

**UNIVERSITI TEKNOLOGI MARA**

**ANALYSIS OF IMMEDIATE  
RADIATION EFFECTS ON  
OSTEOPOROTIC BONE  
MORPHOLOGY AND MECHANICAL  
PROPERTIES**

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## ABSTRACT

**Introduction:** Although bone architecture and its mechanical properties are known to deteriorate after radiotherapy, the effects of radiation on osteoporotic bones in menopause patients have not been fully understood. Therefore, this study investigates the effects of radiation on the osteoporotic femur of menopause-induced mice.

**Materials and Methods:** Ovariectomy was performed on 38-week-old BALB/c mice (n=6) to induce menopause and osteoporosis, and the animals were allowed to recover for 10 weeks. Then, the mice in the irradiated group were exposed to Caesium-137 Chloride sources at a dose of 30 Gy. After seven days, all mice were euthanised and their femurs were dissected. Micro-computed tomography ( $\mu$ CT Skyscan 1172) was performed on the distal femurs at voxel size of 8  $\mu$ m in 20-minute scans, and the bones were quantified using a CT-analyser. Thereafter, bone durability was analysed in a three-point bending simulation (ANSYS Workbench software version 2020 R1). **Results:**  $\mu$ CT analysis showed that irradiated mice had reduced bone volume (-41.65 %), trabecular number (-30.56 %) and trabecular thickness (-21 %), besides increased trabecular separation (50.95 %) compared with control littermates. The same trend was observed in the cortical bone at the diaphysis region. There was reduction in total area (-1.75 %) and cortical area (-4 %) despite an increase in cortical thickness (10.56 %). Additionally, cortical stiffness and flexural strength was also significantly reduced by -35.06 % and 18 %. **Conclusion:** The findings show that irradiation can alter the microarchitecture and mechanical properties of bones in an animal model. Hence, targeted therapy strategies should be improved to reduce the deleterious effects on the bone caused by the irradiation.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the study

Osteoporosis is a skeletal condition characterized by porous and weak bones. In clinical practice, osteoporosis becomes manifest primarily fragility fractures, especially at the spine, hip, and wrist (Subramaniam et al., 2019). Fractures caused by osteoporosis are known to be a serious health issue for the elderly. However, there is relatively limited information about osteoporosis in Malaysia. The most thorough investigation of hip fracture incidence in Malaysia was conducted between 1996 and 1997 (Lee & Khir, 2007). They reported that between 1996 and 1997, 90 hip fractures per 100,000 people were among those age over 50. Furthermore, it was expected that from 2018 to 2050, the number of hip fracture cases in Malaysia would multiply by 3.55, the most significant growth in the Asian region (Cheung et al., 2018). This is due to the rising in life expectancy by 5 years in the last 15 years reported by World Health Organization (J. Kim et al., 2016). Thus, increase hip fracture due to osteoporosis.

On the other hand, cancer is Malaysia's fourth significant cause of death, accounting for 12.6 percent of all fatalities in government hospitals and 26.7 percent in private hospitals in 2016 (Yusof & Ishak, 2022). Overall, 48,639 new cancer cases were reported in Malaysia in 2020. Colorectal cancer is the second most common cancer in Malaysia (World Health Organization, 2021) and a major cause of morbidity and mortality. Mortality due to colorectal cancer is rising, and it is the third most common cause of cancer mortality in Malaysia (International Agency for Research on Cancer, 2020). The rising socioeconomic level and growing westernised lifestyle in developing Asian countries, such as Malaysia, could be linked to increased colorectal cancer incidence. Malaysia's population is undergoing aging (Cetin & Kalaycı, 2012) and westernised food, obesity, and smoking are increasing colon cancer risk factors