

# Urinary stones as a novel matrix for human biomonitoring of toxic and essential elements

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**Abstract** Monitoring of body burden of toxic elements is usually based on analysis of concentration of particular elements in blood, urine and/or hair. Analysis of these matrices, however, predominantly reflects short- or medium-term exposure to trace elements or pollutants. In this work, urinary stones were investigated as a matrix for monitoring long-term exposure to toxic and essential elements. A total of 431 samples of urinary calculi were subjected to mineralogical and elemental analysis by infrared spectroscopy and inductively coupled plasma mass spectrometry. The effect of mineralogical composition of the stones and other parameters such as sex, age and geographical location on contents of trace and minor elements is presented. Our results demonstrate the applicability of such approach and confirm that the analysis of urinary calculi can be helpful in providing complementary information on human exposure to

trace metals and their excretion. Analysis of whewellite stones (calcium oxalate monohydrate) with content of phosphorus <0.6 % has been proved to be a promising tool for biomonitoring of trace and minor elements.

**Keywords** Urinary stones · Trace elements · Biomonitoring · Exposure · Urolithiasis

## Introduction

Urinary stones are products of pathological biomineralization processes in the urinary system. About 40 components that can form urinary calculi have been identified. The most frequent components are calcium oxalates, magnesium and calcium phosphates, uric acid and their combinations (Bazin et al. 2012; Daudon et al. 2004). Urolithiasis is one of the most common health problems in the world and can affect entire population regardless of sex, age or race (Scales et al. 2012; Daudon et al. 2004). Diet and lifestyle factors can play an important role in kidney stones formation (Scales et al. 2012).

Elemental composition of urinary stones is related to a particular mineral component. However, urinary stones also contain other minor or trace elements due to their natural occurrence in urine. Many researchers dealt with investigation of trace elements in urinary stones in relation to kidney stones formation (Atakan et al. 2007; Durak et al. 1992; Perk et al. 2002;

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