



Estimation of Spinal Curvature without Radiation Exposure Using a Polynomial Regression Equation Calculated from Shoulder, Waist and Hip Inclination Angles

Aratchaporn Jirapraphip¹, Punyarat Boonyou¹ Tritsawan Suddee^{1*}

Sonruedee Srisawat¹ and Supreeya Phothon²

¹Princess Chulabhorn Science High School Phetchaburi, Kao-Yai, Cha-Am, Phetchaburi

²Bangkok Hospital Hua Hin, Hua Hin, Hua Hin, Prachuap Khiri Khan

*Email : 67tritsawan.sud@pccphet.ac.th

Abstract

Scoliosis is a condition characterized by abnormal curvature of the spine, which affects posture, balance, and overall mobility. The Cobb angle obtained from X-ray imaging is the standard measure of spinal curvature; however, repeated exposure limits long-term follow-up. This study developed a non-radiographic method for estimating the Cobb angle (y) using observable body-tilt variables, including shoulder tilt (x_1), waist tilt (x_2), and hip tilt (x_3). Polynomial Regression was applied to create predictive equations based on the Apex of the spinal curve, and the model was developed in two groups according to the direction of the Apex, yielding the following results.

The first regression equation is:

$$y = 13.1445x_1 - 2.8507x_2 + 14.2826x_3 - 1.6406x_1^2 - 0.0018x_2^2 - 0.5919x_3^2 + 1.5023x_1x_2 - 1.4141x_1x_3 - 0.9068x_2x_3$$

with an accuracy of $R^2 = 0.9988$

The second regression equation is:

$$y = 15.1265x_1 + 2.4006x_2 + 5.0196x_3 - 1.3531x_1^2 + 0.0039x_2^2 - 0.9461x_3^2 - 0.3011x_1x_2 + 1.2812x_1x_3 - 0.0732x_2x_3$$

with an accuracy of $R^2 = 0.9966$

The model evaluation showed an average prediction error ranging from 4.26% to 4.66%, which is acceptable for preliminary use. The high determination coefficients ($R^2 \approx 0.9966 - 0.9988$) confirm that body-tilt variables can effectively support scoliosis screening without radiation. The equations were integrated into a prototype radiation-free Cobb angle assessment device that calculates spinal curvature from external body-tilt data. This system simplifies screening, reduces radiation exposure, and shows strong potential for practical use in hospitals and community healthcare settings.

Keywords: Scoliosis, Cobb angle, Polynomial regression, Body-tilt equation, Non-radiographic assessment