ELEVATED SERUM PCDD/FS LEVELS IN DUCK'S FARMERS DUE TO CONSUME THE POLLUTED DUCK EGGS

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Abstract

A high PCDD/Fs level of duck egg was found from the study of the food market basket survey. The further study found in Chang-Hua county, central Taiwan, 9 duck farms for egg production locating there, and the suspected high PCDD/Fs polluted duck eggs were proved in the secondary sampling. This study therefore aimed to evaluate the serum PCDD/Fs levels, dietary consumption, and health effects for all duck farmers' families. Forty-two duck farmers' families (exposure group) and 88 residents living in the Chang-Hua County (control group) were recruited, and the measured data was used to estimate how the influence of consuming contaminated duck egg on serum PCDD/Fs accumulation. Serum PCDD/Fs levels of duck farmer's families was significant higher than those of control group (28.1 vs. 18.6 pg WHO-TEQ/g lipid, p=0.0001). Significant differences of PCDD/F levels were found for most congeners, especial for 2,3,4,7,8-PeCDF. Serum PCDD/Fs TEQ levels will elevate 1.021 and 1.118 pg WHO-TEQ/g lipid, respectively while the age increase1 year old or increase a duck egg consumption per month after adjustment for fish consumption.

Introduction

A high PCDD/Fs level in duck egg was measured in central Taiwan from the study of the food market basket survey. We further found 9 duck farms for contaminated egg production located in Chang-Hua county, central Taiwan. Therefore, the high PCDD/Fs contaminated eggs were hypothesized collecting from there, and proved in secondary sampling. The PCDD/Fs levels of these sampling eggs (7.82 -15.03 pg WHO-TEQ/g fat) were notable higher than the maximum PCDD/Fs level of hen egg and egg products (3 pg WHO-TEQ/g fat) by Scientific Committee on Food (SCF) of the European Commission.

The transportation of agricultural products around Taiwan is common[1] as well as livestock products. The 9 duck egg farms mainly produced duck eggs, therefore the duck farmers exposed to environmental PCDD/Fs due to consumed the duck egg for the long time has raised much public concern immediately. Previous study has evaluated the chicken egg consumption in men (average range from 14.9 to 28.2 per month) and women (ranged from 13.3-19.3 per month) (data not publish), and the data indicted that chicken egg were the common food for Taiwanese. In this specific population, the duck farmers consume duck egg instead of the hen egg, and the PCDD/Fs concentrations obviously higher in the previous people than the after. According to the evaluation around the environments, we found there was a zinc oxide recovery plant located near the duck farms, and the plant was highly hypothesized to have PCDD/Fs emission because of their stack sampling[2].

Therefore, the study aimed to evaluate the serum PCDD/Fs levels, dietary consumption, and health effects in all duck farm's family, and the information might provide to estimate how the influence of the contaminated duck egg on serum PCDD/Fs accumulation of duck farmers' families.

Material and methods

Subject Selection and Serum Collection This study was approved by the Ethics Committee of the National Cheng Kuang Hospital (Tainan, Taiwan). The exposure group, 42 people, was recruited from duck farmers' families, residing in Chang-Hua country, central Taiwan, a famous agricultural duck area. The control group, 88 people lived far from duck farms at least 20 km away from duck farm were invited. Subjects from control group were confirmed to have no occupational exposures to PCDD/Fs, such as having worked in incinerators, pesticide manufacturing factory, ferrous and nonferrous metal smelting plants and others before this study. At the beginning of the study, the subjects from exposure and control groups have to sign a consent form for participating in this study and agree to provide 60 mL of venous blood. Finally, 42 and 80 volunteers from the respective exposure and control areas were available for the current study. There was a requirement for overnight fast was delivered to all study participants before the blood samples were drawn. Blood samples were drawn to

chemically clean tubes containing no anti-coagulants, and serum samples were obtained after centrifugation.

Serum Sample Cleanups and HRGC/HRMS Analysis of PCDD/F Seventeen 2,3,7,8-substituted PCDD/Fs were measured in serum samples, using isotope dilution method. Each serum sample was spiked with a mixture containing 15 $^{13}C_{12}$-PCDD and PCDF standards as defined in USEPA Method 1613. Serum samples were enriched and fractionated by C18, SCX, silica, and highly selective adsorbent magnesium-silica gel cartridges (Florisil) before HRGC/HRMS analysis. Each analytical run consisted of a method blank, a quality control, and seven unknown samples for quality assurance and quality control. The detection limit of 2,3,7,8-TCDD for the analysis was 0.03 pg/column-injection or 0.007 pg/ML-serum. All PCDD/Fs were adjusted to the lipid content analyzed from the corresponding samples and were reported as pg WHO-TEQ/g lipid.

Interviewer-administered Questionnaire Information was obtained from the questionnaire including personal characteristics (gender, age, height, weight, occupational history, neighborhood geography, pregnancy history, etc), and life style (alcohol intake and tobacco usage). Trained interviewers administered the questionnaires according to standard operating procedures prepared and trained in advance.

Results and Discussion

Table 1 presented the basic demographic data, such as age, gender, BMI, education level, smoking habit, chicken and duck eggs consumption between 42 people of duck farmers' families and 88 residents living in the Chang-Hua County. The higher percentage of men was found in duck farmers' families than the residents. The duck farmers' families were older the residents, as well as the BMI distribution was found between the two groups. In addition, the education level was lower in subjects from duck farmers' families than the residents, and notable high duck egg consumption (23.25 per month) was only found in duck farmers' families.

Table 2 showed the distribution of serum 17 PCDD/Fs levels between duck farmers' families and the control group. Average PCDD/Fs level of duck farmers' families was significant higher than those of the control group (28.1 vs. 18.6 pg WHO-TEQ/g lipid, p=0.0001). Significant differences of PCDD/F levels were found for most congeners, especial for 2,3,4,7,8-PeCDF showed significantly higher level in duck's farmers than the control group (11.50 vs. 5.60 pg WHO-TEQ/g lipid, $p<0.0001$), and the PCDFs TEQ level also showed the similar trend (14.43 vs. 7.72 pg WHO-TEQ/g lipid, $p<0.0001$).

The differences of consumption quantity of each food item in the two study groups were examined, and statistical significance was found for food consumption of pork, leafy vegetables, whole fat milk, sea fish, whole fat milk, fruit milk, drink yogurt, peeled fruit, tofu and animal oil ($p<0.05$). The total egg consumption in duck farmers' families was 16.47, and 21.32 for general residents (p=0.972), however, notable high duck egg consumption (Number: 23.25) was only found in duck farmers' families.

We further evaluated the influence of duck egg consumption on serum PCDD/Fs accumulation (Table 3). Twenty-two people of duck farmers' families were grouped as having duck egg consumption $\geq$18 and 20 people consumed less than 18. Significant higher serum TEQ level of PCDD/Fs was found in subjects with high duck egg uptake than the less (32.6 vs. 23.1 pg WHO-TEQ/g lipid, p=0.027), as well as for PCDF levels' distribution (17.1 vs. 11.5 pg WHO-TEQ/g lipid, p=0.016) and for PCDD (15.5 vs. 11.6 pg WHO-TEQ/g lipid, p=0.039). The association of serum PCDD/Fs levels and duck egg consumption after adjustment for age and fish intake by multivariate regression analysis was shown in Table 4. The positive associations were depicted for age and duck egg consumption (R-squared= 0.416, β coefficient=0.021 and 0.041, p value all <0.05, respectively) even after considering for the fish intake. The residing period was further considered to analyze the effect of diet component on PCDD/Fs accumulation, and the result also showed the similar trend as the previous finding. The distribution of 17 PCDD/Fs concentrations of duck farmers, residents living in Chang-Hua, and duck egg were shown in Figure 1. The notable levels were found in 2,3,4,7,8-PeCDF, 2,3,7,8-TCDD, and 1,2,3,7,8-PeCDD. Meanwhile, the trend of congener pattern in duck farmers was similar to duck egg than the residents living in Chang-Hua.

Conclusion

This study suggests that duck farmers' families might uptake PCDD/Fs contaminants via consuming the duck egg cultivated in their duck farms. Significant higher PCDD/F level was found in duck farmers' families than the control group for most congeners, especial for 2,3,4,7,8-PeCDF. The positive associations were depicted between age and duck egg uptake and serum PCDD/Fs accumulation even after adjustment for age and the fish intake. The further study need to clarify whether there were some other contaminant sources might also account

for the PCDD/Fs accumulation of the duck's families, such as ambient emission or the local cultivated animals or other vegetations.

Acknowledgements

We extend our heartfelt appreciation to the study participants, to the Bureau of Health Promotion, Department of Health for sampling assistance and grants support, and to our colleagues for sampling and analytical support.

References

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Table 1 Demographic characteristic between residents living near Chang-Hua incinerator and people of duck farmers' families in Chang-Hua

		Residents (n=88)	Duck's farmers (n=42)	P value
Gender (N: %)	Men	51 (58.0)	26 (61.9)	0.706
	Women	37 (42.1)	16 (38.1)	
Age (years old)		45.3 (11.2)	50.9 (14.6)	0.033*
BMI		24.5 (4.4)	26.3 (3.8)	0.003*
Education (years)	0-6	32 (36.4)	26 (61.9)	0.030*
	7-15	46 (52.3)	13 (31.0)	
	>15	10 (11.3)	3 (7.1)	
Smoking status	Smokers	30 (34.1)	11 (26.2)	0.330
	Passive smokers	30 (34.1)	20 (47.6)	
	Nonsmokers	28 (31.8)	11 (26.2)	
Chicken eggs (number per month)		21.32 (20.95)	16.47 (24.66)	0.972
Duck egg (number per month)		--	23.25 (33.33)	--

Table 2 The difference of serum PCDD/Fs TEQ levels between residents living near Chang-Hua incinerators and duck's farmers in Chang-Hua

Incinerator	Residents (n=88)	Duck's farmers (n=42)	P value†
2,3,7,8-TCDF	0.24 (0.17)	0.18 (0.11)	0.045*
1,2,3,7,8-PeCDF	0.09 (0.15)	0.16 (0.08)	<0.0001**
2,3,4,7,8-PeCDF	5.60 (3.36)	11.50 (7.87)	<0.0001**
1,2,3,4,7,8-HxCDF	0.62 (0.62)	1.30 (1.25)	<0.0001**
1,2,3,6,7,8-HxCDF	0.54 (0.29)	0.88 (0.40)	<0.0001**
2,3,4,6,7,8-HxCDF	0.32 (0.82)	0.23 (0.10)	0.037*
1,2,3,7,8,9-HxCDF	0.12 (0.07)	0.04 (0.02)	<0.0001**
1,2,3,4,6,7,8-HpCDF	0.15 (0.08)	0.13 (0.09)	0.009*
1,2,3,4,7,8,9-HpCDF	0.03 (0.01)	<0.001	<0.0001**
OCDF	0.00	<0.001	<0.0001**
2,3,7,8-TCDD	3.16 (2.80)	2.59 (1.13)	0.332
1,2,3,7,8-PeCDD	5.25 (2.93)	8.09 (4.36)	<0.0001**
1,2,3,4,7,8-HxCDD	0.26 (0.21)	0.45 (0.25)	<0.0001**
1,2,3,6,7,8-HxCDD	1.51 (0.81)	1.70 (1.07)	0.282
1,2,3,7,8,9-HxCDD	0.33 (0.22)	0.50 (0.30)	<0.0001**
1,2,3,4,6,7,8-HpCDD	0.31 (0.19)	0.30 (0.47)	0.012*
OCDD	0.05 (0.04)	0.04 (0.04)	0.085
PCDF levels-TEQ	7.72 (4.29)	14. 43 (9.41)	<0.0001**
PCDD levels-TEQ	10.87 (5.17)	13.67 (6.72)	0.022*
PCDD/Fs level-TEQ	18.60 (8.44)	28.10 (13.93)	0.0001*

† : test by wilcoxon sign rank test *: p value <0.05 **: p value <0.0001

Table 3 Difference of demographic characteristics and serum PCDD/Fs levels between duck's farmers consumed duck egg over 18 per month or less

	duck egg < 18 (N=20)	Duck egg ≥ 18 (N=22)	P value
Men ratio† Men Women	11 (55.0) 9 (45.0)	15 (68.2) 7 (31.8)	0.527
Age (years old)‡	48.2 (14.6)	53.3 (14.4)	0.242
BMI‡	26.5 (4.6)	26.1 (3.0)	0.529
Lipid percentage‡	29.3 (7.9)	29.4 (6.8)	0.979
PCDD/Fs level-TEQ‡	23.1 (12.4)	32.6(13.9)	0.027*
PCDF levels-TEQ‡	11.5 (8.3)	17.1 (9.8)	0.016*
PCDD levels-TEQ‡	11.6 (5.7)	15.5 (7.1)	0.039*

†: N (%) ‡: mean (standard deviation)

Table 4 Multivariate regression model between serum natural logarithm PCDD/Fs levels and age, consumption of duck egg and fish

Models	R^2	β coefficient	P value
Model 1	0.435		<0.0001**
Intercept		1.872	<0.0001**
Age		0.020	<0.0001**
Duck egg consumption		0.011	0.026*
Model 2	0.416		0.0001**
Intercept		1.819	<0.0001**
Age		0.021	0.0001*
Duck egg consumption		0.041	0.023*
Fish intake		0.041	0.389
Model 3	0.429		0.0002**
Intercept		1.566	<0.0001**
Age		0.018	0.001*
Resident period (years)		0.118	0.199
Duck egg consumption		0.116	0.021*
Fish intake		0.031	0.513

*: P value<0.05 **: P value<0.0001

Note: Resident period, duck egg consumption and fish intake was nature log transformed

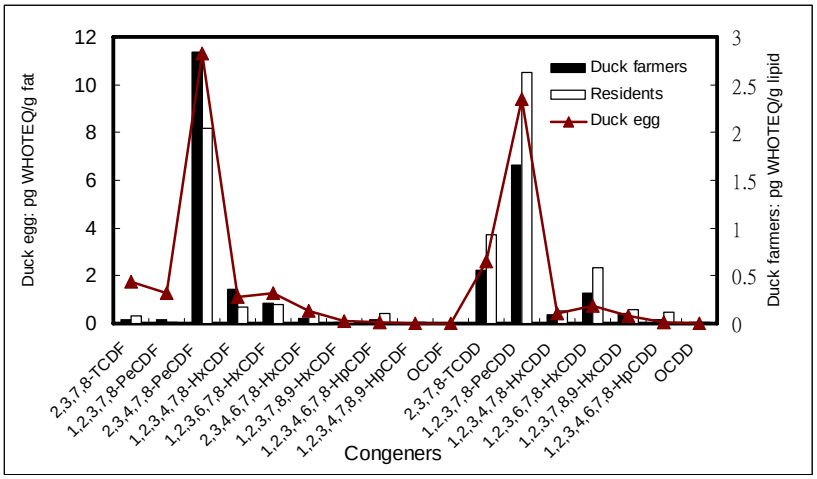

Figure 1 Comparison congener profile of PCDD/Fs between duck farmers, residents living near incinerator of Chang-Hua and duck eggs