

Background levels of key biomarkers of chemical exposure within the UK general population – Pilot study

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Abstract

The use of biomarkers is now an accepted measure of chemical uptake (possibly exposure) in risk assessment. However, information on background exposures and biomarker concentrations of many environmental chemicals in the general UK population is limited. This study aims to determine reference ranges for eleven biomarkers of chemical exposure, measurable in urine, within the general adult UK population. The study will involve 400 volunteers throughout the UK and is currently underway. Described here is a pilot study, carried out during August and September 2005 to test the study methodology. The initial results of the postal survey and urinary concentrations for cadmium (UCd) and mercury (UHg) are reported. A total of 78 individuals were recruited by post from the UK Electoral Register, to take part in the pilot study. Participants were asked to complete a questionnaire and provide a urine sample. The overall response rate was 16%, of which 60.3% were female and 39.7% male. Those living in suburban areas accounted for 60% of respondents, current smokers 12.8% and vegetarians 1.3%. Levels of UCd were higher in females compared to males and smoking status influenced levels; smokers displayed higher levels of UCd than individuals who had previously smoked or who had never smoked. The mean, median and range of UHg was 1.12, 0.55 (<limit of detection (LD)–13.46) µg/g creatinine, respectively. This pilot study shows that postal sampling may be a useful and cost effective method for carrying out biomonitoring studies using urine as the matrix.

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Keywords: Human biomonitoring; Urinary cadmium; Urinary mercury; Urinary biomarkers; Biological monitoring; Postal questionnaire

Introduction

The application of biomarkers and measurement of occupational, environmental and consumer exposures via biomarkers has progressed substantially in the past 20 years, resulting in several occupational exposure limits being set on the basis of biomarker measurement,

and the acceptance of biomarkers as surrogates of exposure in risk assessment. However, information on background levels of biomarkers in the general population to many commonly occurring environmental chemicals is lacking, as the majority of biomarker studies have been conducted to look at high-level exposures and have generally only examined small control groups for background exposures. As a consequence, there are very few established reference ranges for most biomarkers against which to compare measured environmental biomarkers of exposure and to

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determine whether particular exposure levels are higher than would normally be expected. This severely limits the interpretation of individual biomarker measurements and studies. This project will be amongst the first European projects to establish background incidence of a range of biomarkers to a number of substances in the general population. Similar projects have been conducted in Germany; the German Environmental Survey (GerES), carried out in 1985/86, 1990/92 and 1998, and in the US, the on-going National Health and Nutrition Examination Survey (NHANES) programme. Reference ranges will be determined for eleven biomarkers of chemical exposure (Table 1), measurable in urine, within the general adult UK population. Described here are the initial methodological findings from the pilot study carried out between August and September 2005. Some data for urinary levels of cadmium and mercury are also included.

Method

Ethical approval was obtained from the Central Manchester Local Research Ethics Committee prior to commencement of the study and the names and addresses of the study participants are stored in

accordance with the Data Protection Act 1998. For the pilot study, a sample of 18,000 names and addresses were systematically sampled from the UK Electoral Roll, from which a sub-sample of 500 individuals was randomly selected. A letter was sent to each individual inviting them to participate in the study and a £5 gift voucher was offered as a thank you for taking part. Individuals that responded positively, i.e. by signing and returning a consent form, were sent a sample pack and asked to provide a urine sample and complete a questionnaire about everyday exposures. Questions were asked on tobacco use and exposure to environmental tobacco smoke, diet, the use of household and personal care products and employment. Both urine sample and questionnaire were returned by post. Urine samples were logged and stored at -20°C until analysis.

Chemical analysis

Environmental chemicals and their relevant biomarkers were selected for analysis based on the likelihood of exposure of the general UK population to the chemicals of interest, their toxicity, and the availability of robust validated analytical methods for the corresponding biomarkers. Creatinine was also determined in all samples to correct for urine dilution. Table 1 lists the

Table 1. Biomarkers to be analysed in urine samples supplied by individuals in the general UK population

Chemical	Biomarker	Reason for inclusion
Benzene	S-Phenylmercapturic acid	Carcinogenic, wide general population exposure, continuing regulatory interest
Cadmium	Cadmium	Nephrotoxic and long half-life in humans giving potential for toxic effects after chronic exposure. Small safety margin between background levels and toxicity
Caffeine	Caffeine	Generic chemical exposure almost universally experienced by the general population
Chlorinated hydrocarbons	Trichloroacetic acid	Widely used as solvents and wide exposure from drinking water. Carcinogenic and reprotoxic properties
Dithiocarbamates	Ethylene thiourea	Widely used fungicides with residues frequently detected in food pesticide monitoring surveys. Potential endocrine disrupters
Mercury	Mercury	Found in dental fillings, batteries, pharmaceuticals, pesticides and cosmetics. Regulatory concern over exposure of the foetus to dietary levels of mercury. Neurotoxic effects in infants
Naphthalene	1-Naphthol	Recently classified as potentially carcinogenic, wide consumer exposure from bathroom products and mothballs
Nicotine	Cotinine	Broad exposure of general population, important to understand relative contribution of sources of environmental pollution
Phthalates	Phthalate secondary metabolites	Found in numerous consumer products including food packaging, personal-care products and plastics. Current regulatory concern over high background consumer exposure. Potential endocrine disrupter
Pyrethroids	3-Phenoxybenzoic acid and specific pyrethroid metabolites	Widely used agricultural and home and garden pesticides, potential endocrine disrupters
Xylene	Methyl-hippuric acid	Second most widely used solvent (after toluene), but with more specific biomarker

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