

Use of Toenails as a Non-invasive Method of Determining Salt Intake in Epidemiologic Studies

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Objectives: The currently recommended method for assessing salt intake is a 24-hour urine sodium excretion which is not feasible in large epidemiologic studies. This study aimed to investigate the validity of measuring sodium in toenails, as a novel feasible method, against 24-hour urine (24 HR) samples collected in the PERSIAN Cohort.

Methods: We recruited 176 individuals, aged 35–70, and obtained 24 HR urine samples every three months for a year and toenail samples at the end of the study. The concentrations of sodium were determined by flame photometry in urine samples and by instrumental neutron activation analysis in toenail samples. Toenails were washed with 10% nitric acid before measurement. The mean of the four 24 HR (m24 HR) urine samples was used for validation. A Spearman correlation test was conducted to assess agreement between the 24 HR urine samples and the toenail samples. A questionnaire asking about the frequency

of bathing, swimming, or washing feet, and the time between the last wash/bath/swim and toenail clipping was filled out at the time of toenail collection.

Results: Toenails and 24 HR urine samples were provided by 111 and 130 participants, respectively but in 43 participants the volumes of 24 HR urine samples were not reported. The median concentration of sodium in the toenail samples was 325.8 (235.4–479.3) $\mu\text{g/g}$ and in the m24 HR samples was 1067.2 (1294.6–2305.2) mg/d . Twenty-one %, 1%, and 78% of participants reported daily bathing, swimming, and washing of their feet, respectively. The mass of nail samples and foot washing frequency were correlated with sodium concentrations in the toenails ($r = 0.34$ and -0.41 respectively). The correlation coefficient between sodium concentrations in toenails and m24 HRs was 0.12 ($P = 0.3$). However, by excluding the participants who reported more than one time per day washing their feet ($n = 21$), the coefficient became 0.22 ($P = 0.13$), and by excluding the participants who reported bathing or washing their feet every day ($n = 32$), the coefficient became 0.50 ($P = 0.04$).

Conclusions: Our results show sodium may leak out during frequent foot washing and do not support the usage of toenails as a biomarker for sodium intake.

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