



Cyprus  
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Sciences

**Doctoral Dissertation**

**EXPOSURE ASSESSMENT TO DISINFECTION  
BYPRODUCTS: FROM PERSONAL EXPOSURE  
ASSESSMENT TO POPULATION HEALTH**

**Stephanie Gängler**

**Limassol, November 2017**



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# Approval Form

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## **EXPOSURE ASSESSMENT TO DISINFECTION BYPRODUCTS: FROM PERSONAL EXPOSURE ASSESSMENT TO POPULATION HEALTH**

Presented by

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Cyprus University of Technology

Limassol, November 2017

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The approval of the dissertation by the Cyprus International Institute for Environmental and Public Health does not imply necessarily the approval by the Department of the views of the writer.

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## **ABSTRACT**

Exposure to disinfection byproducts (DBP) affects large population groups around the world, thus any association with adverse outcomes should be known. Trihalomethanes (THM) are a representative group of DBP and their exposure distribution and health effects are often used as surrogates for the whole class of DBP. THM comprise of chloroform, bromodichloromethane, dibromochloromethane and bromoform, all of which are known to exhibit hepatotoxic effect in high concentrations. This study aimed to assess the different tools for exposure assessment, population differences as well as metabolic markers of exposure and possible health outcomes related to exposure to THM. The methodologies included personal exposure assessment, environmental monitoring, biomonitoring of biomarkers of exposure and effect and untargeted metabolomics along with extensive statistical analysis. Factors such as geography, climate conditions, lifestyle, environment, chemical exposures, and endogenous processes were integrated, showing the various stages and steps towards the comprehensive assessment of the exposome.

Through this project we were able to point out significant country differences in urine levels of THM in populations of Cyprus, Kuwait, Norway and the Netherlands. An exposure gradient from North to South was seen, with increasing median [IQR] urinary total THM levels from Norway (199 [76-486] ng/g), the Netherlands (340 [174-596] ng/g), Cyprus (691 [510-919] ng/g) to Kuwait (1044 [814-1270] ng/g). Both, external (e.g. exposure sources, habits) and internal (e.g. metabolism) factors influenced the THM biomarker levels and the biomarkers of effect. While under a high THM exposures (cleaning activities), differences in metabolomic profiles in urine were observed, this was not obvious under low exposures. Populations in Norway and the Netherlands, exposed

to low levels of THM based on their urinary THM levels, showed no specific metabolic changes. This research provides additional insight for methodological improvement in THM exposure assessment and the basis for targeted hypothesis-driven investigation towards improved dose-response assessment and safe exposure levels.

**Keywords: Trihalomethanes, exposure assessment, metabolomics, type 2 diabetes mellitus, exposome**