Multi-State Model for the Progression to Osteopenia and Osteoporosis among HIV-infected patients

Klaus Langohr[1], *Nuria Pérez-Alvarez*[2], *Eugenia Negredo*[3], *Anna Bonjoch*[4], *Guadalupe Gómez*[5]

[1]klaus.langohr@upc.edu, Departament d'Estadística i Investigació Operativa, Universitat Politècnica de Catalunya/ BARCELONATECH

[2]nperez@flsida.org, Fundació Lluita contra la SIDA, Badalona

[3]enegredo@flsida.org, Fundació Lluita contra la SIDA, Badalona

[4]abonjoch@flsida.org, Fundació Lluita contra la SIDA, Badalona

[5]lupe.gomez@upc.edu, Departament d'Estadística i Investigació Operativa, Universitat Politècnica de Catalunya/ BARCELONATECH

Bone mineral density (BMD) measurements are used to determine bone health and can help to identify the risk of fracture. The most widely recognized BMD scan, which measures bone density at different parts of the body, is called dual-energy x-ray absorptiometry (DXA). The DXA measures are compared to the BMD of a healthy 30-year-old adult and converted into T-scores: T-scores above -1 are considered normal, values between -1 and -2.5 indicate low bone mass (osteopenia), and values below -2.5 indicate osteoporosis. To study the evolution of BMD over time in a cohort of more than 700 HIV-infected persons with at least two DXA scans and to determine the risk factors for the progression of bone loss are the main goals of the present study.

We propose a multi-state model with three states: normal BMD, osteopenia, and osteoporosis and two transitions of interest: Normal BMD to osteopenia and osteopenia to osteoporosis. Both transitions are analyzed with accelerated failure time models that permit the identification of risk factors. Progression times to osteopenia and osteoporosis are either right or interval-censored, since osteopenia and osteoporosis onset cannot be determined exactly. Hence, time from osteopenia to osteoporosis is doubly interval-censored, and the model fit for this transition has to take this into account.

The multi-state model will allow us to predict the percentages of patients in every health state as a function of time. The clinical relevance of building such a model is to guide the clinical practice and the rationalization of DXA scans measurements.

Keywords: Interval censoring; Multi-state model; DXA scans