

PREDICTIVE MODELING FOR STUDYING THE DISEASE PROCESS OF OSTEOPOROSIS

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Background:

Osteoporosis exerts a burden on the national health services. Hip fractures cause significant pain, functional disability, and lengthy inpatient treatment. Therefore, prevention is of utmost importance for patients and physicians, as well as insurance payers and insurance providers [1].

Significance:

There are gaps in knowledge about the complex interactions among the multiple factors which control the disease process. Computational modeling can aid in understanding the intermingled relations between the various factors at different levels and provide further insight into the disease development mechanism.

Methodology:

In the first aim, we built a computational model using Agent-Based Modeling (ABM) to investigate osteoporosis disease's progression by simulating the interactions among the cellular and biochemical factors within the BMU and external factors such as weight, and physical activity. In the second aim, we added a therapeutic agent to predict the changes in patients who are receiving that treatment. In the third aim tested the model's ability to estimate the bone density without the use of an initial DXA Scan reading. In the three aims, we validated the model by performing statistical tests to compare the model's predictions and the DXA scan readings from the patients.

Results:

The Paired Sample T-test results was statistically not significant $t(16) = -1.6$, $p = 0.12$ in first aim and $t(42) = 8.1$, $p = 0.28$ and in the second aim. The sensitivity was between 85.7% and 100%, and the specificity was 90% to 100%. In the third aim, the model successfully predicted the bone density in the first group (40-50 years age group) of patients Wilcoxon-sign (13), $p=0.196$. The model was not able to estimate the bone density for the other age groups.

Conclusion:

We successfully built an ABM that can predict the bone density changes in osteoporosis patients and patients who are receiving alendronate drug treatment. The model, however, requires further improvement and testing to be able to estimate the bone density as a diagnostic tool. We conclude our ABM model can be used in research for studying the process of osteoporosis and has the potential to be developed into a clinical diagnostic tool.