raphy is likely to identify few findings and findings of unclear clinical relevance.

Stella Sin Yee Ho, Ph.D.
Winnie Chiu Wing Chu, F.R.C.R.
Ka Tak Wong, F.R.C.R.
Chi Kong Li, M.D.
William Wong, F.R.C.P.
Pak Cheung Ng, M.D.
Anil T. Ahuja, F.R.C.R.
Chinese University of Hong Kong
Hong Kong, China
aniltahuja@cuhk.edu.hk

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Melamine and Nephrolithiasis in Children in Taiwan

TO THE EDITOR: The adverse renal effects of melamine-tainted formula have raised international concern. To address public concerns about melamine, the department of health in Taiwan initiated services to screen exposed children.

From September 24 through October 23, 2008, we screened 1129 children in Taiwan who had possible exposure to contaminated formula, investigating the clinical symptoms and risk factors for nephrolithiasis. Clinical presentation and urinary calcium and creatinine levels were evaluated, and urinalysis and renal ultrasonography were performed. We categorized our patients into three groups, according to exposure history.[1,2] The high-

Table 1. Baseline Characteristics of the Study Children, According to Melamine Exposure.*

Variable	High Exposure (>2.5 ppm) (N=44)	Low Exposure (0.05–2.5 ppm) (N=607)	Control (<0.05 ppm) (N=478)	P Value
Age — yr	4.32±2.60	3.97±2.72	4.26±3.60	0.28
Male sex — no.	22	324	292	0.03
Urinalysis findings — no.				
Occult blood (>2+)	1	26	22	0.77
Hematuria (red-cell count, >5/HPF)	0	13	14	0.40
Pyuria (white-cell count, >5/HPF)	0	25	11	0.11
Proteinuria (>2+)	0	3	3	0.85
Hypercalciuria (calcium:creatinine, >0.2)	0	7	5	0.77
Nephrolithiasis on renal ultrasonography — no.	9	2	1	<0.001
Clinical symptoms and history — no.				
Abdominal pain	0	10	3	0.23
Flank pain	0	0	2	0.26
Dysuria	2	16	7	0.24
Increased urinary frequency	2	9	7	0.28
History of UTI	1	8	3	0.40
Family history of nephrolithiasis	0	7	6	0.76
History of residence in the mainland of China	37	41	105	<0.001

* Plus–minus values are means ±SD. HPF denotes high-power field, and UTI urinary tract infection.

exposure group consisted of children who consumed dairy products from the mainland of China presumed to be highly contaminated (e.g., Sanlu or Mengniu brand, with melamine levels reported as exceeding 2.5 ppm).[1] The low-exposure group comprised children who consumed brands of contaminated milk with lower measured melamine levels (e.g., Klim or Neslac imported from the mainland of China, with melamine levels of 0.05 to 2.5 ppm).[2] The control group consisted of children who consumed brands of milk without detected melamine levels (<0.05 ppm).[2]

There were 44 children in the high-exposure group; none had hematuria, hypercalciuria, flank pain, or acute renal failure (Table 1). Nephrolithiasis and a history of residence in the mainland of China were significantly more frequent in the high-exposure group than in the other two groups ($P<0.001$). In the high-exposure group, children with nephrolithiasis were younger than those without nephrolithiasis (mean ±SD, 2.33±1.12 vs. 4.83±2.64 years; $P=0.009$). The mean duration of exposure was 7.19 months (range, 0.67 to 36) in the high-exposure group and 17.40 months (range, 3 to 48) in the low-exposure group.

The most common metabolic risk factor for stone formation is hypercalciuria, which in the past has been described in 75 to 80% of children with nephrolithiasis.[3] Hematuria as a presenting symptom for nephrolithiasis is also reported to vary, from 30 to 55%.[4] However, neither hypercalciuria nor hematuria was detected in any of the nine children in the high-exposure group with nephrolithiasis associated with the consumption of dairy products from the mainland of China. Plain abdominal radiography in these patients was negative; the stones were detected on ultrasonography. The negative plain films suggest that stones related to melamine ingestion are relatively radiolucent and do not contain substantial amounts of calcium.

Consumption of melamine-contaminated dairy products appeared to be a major factor in the development of nephrolithiasis in the children we screened. Furthermore, the children in the high-exposure group in whom nephrolithiasis developed were all under the age of 3 years. Because of the lack of symptoms and signs, we recommend that ultrasonography be performed in children exposed to melamine-contaminated formula.

I-Jen Wang, M.D., Ph.D.
Taipei Hospital Department of Health
Taipei 242, Taiwan

Pau-Chung Chen, M.D., Ph.D.
National Taiwan University College of Public Health
Taipei 10055, Taiwan

Kung-Chang Hwang, M.D., M.P.H.
Hospital Administration Commission
Taipei 100, Taiwan
r92846001@ntu.edu.tw

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