SVM is a powerful classification technique used to extract, in a high dimensional space, complex nonlinear “decision functions” between two classes of data. It does not have any model assumptions and is often referred as a machine learning approach. (Figure 1)

Logistic Regression:
- Logistic regression was used to build a prediction model for 10-year hip fracture risk. The model was fitted on the OS cohort with all 11 predictors identified by Robbins et al. (2007) and used to predict 10-year hip fracture risk for the CT subjects.

Acknowledgements

The WHI program is funded by the National Heart, Lung, and Blood Institute, National Institutes of Health, U.S. Department of Health and Human Services through contracts N01WH22110, N01WH22112, N01WH22113, N01WH22105-5, 32105-9, 32117-9, 32118-22119, 32122, 42107-2, 42129-2, and 42227.

Hip structural geometry analysis was supported by NIAMS ROI AR061414.

This work is supported by NIAMS 1R21AR068811-01.