Sex-and Smoking-related Differences in Cadmium (Cd) Levels in Kidney of Thai Cadavers without History of Occupational Exposure to Cd

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Background and Objective: Cadmium (Cd) is a toxic heavy metal which is ranked as the one of ten chemicals with major public health concerns. There have been so far no studies on the Cd levels in human organs in Thailand. Therefore, this study was attempted to investigate the levels of Cd in the kidney, which are known to be the most targets of Cd accumulation in 90 Thai cadavers without experience of occupational exposure.

Method: Samples of the acid-digested kidney were analyzed for Cd with flame atomic absorption spectrometer (FAAS). The cadavers were divided into three groups as female non-smokers, male non-smoker and male smokers. Each group was composed of 30 cadavers. None of female smokers were included in the analysis because of very few numbers of female smokers in Thailand. The study was further attempted to examine whether any relations are present among tissue Cd-level, sex and smoking habit.

Result: As a result, the Cd-level (ฅg/gm wet tissue weight) was remarkably high in the kidney (17.30±5.1 ฅg/gm wet tissue weight) in all the cadavers. On the other hand, the Cd-level was significantly higher in the kidney of non-smoking females (20.26±3.55 ฅg/g wet tissue weight) than non-smoking males (11.23±3.60 ฅg/g wet tissue weight), ($p<0.05$). Furthermore, it was significant higher of Cd-level in the kidney of male smokers (20.40±3.66 ฅg/g wet tissue weight) than those of male non-smokers (11.25±3.69 ฅg/g wet tissue weight) ($p<0.05$).

Conclusion: The present finding represents the first databases of Cd-levels directly measured in organs of general human population in Thailand. The Cd-levels show some differences in sex and smoking habit.

Key words: Cadmium, Thailand, Kidney, smoking

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Proceeding

Introductions

Cadmium (Cd) is one of the most heavily cumulative toxics with an estimated half-life of more than 10 years in man. Once absorbed, Cd irreversibly accumulates in human body, in particularly in kidneys and other vital organs. The kidney contains the highest concentrations of Cd, and it is considered as the critical organ whatever the source is and portal of entry of Cd[1]. In addition to the direct cytotoxic effects that can lead to apoptotic and/or necrotic events, Cd has potent carcinogenic effects in target organs[2]. Cd occurs naturally in some rock phosphate fertilizers. Industrial uses of the metals and agricultural activities have led to dispersion of Cd at trace levels into the environment and human foods[3]. In non-occupationally primary exposure sources of Cd for the general population include food and tobacco smoking. In the industry, Cd exposure is mainly by inhalation although significant amounts of Cd can be

ingested via contaminated hands or cigarettes[4]. Tobacco smoking is an important additional source of exposure for smokers. Since one cigarette contains approximately 1 to 2 ตg Cd, smoking one pack of cigarettes per day results in a daily uptake of Cd that approximates that derived from food. When exposure is by inhalation, it is estimated that between 10 and 50 percent of Cd is absorbed, depending on the particle size and the solubility of Cd compounds. In the case of Cd in tobacco smoke (mainly in the form of CdO), an average of 10 per cent of Cd is absorbed[1,5]. The Cd body burden, negligible at birth, increases continuously during life until approximately the age of about 60-70 yr from which Cd body burden levels off and can even decrease[6]. Non-workplace exposure to Cd has been linked to a number of adverse health effects attributable to distinct pathological changes in a variety of tissues and organs[4,6]. These include the development and/or progression of diabetic renal complications, hypertension, osteoporosis, leukemia and cancer in several organs such as the lung, kidney, urinary bladder, pancreas, breast and prostate. Adverse health effects by Cd exposure in non-occupational populations include interactions with diabetes, osteoporosis and renal toxicity, particularly impairment of renal tubular re-absorption function[7]. The study of Cd levels in human organs in Thailand witch may be one of the health effect factors has never been reported. Therefore, this study was conducted among non-occupational Cd-exposed Thai populations.

Objective

The aim of the present study was to investigate the levels of Cd in the kidney Thai cadavers without occupational exposure to metals, and to determine the correlation among kidney Cd levels, sex and smoking behavior.

Table 1 Demographic data for all subjects included in the study. Data are presented as mean±SD and (range) or number (%) values

Parameters	Total subjects(n = 90)	Males(n =60)	Females(n =30)
Number of subjects, n (%)	90 (100)	60 (66.70)	30 (33.30)
Age (years)	66.60±13.96 (39-103)	66.82±14.24 (30-91)	66.24±13.67 (39-103)
Body weight (Kg)	60.75±13.80 (38-94)	62.44±13.22 (38-88)	58.00±14.46 (44-94)
Occupation, n (%)			
Official	37(41.11)	26 (28.88)	11 (12.22)
Farmer	17 (18.88)	9 (10.00)	8 (8.88)
Merchant	21 (23.33)	16 (17.77)	5 (5.55)
Housewife	8 (8.88)	4 (4.44)	4 (4.44)
Laborer	7 (7.77)	5 (5.55)	2 (2.22)
Smoke, n (%)			
Ever	30 (33.30)	30 (33.30)	0 (0.00)
Never	60 (66.70)	60 (66.70)	30 (33.30)

Material and Methods

The study protocol was approved by the Ethics Committee of the faculty of Medicine, Khon Kaen university. Samples of the kidney were obtained from 90 donated cadavers of anthropologic autopsies carried out in the Department of Anatomy within Khon Kaen university. Subjects were excluded from the study if they had one of the following criteria: not domiciled in the northeast, blood - borne communicable diseases, cadavers had not been kept at 4^0C and historical data is not available. A questionnaire was used to evaluate exposure to Cd including questions on demographic data, general heath, history of chronic disease and smoking status of cases were obtained from donated relatives. Wet tissue samples of the kidney were weighed approximately 10 g. The tissue sample were rinsed in ice-cold normal saline. The medulla and cortex of the kidney samples were dissected apart. The samples were dissected into smaller sizes and were then oven-dried at 70^0C for 48 hr. We weighed dried samples to 4 decimal points to estimate the water content in each sample. Dried samples were digested in 65% HNO_3 and equilibrated to a boiling water bath temperature for 24 hr. Samples were then analyzed for Cd with the flame atomic absorption spectrometer. The quality assurance of this analysis for tissue Cd levels were assessed with a Cd standard solution (TraceCERT®, Sigma).

The questionnaire survey covered demographic data, ethnic background, general health, history of chronic disease, the use of herbal medicine and smoking habit.

Results

The sample population comprised of 60 males and 30 females (age range: 30–103 yr). The overall mean age for the sample population was 66.6 yr. The majority of studied subjects were government officers (41.1%); other occupations including merchants (23.3%), farmers (18.8%), laborers (7.7%) and housewives (8.8%). About 33% of the total populations surveyed were smokers and

Table 2 Cd concentrations (μg/gm wet tissue weight) in kidney samples from the sample population

Descriptors	Kidney Cd		
	Smoker	Non-smoker	Total
Male	(30)20.48±3.72	(30)11.25±3.67	(60)15.63±5.92
	[4.62-29.64]	[3.13-16.77]*	[3.13-29.64]
Female	NS	(30)20.26±3.55	(30)20.26±3.55
	NS	[6.13-29.06]**	[6.13-29.06]□
Total	(30)20.48±3.72	(60)15.07±4.37	(90)17.38±5.92
Total	[4.62-29.64]	[3.13-29.06]***	[3.13-29.64]

Note: each descriptor shows (n)mean ± SD [range], NS: no sample

* Indicates statistically significant difference of kidney Cd levels from male smoker at $p<0.05$

** Indicates statistically significant difference of kidney Cd levels from male non-smoker at $p<0.05$

*** Indicates statistically significant difference of kidney Cd levels from smoker at $p<0.05$

□ Indicates statistically significant difference of kidney Cd levels from male at $p<0.05$

all of them were males are shown in Table 1.

The mean and ranges values for the levels of Cd (expressed in ตg/g wet tissue weight) found in kidney as a function of smoking are shown in Table 2. The mean Cd content kidney was 17.38 ตg/gm wet tissue weight. The total mean estimated kidney Cd amount was higher in female (20.26 ตg/gm wet tissue weight) than in male (15.63 ตg/gm wet tissue weight). And the difference between genders was statistically significant (p=0.02).

About 33.30% of the total populations surveyed were smokers and all of them were males. The male smoker population exhibited higher Cd levels (20.48 ตg/gm wet tissue weight) than male non-smoker (11.25 ตg/gm wet tissue weight). The difference in Cd levels between male smokers and male non-smokers was statistically significant in kidney Cd (p=0.002) and the kidney Cd difference between male non-smoker (11.25 ตg/gm wet tissue weight) and female non-smoker (20.26 ตg/gm wet tissue weight) (p=0.02). Subjects who smokers (20.24 ตg/gm wet tissue weight) had higher Cd levels in kidney than non-smokers (15.07 ตg/gm wet tissue weight) (p=0.01).

Discussions

In the present study, the mean renal Cd level of approximately 20.26 ตg/gm was found in females (Table 2). Kidney accumulation tended to be greater in females than in males. These data may suggest that there is a higher absorption rate in females than in males. Increased absorption of Cd from a shellfish diet was found in females who had low body iron stores[2]. And there has been a study suggesting that the higher kidney Cd concentration may be due to a mobilization of Cd from the liver and other tissues to accumulate into the kidney[3].

This study found the difference in Cd levels between male smokers and male non- smokers was statistically significant in kidney Cd. These findings suggest that tobacco cigarette smoke is by far the largest source of Cd exposure in the general human population. Each cigarette may contain from 1 to 2 ตg of Cd, and 40–60% of the Cd in inhaled smoke generally passes through the pulmonary epithelium into systemic circulation[3,7].

Conclusion

The present finding represents the first data-bases of Cd-levels directly measured in organs of general human population in Thailand. The Cd-levels show some differences in sex and smoking habit.

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