



K31 Comparison of Ethanol Elimination Rate of Human Females and Body-Paired Males

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After attending this presentation, attendees will learn about the importance of the formulation of ethanol elimination rate and human gender difference.

This presentation will impact the forensic science community by revealing the prevalence of higher ethanol elimination rates in forensic (driver) female subjects that were investigated.

Subjects consumed commercial alcoholic beverages (beer, wine, liquor, coolers, and/or liqueur) up to 2.2g of ethanol per kg body mass (median=1.1g/kg) in up to 290 min. (median=151 min). Thereafter, they provided suitable breath samples into two different breath alcohol testing instruments about 20 minutes apart. Instrument calibration was confirmed using forensic ethanol standards from different manufacturers with differing concentrations and simulators. The ethanol elimination rate was the post-absorption/distribution linear decrease of alcohol with time.

Ethanol elimination rates for 102 females were paired with varied body criteria of ultimately 207 males from a larger database (109 females, 702 males) of post-offense forensic toxicology casework. Data from females were first paired with males of identical age (yrs), and then varied body criteria of: (i) body mass index (BMI) (± 3 , n=98); (ii) body mass (BM) (± 4.5 kg, n=70); (iii) estimated total body water (ETBW) (± 10 L, n=83); and, (iv) estimated liver weight (ELW) (± 300 g, n=84). ETBW was calculated from equations derived by Watson¹ and ELW from Chouker.² Ethanol elimination rates were formulated in concentration per time (mg/210 L/hr), mass per time (g/hr), and mass per body mass per time (g/kg/hr). No significant differences (albeit less paired subjects) were found for smaller ranges of body criteria (e.g., BMI ± 2 , ± 1 ; BM ± 2.3 kg, ± 0.9 kg; ETBW ± 5 L, ± 2 L; ELW ± 200 g, ± 100 g).

Breath ethanol elimination rates in concentration per time were significantly higher ($p < 0.01$) in females than males for all body criteria considered (e.g., median of 20.3 vs. 17.1mg/210 L/hr for BMI ± 3 ; 20.5 vs. 17.2 for BM ± 4.5 kg; 20.6 vs. 17.4 for ETBW ± 10 L; 20.2 vs. 17.4 for ELW ± 300 g). Females had a wider and higher range in elimination rate (concentration per time) for all body criteria considered (e.g., 13.7 to 29.0mg/210 L/hr vs. 11.9 to 23.1mg/210 L/hr for BMI ± 3 ; 13.6 to 29.0 vs. 11.9 to 24.3 for BM ± 4.5 kg; 13.6 to 29.0 vs. 11.9 to 24.3 for ETBW ± 10 L; 13.6 to 29.0 vs. 11.9 to 24.3 for ELW ± 300 g).

Breath ethanol elimination rates in mass of ethanol per time (g/hr) were statistically lower ($p < 0.01$) in females than males when paired for BMI (e.g., median of 7.60 g/hr vs. 8.92g/hr for BMI ± 3), but were not statistically different for other body criteria (e.g., median of 7.90 g/hr vs. 8.51g/hr for BM ± 4.5 kg); median of 7.86g/hr vs. 7.77g/hr for ETBW ± 10 L; median of 7.80g/hr vs. 8.26 g/hr for ELW ± 300 g).

Elimination rates in mass of ethanol per body mass per time (g/kg/hr) were not significantly different between gender for all body criteria (e.g., median of 0.119 vs. 0.119g/kg/hr for BMI ± 3 ; 0.112 vs. 0.119g/kg/hr for BM ± 4.5 kg; 0.116 vs. 0.119g/kg/hr for ETBW ± 10 L; 0.114 vs. 0.120g/kg/hr for ELW ± 300 g).

A higher proportion of females had elimination rates (concentration per time) greater than 20.0 mg/210 L/hr than males for all body criteria (e.g., 54.1% vs. 9.2% for BMI ± 3 ; 57.1% vs. 18.6% for BM ± 4.5 kg; 57.8% vs. 18.1% for ETBW ± 10 L; 53.6% vs. 16.7% for ELW ± 300 g).

Dettling et al. (2007) reported that different liver masses as calculated in relation to the distribution volume account for the differing ethanol elimination rates between men and women.³ Dettling et al. (2008) reported that gender differences in the pharmacokinetics of ethanol can partly, but not completely, be explained by progesterone levels.⁴ Dettling et al. (2009) reported the difference in average ethanol elimination rate between gender of 0.012 g/kg/h was statistically significant ($p < 0.0001$).⁵ We found the ethanol elimination rate is higher in human females than males when formulated in concentration per time, but no significant difference in concentration per body mass per time.

References:

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Ethanol, Elimination, Female