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(G*) POS-D18 – Investigating normalizing methods for X-ray fluorescence measurements of Zinc in nail clippings using TOPAS Monte Carlo code

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Development of portable X-ray fluorescence devices has made it easier to quickly assess trace elements such as zinc in human tissue. Zinc deficiency can have serious implications on growth and development of the human body. From recent studies zinc content in nail clippings has been suggested to be an effective biomarker for zinc status. In this study, a simulation approach was used to investigate the use of a portable X-ray fluorescence system for detecting the variation of zinc signal with respect to nail thickness and was compared with the experimental results. The portable X-ray device was modelled using the available information from the manufacturer using the TOPAS Monte Carlo code (Geant4 simulation software).The simulations were carried out for varying nail phantom thickness (0.2 mm –1.2 mm) with concentration of 1000 ppm zinc. Each simulation was run for 10ˆ9 histories and the statistical uncertainty was less than 3.5%. The obtained energy spectra from different measurements were analyzed and three different normalization techniques (Coherent, Compton and Entire) spectrum were investigated to account for the variation of sample interrogated by the X-ray beam. Close agreement between simulation and experimental trends were observed indicating successful benchmarking of the simulation. Compton and Coherent normalization followed a slightly negative trend. One other important observation was coherent normalization can be a robust normalization procedure to improve the accuracy of elemental quantification in order to reduce the variability in nail thickness by ˜8%. Overall the simulation approach can provide additional insights into elemental analysis in keratin based nail phantoms.

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