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Development of a Standard Soil-to-Skin Adherence Probability Density Function for Use in Monte Carlo Analyses of Dermal Exposure

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It has recently been suggested that "standard" data distributions for key exposure variables should be developed wherever appropriate for use in probabilistic or "Monte Carlo" exposure analyses. Soil-on-skin adherence estimates represent an ideal candidate for development of a standard data distribution: There are several readily available studies which offer a consistent pattern of reported results, and more importantly, soil adherence to skin is likely to vary little from site-to-site. In this paper, we thoroughly review each of the published soil adherence studies with respect to study design, sampling, and analytical methods, and level of confidence in the reported results. Based on these studies, probability density functions (PDF) of soil adherence values were examined for different age groups and different sampling techniques. The soil adherence PDF developed from adult data was found to resemble closely the soil adherence PDF based on child data in terms of both central tendency (mean = 0.49 and 0.63 mg-soil/cm²-skin, respectively) and 95th percentile values (1.6 and 2.4 mg-soil/cm²-skin, respectively). Accordingly, a single, "standard" PDF is presented based on all data collected for all age groups. This standard PDF is lognormally distributed; the arithmetic mean and standard deviation are 0.52 ± 0.9 mg-soil/cm²-skin. Since our review of the literature indicates that soil adherence under environmental conditions will be minimally influenced by age, sex, soil type, or particle size, this PDF should be considered applicable to all settings. The 50th and 95th percentile values of the standard PDF (0.25 and 1.7 mg-soil/cm²-skin, respectively) are very similar to recent U.S. EPA estimates of "average" and "upper-bound" soil adherence (0.2 and 1.0 mg-soil/cm²-skin, respectively).

KEY WORDS: Soil-to-skin adherence; dermal exposure; Monte Carlo analysis; risk assessment; probability density function.