BioMedWomen

Clinical and BioEngineering for Women´s Health

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Preface

This book contains the abstracts and fulltexts of the Invited Lectures, Thematic Sessions, and Contributed Papers presented at the International Conference on Clinical and BioEngineering for Women's Health—BioMedWomen, that took place in June 20–23th 2015, in Porto, Portugal. BioMedWomen covered several fields of knowledge related to Women's Health, and brought together researchers from around the world. It included two Invited Lectures, three Thematic Sessions and 54 Contributed Papers.

The Invited Lectures focused on two topics affecting women worldwide: the Biomechanics of Female Pelvic Floor and its applications in the clinical practice (Margot Damaser, PhD) and the Bio-Psycho-Social Model of Women's Health (Heather L. Rogers, PhD).

BioMedWomen gathered the clinical and bioengineering perspectives from different professionals: gynecologists, urologists, physical therapists, nutritionists, sport scientists, radiologists, neurologists, engineers, dermatocosmetologists, gerontologists, psychologists, dentists, among others. Students, residents and postgraduates of all medical specialization were invited to give their contribute and to share their knowledge.

This Conference included Institutional Organizers from the educational, research and clinical settings: the Faculties of Engineering, Medicine, Dental Medicine, Psychology and Educational Sciences, Nutrition and Sports of the University of Porto; the Institute of Science and Innovation in Mechanical and Industrial Engineering (INEGI); and the Centro Hospitalar de São João—EPE.

The Conference Chair would like to express gratitude for the Institutional Support given by the FCT (Fundação para a Ciência e Tecnologia), UNESCO (Comissão Nacional da UNESCO—Portugal), the portuguese section of the IEEE Women in Engineering, biomat.net, and the Atmosfera M (Montepio). Also, a word of appreciation for all the members of the Scientific and Organizing Committees, and to the Local Organizers. Finally, to all the Invited Lecturers, Thematic Session Organizers, Co-chairs, and to all the Authors for sharing their work and their knowledge in the context of the Women's Health and well-being.

The Editors
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Mathematical modelling for assessing fracture risk associated with osteoporosis

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ABSTRACT: Osteoporosis is a systemic skeletal disease, characterized by low bone mass and by changing the bone microstructure. According to the Portuguese Society of Osteoporosis and Metabolic Bone Diseases (SPODOM), this disease affects about 500,000 people in Portugal. This paper presents a study on the evaluation of the fractures risk due to bone demineralization through various risk factors. An optimization code is developed using a mathematical program for diagnosing the disease and to compare it with the diagnosis obtained from DEXA (Dual-energy X-ray absorptiometry) scans. The developed code is performed with Matlab method using genetic algorithms. Analysing the numerical results it is possible to conclude that the program can predict the T-Score value based on previous DEXA exams and the patient life behaviour as physical exercise, drinking coffee, the smoking, previous disease and other factors.

1 INTRODUCTION

Osteoporosis is a systemic skeletal disease, characterized by low bone mass and consequently by changing the bone microstructure, a decrease in bone strength and therefore an increased risk of fracture are promoted. According to the Portuguese Society of Osteoporosis and Metabolic Bone Diseases (SPODOM), this disease affects about 500,000 people in Portugal (Dinis et al. 2012) (Luenberger et al. 2008) (Smith et al. 2002). In this work, the main objective is to find the reference values of bone mineral density that characterize each DEXA machine (Dual-energy X-ray absorptiometry).

2 PURPOSE

This paper presents a study to calculate the values of the reference Bone Mineral Density (BMD) that characterizes each DEXA machine. An optimization code was developed, using a mathematical program, to calculate the reference bone mineral density and tested with different diagnosis from DEXA.

3 MATERIALS AND METHODS

This study included 45 surveys of women aged between 47 and 83 years who underwent bone densitometry by DEXA in two distinct areas, the femur and the spine.

The developed code is performed with Matlab software using Genetic Algorithm (GA). The GA is a stochastic method of random search able to achieve a global optimal solution of optimization problems with, and without, constraints (Teles, Mateus Lembi 2010). In this work, the Genetic Algorithm used was a predefined variant of Matlab software.

To build this code was necessary to determine the equation that relates the Bone Mineral Density (BMD) with *T-Score* value. The expression is given by:

$$T - Score = \frac{BMD - RBMD}{SD} \quad (1)$$

where BMD represents the patient bone mineral density, RBMD the reference bone mineral density and SD the standard deviation.

Currently the bone mineral density is measured by a densitometry technique, the DEXA. In this technique, the equipment needs to be calibrated before any examination. For this adjustment is necessary to use a phantom. This is a filter that contains segments of material equivalent to bone, soft tissue and air (Maciel, Marino 2012).

So, each DEXA machine has a different calibration and different reference values for bone mineral density and standard deviation. This means that for different DEXA machines it is possible to obtain different *T-Score* values for the same patient.

According this situation, a new study arose. Considering the same input values (age, weight, height, age of menopause) it is possible to identify the reference values for bone mineral density and standard deviation. Knowing this information is possible to identify the corresponding *T-Score* obtained in different DEXA machines.

4 RESULTS

The results were obtained through the survey analysis. Thus, initially 22 surveys were selected randomly and, with Matlab-Excel interface, it was possible to determine the values of RBMD and SD for expression (1). This procedure was carried out for the two areas of study, the spine and the femur. The values obtained in this first step are found in Table 1.

To test whether the values were correct, it was made the *T-Score* calculation and it was found that the values were equal to those obtained in DEXA scans. Figure 1 and Figure 2 shows the calculation for *T-Score*.

Table 1. Values obtained of RBMD and SD in Matlab.

	Spine	Femur
RBMD	1,1795	1,0006
SD	0,12006	0,12023

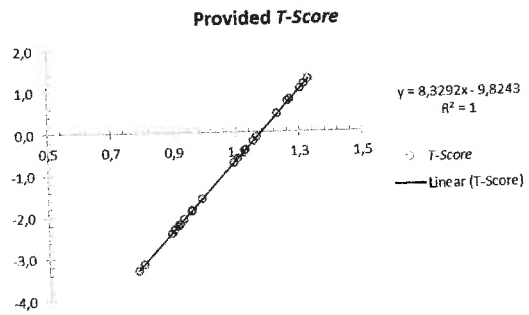

Figure 1. Provided *T-Score* for the spine.

The next step was to select 23 new surveys, taking care to not use any of 22 previously selected and the RBMD and SD values previously calculated to predict the *T-Score*. And as has happened before, the anticipated value of the *T*-Score corresponds to the value obtained in the examination of DEXA.

Figure 3 and Figure 4 shows the predicted values of the *T-Score* with these 23 new surveys.

Analysing the numerical results it is possible to conclude that the program can identify the *T-Score* value based on previous DEXA exams.

By examining the data from the researcher Daniela Rocha (Rocha, Daniela 2011), it was possible

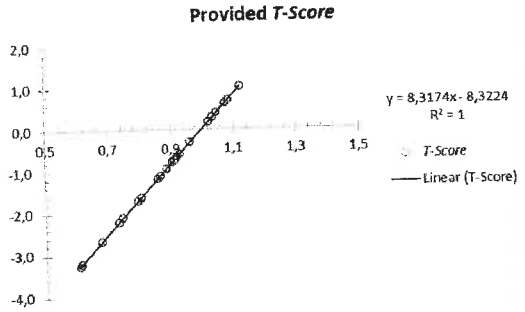

Figure 2. Provided *T-Score* for the femur.

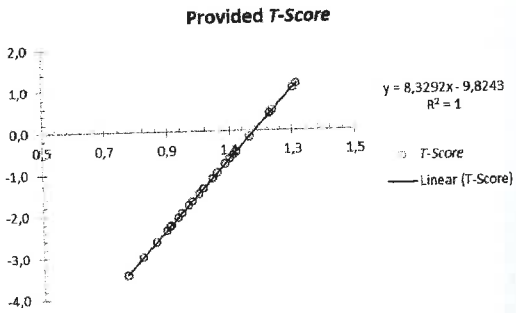

Figure 3. Provided *T-Score* for the spine.

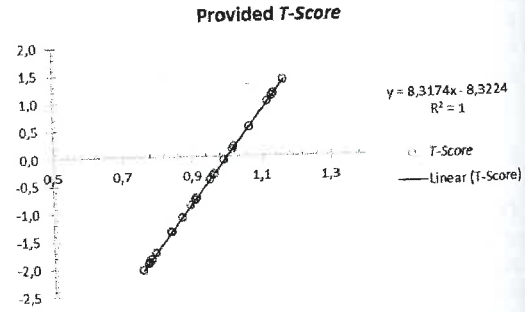

Figure 4. Provided *T-Score* for the femur.

to obtain the graphs of Figures 5–8. They express that the *T-Score* value increases with age, where the green bars represents patients without pathology, the orange corresponds to individuals who have osteopenia and the red pertains to patients with osteoporosis.

Figure 5 and Figure 6 show the *T-Score* values for the 22 surveys mentioned above.

Through of the figures it can be concluded that with age there are more cases of osteopenia and osteoporosis, as studied by the researcher Daniela Rocha (Rocha, Daniela 2011). It can also be noted that with increase age cases, the pathologies are more intense, both in the spine and femur.

Figure 7 and Figure 8 relates the *T-Score* values of 23 surveys.

Doing the same study for the 23 surveys mentioned above, can check and conclude that the pathologies prevalence are more balanced, in other words, the pathologies does not manifest in specific ages, but in several age group study. Thus, through the Figures 7–8 it is not possible to conclude that patients with higher age have a higher prevalence of osteopenia and osteoporosis. For this case in particular pathologies are manifested in all age groups.

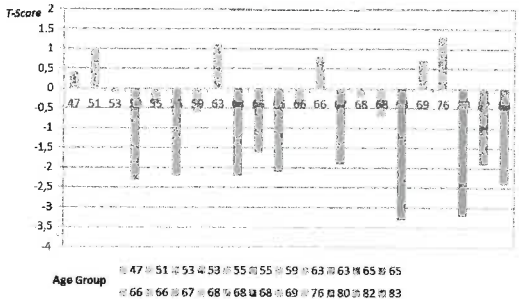

Figure 5. *T-Score* values of 22 surveys as a function of the age range in the spine.

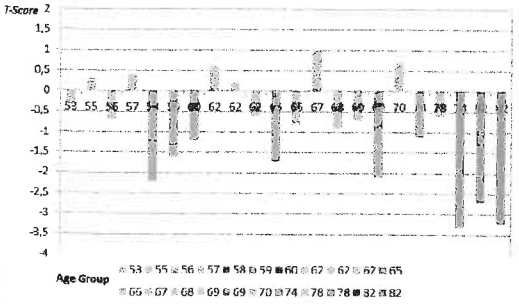

Figure 6. *T-Score* values of 22 surveys as a function of the age range in the femur.

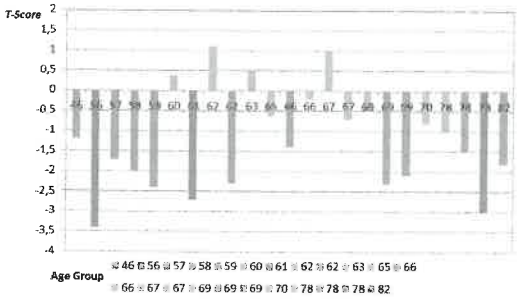

Figure 7. *T-Score* values of 23 surveys as a function of the age range in the spine.

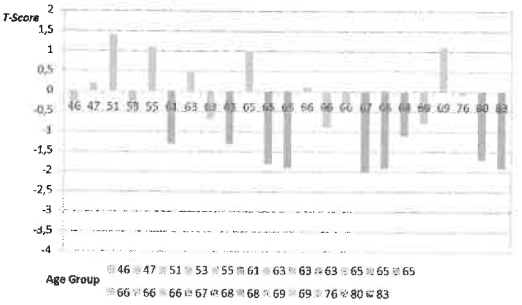

Figure 8. *T-Score* values of 23 surveys as a function of the age range in the femur.

It should be noted that the sample is limited in size and therefore conclusions are not significant.

5 DISCUSSION AND CONCLUSIONS

As mentioned, the obtained results in the developed program were equal to the values presented in the DEXA scans. Thus, it was possible to predict the *T-Score* value and characterize each DEXA machine with reference values.

With this study is possible to identify the *T-Score* value in different DEXA machines considering the BMD value, taken in other DEXA machine.

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BioMedWomen 2015 - Clinical and BioEngineering for Women's Health contains all author contributions presented at BioMedWomen 2015 (Porto, Portugal, 20–23 June 2015). International contributions from countries worldwide provided comprehensive coverage of the current state-of-the-art on different topics:

- Aging
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- Medical Devices
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- Dental Care and Orthodontics

BioMedWomen 2015 - Clinical and BioEngineering for Women's Health will be of interest to academics and to others interested and involved in clinical and engineering subjects related to women's health.

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