**A novel application of the Newcomb-Benford Law to EXPOSURE data**

**B. Fuentes1, D. R. Schultz2,3\*,Ö. Dinçkol4,5, S. Karakitsios2,3,7, D.A. Sarigiannis2,3,6, S. Valentini1, E. De Felip1, L. Ricceri4, G. Calamandrei4, A. Pino1**

1 Department of Environment and Health, Istituto Superiore di Sanità, Viale Regina Elena 299, 00161 Rome, Italy

2 Environmental Engineering Laboratory, Department of Chemical Engineering, Aristotle University of Thessaloniki, Thessaloniki, 54124, Greece

3 HERACLES Research Center on the Exposome and Health, Center for Interdisciplinary Research and Innovation, Balkan Center, 57001, Greece

4 Center for Behavioral Sciences and Mental Health, Istituto Superiore di Sanità, Viale Regina Elena 299, 00161 Rome, Italy.

5 Department of Physiology and Pharmacology "Vittorio Erspamer", Sapienza Università di Roma, Roma, Italy

6 Environmental Health Engineering, School for Advanced Study IUSS, Pavia, Italy

7 ENVE.X, Thessaloniki, Greece https://enve-x.com/

*\* daynaraeschultz@gmail.com*

**ABSTRACT**

The Newcomb-Benford Law (NBL) is a powerful mathematical concept that describes the distribution frequency of the significant digits for in large data sets (Judge and Schechter 2009). NBL suggests that the probability for the significant digits (1 through 9) of a randomly occurring number is not equally distributed but follows a distribution where 1 occurs more frequently than 2, 2 more than 3, and so on. Use of the NBL has frequently been used to identify fraudulent or manipulated data in the political, economic, and natural sciences. However, few studies have used the NBL to identify underlying mechanisms in toxicokinetic and toxicodynamic analyses. We applied NBL to five different exposure data sets with the aim of understanding how toxicokinetics and toxicodynamics (TK-TD) of essential, beneficial, and nonessential elements may influence conformity to the Newcomb-Benford distribution (NBD) in mammalian biosamples. Data sets were collected for observational and experimental studies and measured a range of concentrations of essential, beneficial, and nonessential elements in human adults and children as well as mice.

Findings suggest that underlying physiological mechanisms, such as preferential uptake of essential elements, may lead to violations of the NBD and that in these cases, the violation appeared to follow a characteristic rotated sigmoidal curve. Findings also indicate that competitive co-exposure to a beneficial and nonessential element results in a violation without a characteristic trend. Therefore, the use of the NBL in exposure data to detect data manipulation may be flawed.

**KEYWORDS:** Benford’s Law, data science, toxicokinetics, toxicodynamics, exposure toxicology

**REFERNCES:**

[1] Dieter William Joenssen (2015). BenfordTests: Statistical Tests for Evaluating Conformity to Benford's Law. R package version 1.2.0. https://CRAN.R-project.org/package=BenfordTests

[2] Judge, G. and Schechter, L. (2009) Detecting Problems in Survey Data using Benford’s Law. Journal of Human Resources. 44, 1–24.