Statistical Analysis of hair mineral concentrations measured by PIXE method and its application to the prediction of atopic dermatitis

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According to the Environment Protection Agency, every year thousands of new chemical agents are entering our living environment. The adverse influences to people from this environmental contamination are global, and can compound from one generation to the next.

The objective of this study is to determine possible relationships between atopic dermatitis and the amount of minerals in an infant's and mother's hair as measured by the PIXE method. At this time, PIXE measurements of the hair samples of 842 pairs of mothers and infants at the national one-month and 10- month medical checkup are completed. The PIXE measurements will be linked with the clinical data for a cause and effect analysis of atopic dermatitis. An investigation on the statistical nature of the elements measured in these samples is crucial for epidemiological use, and is being reported here.

The ultimate purpose of this research is to develop a predictive statistical model that can be applied to atopic dermatitis with the goal of either ameliorating the symptoms of atopic dermatitis or preventing its onset altogether. However in order to do this, data had to be analyzed, statistical variables had to be determined, categorized, hypothesis postulated, and models developed and tested.

To this end the main statistical analyses in this body dissertation is divided into 4 sections. The PIXE measurements were statistically analyzed and linked to clinical data to determine a cause and effect relationship between mineral content in hair and atopic dermatitis. An investigation on the statistical nature of the elements measured in these samples was crucial for their use in epidemiological studies.

The first in the series of statistical analyses concerned reproducibility. This statistical analysis examined the accuracy of the PIXE measurements for epidemiological use by statistically analyzing two independent measurements obtained from different hairs of the same person. The F-value was larger for infants than for mothers for each mineral except Br for which they were approximately equal. This may be ascribed to the fact that food and living conditions were far less restricted for

mothers than for infants, causing the mineral amounts in different hairs of each infant to fluctuate less. Despite this consideration, our major concern of the hypothesis that the probability of detecting minerals was the same between the two PIXE experiments, or the experiments are reproducible concerning mineral detection was confirmed.

In the second series analysis the primary interest was whether or not the various minerals and their concentrations in the human body, as measured by PIXE analysis of hair, could be associated with infant AD. The endpoint was whether or not each infant was diagnosed with AD at the ten-month health checkup with the explanatory variables being the hair mineral amounts of mothers at the one-month checkup. We found the hair mineral estimates subject to substantial intra-individual variations, which must have degraded the significance of the statistical testing for the association between mineral concentrations and the onset of AD. We obtained the reliability index λ for each mineral. The reliability index tended to be small for toxic minerals, and a smaller λ causes more degrading effects on the significance and attenuating effects on the estimates. The reliability index varied considerably from one mineral to another. We developed a simple method to recover the degraded significance using the value of λ and obtained significance for each mineral that was masked by the intra-individual variations. We discovered a significant relationship between Se and atopic dermatitis

The objective of the third analysis was to develop analytical techniques to determine the normal ranges of hair minerals taken from our sample. We also presented some fundamental characteristics of these hair mineral distributions. 30 mineral ranges were calculated where previously there had been none or only poorly provided data.

The fourth and final statistical analysis was a cumulation of the three previously discussed studies. The goal was to create a risk analysis model to predict the onset of atopic dermatitis for primary prevention of the disease. This analysis resulted in an equation that predicted the onset of atopic dermatitis in infants far more accurately than earlier reports.

It is our hope that this work and future projects that will use this research as a foundation will eventually help provide a better understanding and in the future help lead to the prevention of atopic dermatitis.