

MASTER'S THESIS

Accumulation of heavy metals and organochlorine pesticides in human milk and adipose tissues, and its health concerns

Chen, Xuehui

Date of Award:
2007

[Link to publication](#)

General rights

Copyright and intellectual property rights for the publications made accessible in HKBU Scholars are retained by the authors and/or other copyright owners. In addition to the restrictions prescribed by the Copyright Ordinance of Hong Kong, all users and readers must also observe the following terms of use:

- Users may download and print one copy of any publication from HKBU Scholars for the purpose of private study or research
- Users cannot further distribute the material or use it for any profit-making activity or commercial gain
- To share publications in HKBU Scholars with others, users are welcome to freely distribute the permanent URL assigned to the publication

**Accumulation of Heavy Metals and
Organochlorine Pesticides in Human Milk and Adipose
Tissues, and Its Health Concerns**

CHEN Xuehui

A thesis submitted in partial fulfillment of the requirements

for the degree of

Master of Philosophy

Principal Supervisor: Prof. WONG Ming Hung

Hong Kong Baptist University

February 2007

ABSTRACT

Being one of the fastest developing regions in terms of socio-economical development in China, the Pearl River Delta (PRD) has met with deteriorating environmental contamination as a sacrifice due to the expansion of industry and increased quality of life. A wide-range of pollutants including persistent organic pollutants (POPs) and toxic metals have been detected in different environmental compartments, such as air, water, soil and sediments, as well as in human bodies.

The present study aims to investigate the concentrations of heavy metals (Cu, Zn, As, Cd, Cr, Ni, Pb, Hg) and OC pesticides (HCHs and DDTs) in human milk and adipose tissues, for the assessment of body loadings of these toxic compounds, with an attempt to interpret their impacts on human health. In the first part of the study, 67 adipose tissue and 23 milk samples from smokers, cancer patients and normal healthy controls were collected from Hong Kong hospitals for the measurement of toxic metals. The results indicated a significant correlation of Cd ($r=0.559$, $p<0.01$), Pb ($r=0.695$, $p<0.01$) and Cr ($r=0.786$, $p<0.01$) between human milk and adipose tissues. Age, body weight, diet habit and smoking are potential factors that contributed to heavy metal accumulation, particularly Pb, Cd, and As were significantly ($p<0.05$) associated with the frequency of seafood dietary intake. Significantly higher ($p<0.05$) levels of Cd and Pb were measured in the adipose tissues of patients with cancer and infertility than healthy controls.

In the second part of the study, 62 subcutaneous and 31 paired visceral adipose tissue samples were collected for the detection of Cu, Zn, As, Cd, Cr, Ni, Pb and Hg. Levels of Cd, Pb and Hg were significantly related to seafood diet, with the highest levels of Pb in frequent consumers (>7 times/wk) about 1.5 times higher than the level in low consumers (≤ 1 time/wk) (6.13 ± 2.20 vs 4.22 ± 2.39 $\mu\text{g}/\text{kg}$ fat); and the highest levels of Hg about 3

times higher than the lowest (18.6 ± 7.51 vs 5.63 ± 1.58 $\mu\text{g}/\text{kg}$ fat). Positive correlations of heavy metal accumulation in adipose tissue and genealogical diseases were observed, particularly, As, Cd and Pb were found to be bioconcentrated in female adipose tissue from participants with uterine fibroid, cervix/corpus carcinoma and ovary tumor.

The third part of this study concerned the bioaccumulation of OC pesticides (DDT, DDE, DDD and HCH) in human adipose tissues. All these compounds were found to be significantly ($p < 0.05$) correlated between subcutaneous and visceral adipose tissues. The OC pesticide levels seemed to be related to reproductive ages, indicating the age-related bioaccumulation in adipose tissues. There was also a potential elimination through placenta transmission and lactation. Significantly elevated ($p < 0.05$) concentrations of HCHs and DDTs were detected in patients with endometrial cancer of the uterus, reflecting the impact of OC pesticides on the etiology of this disease, which was hormonal-related pathology.

Heavy metals and OC pesticides were detected in human milk and adipose tissues in Hong Kong residents, and the data indicated that human milk and adipose tissue samples were reliable biomarkers for the assessment of human exposure to environmental toxic substances. In addition to environmental exposure, individual parities such as age, body fat, diet habit and disease outcomes were possible factors which will influence the bioaccumulation of heavy metals and OC pesticides.

Table of Contents

Declaration	i
Abstract	ii
Acknowledgements	iv
Table of Contents	v
List of Tables.....	xi
List of Figures	xiv

CHAPTER 1 General Introduction

1.1 Research Background.....	1
1.1.1 Heavy Metal Contamination and Human Health.....	1
1.1.1.1 Contamination Sources and Fate in the Environment.....	1
1.1.1.2 Routes of Entry into the Human Body, Human Exposure and Bioaccumulation in Human Tissues.....	3
1.1.1.3 Toxicity and Potential Health Impacts.....	5
1.1.2 Organochlorine Pesticides and Human Health.....	7
1.1.2.1 Contamination Sources and Fate in the Environment.....	7
1.1.2.2 Routes of Entry into the Human Body, Human Exposure and Bioaccumulation in Human Tissues.....	9
1.1.2.3 Toxicity and Potential Health Impacts.....	14
1.1.3 Human Tissues as Indicators of Human Exposure to Environmental Chemical.....	18
1.2 Research Objectives and Design Framework.....	19

1.2.1 Research Objectives.....	19
1.2.2 Designed Framework.....	21

CHAPTER 2 Heavy Metals in Human Adipose Tissue and Milk Samples

2.1 Introduction.....	24
2.2 Materials and Methods.....	28
2.2.1 Sample Collection and Preparation.....	28
2.2.2 Chemicals and Apparatus.....	29
2.2.3 Statistical Analysis.....	30
2.3 Results.....	30
2.3.1 Heavy Metal Accumulation in Human Adipose Tissue Samples.....	30
2.3.1.1 Heavy Metal Distribution and Women’s Age.....	30
2.3.1.2 Heavy Metal Distribution and Women’s Body Weight.....	31
2.3.1.3 Heavy Metal Distribution and Women’s Seafood Diet.....	31
2.3.1.4 Heavy Metal Distribution in Relation to Clinical Disease and Lifestyle.....	32
2.3.2 Heavy Metal Accumulation in Human Milk Samples.....	33
2.3.2.1 Heavy Metal Concentrations and Women’s Age.....	33
2.3.2.2 Heavy Metal Concentrations and Women’s Body Weight.....	33
2.3.2.3 Heavy Metal Concentrations and Women’s Seafood Dietary Habit.....	33
2.3.2.4 Heavy Metal Concentration in Relation to Cigarette Smoking and Vitamin Supplementation.....	34
2.3.3 Correlation of Heavy Metal Concentrations in Adipose Tissue and Milk.....	34

2.4 Discussion.....	48
2.4.1 Maternal Age and Heavy Metal Concentrations in Women’s Adipose Tissue and Milk Samples.....	48
2.4.2 Maternal Body Weight and Heavy Metal Concentration.....	50
2.4.3 Maternal Diet Habit and Heavy Metal Concentration.....	52
2.4.4 Heavy Metal Accumulation in Maternal Adipose Tissue and Milk in Relation to Mother’s Lifestyle and Cigarette Smoking.....	54
2.4.5 Correlation Study of Heavy Metal in Adipose Tissue and Maternal Milk.....	58
2.5 Conclusion.....	60

CHAPTER 3 Heavy Metals in Female Subcutaneous and Visceral Adipose Tissues

3.1 Introduction.....	61
3.2 Materials and Methods.....	65
3.2.1 Sample Collection and Treatment.....	65
3.2.2 Chemicals and Apparatus.....	66
3.2.3 Statistical Analysis.....	67
3.3 Results.....	68
3.3.1 Women’s Age and Heavy Metal Distribution in Subcutaneous and Visceral Adipose Tissues.....	68
3.3.2 Women’s Body Weight and Heavy Metal Distribution in Subcutaneous and Visceral Adipose tissues.....	68
3.3.3 Women’s Seafood Diet and Heavy Metal Distribution in Subcutaneous and Visceral Adipose Tissues.....	69

3.3.4 Women's Clinical Status and Heavy Metal Distribution in Subcutaneous and Visceral Adipose Tissues.....	70
3.3.5 Correlations of Heavy Metals in Paired Subcutaneous and Visceral Adipose Tissues.....	71
3.4 Discussion.....	87
3.4.1 Women's Age and Heavy Metal Distribution in Subcutaneous and Visceral Adipose Tissues.....	87
3.4.2 Women's Body Weight and Heavy Metal Distribution in Subcutaneous and Visceral Adipose Tissues.....	88
3.4.3 Women's Diet Habit and Heavy Metal Distribution in Subcutaneous and Visceral Adipose Tissues.....	90
3.4.4 Heavy Metal Distribution in Subcutaneous and Visceral Adipose Tissues in Relation to Clinical Genealogical Disease.....	92
3.4.5 Correlation Study of Heavy Metal Distribution in Paired Female Subcutaneous and Visceral Adipose Tissues.....	97
3.5 Conclusion.....	99

CHAPTER 4 Organochlorine Pesticides in Female Subcutaneous and Visceral Adipose Tissues and Their Relations with Gynecological Diseases

4.1 Introduction.....	101
4.2 Materials and Methods.....	104
4.2.1 Sample Collection and Treatment.....	104
4.2.2 Chemicals and Apparatus.....	106
4.2.3 Statistical Analysis.....	106

4.3 Results.....	107
4.3.1 Women' s Age and Organochlorine Pesticides Concentrations in Female Paired Subcutaneous and Visceral Adipose Tissues.....	107
4.3.2 Women' s Body Weight and Organochlorine Pesticides Distribution in Subcutaneous and Visceral Aadipose Tissues.....	107
4.3.3 Seafood Diet and Organochlorine Pesticides Concentrations in Female Paired Subcutaneous and Visceral Adipose Tissues.....	108
4.3.4 Comparison of Organochlorine Pesticides in Paired Subcutaneous and Visceral Adipose Tissues in Relation to Gynecological Diseases.....	109
4.3.5 Correlation Coefficients of OC Pesticide Concentrations in Female Subcutaneous and Visceral Adipose Tissues.....	110
4.4 Discussion.....	119
4.4.1 Comparison of OC Pesticide Concentrations in Female Paired Subcutaneous and Visceral Adipose Tissues in Relation to Women' s Age.....	119
4.4.2 Women' s Body Weight and Organochlorine Pesticide Concentrations in Subcutaneous and Visceral Adipose Tissues.....	120
4.4.3 Comparison of Organochlorine Pesticide Concentrations in Paired Subcutaneous and Visceral Adipose Tissues in Relation to Seafood Diet.....	121
4.4.4 Comparison of Organochlorine Pesticide Concentrations in Subcutaneous and Visceral Adipose Tissues in Relation to Gynecological Diseases.....	123
4.4.5 Correlation Coefficients of Organochlorine Pesticide Concentrations in Female Subcutaneous and Visceral Adipose Tissues.....	125
4.5 Conclusion.....	126

CHAPTER 5 General Discussion and Conclusion

5.1 Human Tissues for Biomonitoring of Environmental Chemicals.....	128
5.2 Heavy Metals in Female Adipose Tissues and Milk.....	129
5.3 Comparison of Human Exposure to Cd, Zn and Pb in Different Regions	130
5.4 Heavy Metals in Human Subcutaneous and Visceral Tissues.....	136
5.5 Organochlorine Pesticides in Subcutaneous and Visceral Adipose Tissues... 	136
5.6 Limitations of the Present Research.....	140
5.7 Future Work.....	141
5.7.1 Enlarge Sample Scale for Obtaining Stronger Explanation Evidence....	141
5.7.2 Molecular Mechanism Study.....	141
References.....	142
Appendix.....	189
Curriculum Vitae.....	191