Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Melamine and other food safety and health scares in China: Comparing households with and without young children

Guanghua Qiao a,1, Ting Guo a, K.K. Klein b,∗

a College of Economics and Management, Inner Mongolia Agricultural University, Hohhot, Inner Mongolia, China
b Department of Economics, University of Lethbridge, Lethbridge, Alberta, Canada T1K 3M4

Abstract

The purpose of this study was to determine whether household responses to melamine and other recent food safety and health scares in China in recent years differed between households that did or did not have young children (less than six years of age). A consumer survey was conducted in Hohhot, China in September 2009, one year after the melamine contamination of milk was disclosed to the public. Households with young children who were not being breast-fed reported that they had reduced milk consumption by at least 1/3 in the immediate aftermath of the melamine disclosure and 39% reported that they cut out milk consumption altogether. A significantly higher percentage of households with children reported being concerned with the effects of melamine in milk and two communicable diseases: SARS and H1N1 influenza than were those with no children. A significantly higher percentage of households with no young children were concerned with the effects of Trace Sudan in chicken, Clenbuterol in pork, chicken eggs with red yolks, and excess iodine in milk powder than were those with young children. All households that reduced consumption of fluid milk following news of the melamine contamination reported a much greater concern with most food safety and health scares than did households that did not reduce consumption of fluid milk. Survey data revealed that most consumers had a relatively low level of knowledge of the Food Safety Law that went into effect just over three months before this survey was conducted.

Households with children also were significantly more concerned about melamine and two communicable diseases, SARS and H1N1 than were households without children.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Less than one month after the August 2008 Olympic Games were concluded in Beijing, Chinese consumers were shocked by the announcement that melamine, an industrial compound usually used in plastics, was present in infant milk formula. The first tainted product that was reported was produced by the Sanlu Dairy Company, one of the largest milk processors with a distribution network throughout China. Although it is clear in hindsight that several Chinese government agencies and at least one dairy company had previous knowledge of melamine contamination and the damaging effects of this chemical on the kidneys of babies (see timeline in Fig. 1), the public was not generally aware of the danger until September 16 when the Chinese government announced that melamine had been detected in the infant milk formula of 22 dairy companies. Panic spread when, on the following day (September 17, 2008), Health Minister Chen Zhu stated tainted infant milk formula had “sickened more than 6200 children, and that more than 1300 others, mostly newborns, remain hospitalised with 158 suffering from acute kidney failure” (Chang, 2008). Consumer confidence plummeted when it was revealed later that six babies had died, almost 300,000 sickened, and more than 50,000 hospitalized (many for several weeks) from consuming the contaminated milk products (Graham-Harrison, 2009; Jacobs, 2009; Qiao, Guo & Klein, 2010). As most of those hospitalized were less than two years old, parents of young children searched frantically for alternative sources of milk products, including products imported from abroad. The fear extended throughout 2009 as reports periodically appeared in the press about new batches of melamine-contaminated dairy products being discovered for sale (Areddy, 2010; Midler, 2010) and even into 2010 (Qiu, 2010) though no further reports of serious illnesses or deaths of babies appeared.

* Corresponding author. Tel.: +1 403 329 2438; fax: +1 403 329 2519. E-mail addresses: qiao.guanghua@gmail.com (G. Qiao), hhhtt0758@yahoo.com (T. Guo), klein@uleth.ca (K.K. Klein).

1 Tel.: +86 471 430 9850.
In March, 2008, Ningjing Children’s Hospital handed over 10 children kidney stone samples to the Urological Department of Ningjing Gulou Hospital for further examination. They are told that these baby patients drank infant milk formula produced by Sanlu Dairy Company.

On June 28, Lanzhou (the capital city of Gansu Province in Northwestern China) Army First Hospital reported the first baby patient with kidney stones. It was reported that this baby had been drinking infant milk formula produced by Sanlu since birth.

By mid-July of 2008, the Ministry of Health Care of Gansu Province received a telephone report from the Second Hospital of Lanzhou University, which claimed that there were increasing number of baby patients with kidney stones and these babies all drank infant milk formula produced by Sanlu.

On July 24, the Technical Center for Inspection and Quarantine of Hebei Bureau of Export and Import Inspection and Quarantine examined 16 batches of infant milk formula produced by Sanlu and 15 batches were found to have significantly high content of melamine.

On August 13, Sanlu decided to: (i) keep on selling the infant milk formula with less than 10 g of melamine per kg and stop selling that with higher melamine content. (ii) assemble infant milk formula with 20 g of melamine per kg to exchange those with more than 20 g of melamine content until all over-tainted infant milk formula is recalled.

On Sept. 9, public media released a report claiming that the 14 babies with kidney stones were all victims of the Sanlu-produced tainted infant milk formula.

On that same day, China’s General Bureau of Quality Inspection sent a joint investigation team to Sanlu Company.

On Sept. 11, several more provinces including Sha’anxi, Ningxia, Hunan, Hebei, Shandong, Anhui, Jingxi and Jiangsu reported that they found the same problems.

Also on that day, Sanlu processing plants were shut down.

In the evening of the same day, Sanlu Company announced an open recall of all tainted infant milk formula, freezing of all the 2176 tonnes of inventories, recalling 8210 tons of infant milk formula and another 700 tons on the way to distribution.

On Sept. 12, the joint investigation team confirmed that “the melamine-tainted powder leads to kidney stones in people, especially on children.” Also, on that same day, Shijiazhuang Municipal Government announced that illegal merchants added melamine into the raw milk processed by Sanlu.

On Sept. 13, China’s Central Government initiated a Level-I Food Safety Reaction: an Urgent Event Handling Leading Group was set up. Also, it was announced that all hospitals across the country would provide free examinations to all babies who potentially have melamine-related illnesses.

On September 16, the Chinese government announced a list of 22 dairy companies in whose infant milk formula melamine had been detected. The government announced on television news networks that 491 batches of dairy products in 109 companies had been inspected. They had found 69 batches in 22 companies containing different amounts of melamine. Sanlu infant milk formula in Shijiazhuang had the highest melamine, up to 2563mg/kg. There were individual batches of products in the other 21 companies that also contained melamine, with concentrations between 0.09 mg/kg and 619mg/kg.

On Sept. 18, China’s General Bureau of Quality Inspection announced the abrogation of a policy that allowed the exemption of quality inspection for the food produced by certified companies.

On Oct. 8, five ministries of China’s Central Government announced a new preliminary limit criterion on melamine content in dairy products for baby-consumed formula; the limit was set at 1 mg/kg.

On Oct. 9, Premier Wen Jiabao signed a new regulation: the Dairy Product Quality Safety and Inspection Management Regulation.



The melamine contamination was only the latest of several types of food contamination that have frightened Chinese consumers. Though previous food safety incidents in China had made clear the need for improved food safety throughout the supply chain, the melamine scare seemed to precipitate legislative actions. Less than one year after the melamine problem became widely known, the Chinese government introduced a new Food Safety Law (USDA, 2009), which replaced the Food Sanitation Law that had been in effect since 1995. The new law notably changed the emphasis from “Food Sanitation” to “Food Safety,” reflecting the priority placed by the Chinese government on improving the safety and the international reputation of the country’s food system (Xiu & Klein, 2010). The Food Safety Law established improved procedures for supervision and management of food products. It implemented rules for reporting food safety accidents, strengthened risk assessment procedures, improved supervision of food additives (which now must be approved and listed in a government catalogue), implemented improved measures for recall of products, and, importantly, abolished provision of inspection-free food items (which previously had been available to approved enterprises). Violators of the Food Safety Law are subject to severe penalties, including compensation to consumers of ten times the value of their purchases of substandard products plus their economic losses (Xiu & Klein, 2010).

The melamine contamination of dairy products was of particular concern to parents of young children because a large part of the diets of young children typically are milk products and young children have the least capacity to deal with the chemical. Parents of young children everywhere naturally are concerned over the safety of foods ingested by their children. Baker (2003), in a survey of 2000 consumers in the United States, found that women and members of households with young children were the most likely to have an extreme avoidance reaction to food risks. Benson (2011) noted that consumer attitudes towards risk of a major food safety hazard are shaped by “the affected party’s feelings regarding the value of what might be lost.” There can be no greater loss than losing one’s child. Concerns about the safety of children’s foods can even have effects in the labour market. Xue and Sun (2009) found that when risks of food safety for infants exist, Chinese women prefer to increase the time spent bringing up their old children and, consequently, reduce time worked outside the home.

The main purpose of this study is to determine whether (and the extent to which) household responses to melamine and other recent food safety and health scares in China have differed between households that include young children and those that do not. In a survey of consumers conducted in Hohhot, capital city of Inner Mongolia and the heart of the burgeoning dairy industry in China, in November 2008 (two months after the public was alerted to the melamine danger), Qiao et al. (2010) found that consumer perceptions of the safety of fluid milk, yogurt, milk powder (for adults) and ice cream, which had plummeted in the days following the contamination announcement, had recovered strongly by the time of the survey. However, no attempt was made in that survey to differentiate between households that included or did not include young children. This study reports on the results of a more recent consumer survey that also was conducted in Hohhot, but in September, 2009, almost exactly one year after the melamine scandal had been publicized.

The first objective of this study was to determine the extent to which consumers’ confidence (differentiating between households with young children of less than six years of age and those with no young children) in the purchase and use of Chinese dairy products had returned to pre-September 2008 levels. The second objective was to determine, within households that reported having young children, the proportion that were feeding their young children with fluid milk, infant milk formula or breast-milk and the extent of reductions within these households in consumption of all major dairy products (fluid milk, yogurt, milk powder for adults, and ice cream). Since the melamine contamination was only the latest in a number of highly publicized food safety and health scares in the last few years, the third objective was to compare the assessments of households with and without young children of the seriousness of the melamine-contaminated dairy products with those from scares in seven other recent food safety incidents and two communicable diseases that caused a lot of public worry throughout the country: SARS and H1N1.
influenza. The fourth objective of this study was to compare the levels of knowledge of the new Food Safety Law between households with and without young children.

2. Recent food and health scares in China

Food safety threats are not new to Chinese consumers. With the fast-paced development of China’s economy, it is perhaps unsurprising that inspection of food products for health and safety has been inadequate. In recent years, several other cases of deliberate food contamination have received widespread publicity and caused great concern in China (Hays, 2010), including:

1) Trace Sudan in chicken. The carcinogenic red dye Sudan I, widely used as a synthetic colourant in industrial compounds, was found in two chicken products sold by KFC in China in March 2005: New Orleans chicken wings and chicken hamburgers. The Sudan dyes are permitted for use in household and textile products but are not permitted as food colour additives in China (Xu, Wang, Fang, Song, & Zhang, 2010). It has been shown that this dye causes genotoxic and carcinogenic effects in humans (An, Jiang, Cao, Geng, & Zhong, 2007). Understandably, its discovery in chicken products in a popular fast-food restaurant chain caused widespread anxiety across China.

2) Clenbuterol hydrochloride in pork. This is a drug used to treat bronchial asthma but has been abolished because of its side effects, including increased heart rates, fatigue, hand tremors and vomiting. However, some farmers used it to develop more muscle (and less fat) tissues in pigs before they were sold. Many people became ill following consumption of the tainted pork (BBC News, 2009). This problem has been identified almost every year and in every province of China.

3) Inferior milk powder. Substandard milk powder was found in ten provinces, autonomous regions and municipalities in 2004. The substandard milk powder was produced by starch, sugar, milk essence and other cheap ingredients and was deficient in protein, fat, and vitamins that are necessary for growth of children. Several babies died and many more were found to be suffering from malnutrition as a result of consuming the inferior milk powder. Many of the babies harmed by the inferior milk powder were the children of impoverished and poorly educated farm people who have little understanding of nutrition and the dangers of counterfeit products (Li, 2004).

4) Red yolk chicken eggs. In early 2004, some companies promoted and sold eggs with red yolks. They were advertised as the “best quality free-range chicken eggs,” with the red yolks the result of using first-class chicken feed (Lee, 2005). However, it was soon discovered that the red yolks were not the result of ordinary chicken feed but rather were caused by feed that was mixed with an unknown quantity of poultry feed additive called carophyll red. Carophyll red (with 10% canthaxanthin) is a colouring agent for foods and drugs. The European Commission of Health and Consumer Protection has limited the use of canthaxanthin in chicken feed to no more than 25 mg/kg because long term consumption of high dosages of canthaxanthin has been shown to cause retinal damage, possibly leading to blindness (Lee, 2005).

5) Injecting meat with water. This involves either forcing water into the stomachs of pigs or cattle shortly before slaughter or injecting water into the hearts of recently slaughtered animals so that the water will quickly flow into the animals’ flesh through the blood vessels. This process increases the weight (and, consequently, the returns) of the products. Reports indicate that the practice has been applied to much pork and practically all beef for more than twenty years (WSJ, 2009). Watered meats are less nutritious, spoil more easily, and encourage the growth of toxin-producing bacteria. In some cases, the water may even contain industrial waste.

6) Expired fluid milk. In June 2005, the Zhengzhou subsidiary of dairy company Guangming (also known as Bright Dairy) was found to be re-processing and selling expired milk and pre-dating other products. The news of this incident was followed by a widely circulated report that quoted an unnamed “industry insider” as saying that recycling expired milk is the norm in the domestic dairy industry and more than 90 percent of fresh milk had been contaminated before entering processing procedures (China Daily, 2005). An online survey following the reporting of this incident showed that 80.5% of nearly 200,000 netizens said they would no longer buy Bright Dairy products although 72.5% once trusted the brand (Asia Times, 2005).

7) Excessive iodine in milk powder. Nestle, the Swiss food industry giant, was found to have allowed excess iodine levels in some of the milk powder sold for consumption by infants and young children in China. It is well-known that excess iodine can cause changes to the thyroid gland. According to the National Food Standards in China, the amounts of iodine in 100 g of milk powder should be between 30 and 100 μg. The Nestle’s product reportedly contained as much as 191 μg (Guo, 2005). Although the company refuted the claims, responding that the products conformed to international standards set by the Codex Alimentarius (Chinadairy, 2005), the news panicked many of the parents of small children throughout the country.

In addition to the many food safety scares in recent years, widespread alarm among the Chinese public occurred with the outbreak of SARS in 2003 and H1N1 in 2009, two diseases that are highly communicable. SARS (or Severe Acute Respiratory Syndrome) infection causes fever, coughs and chest tightness. The symptoms of severe respiratory failure occur rapidly, are progressive, and can quickly lead to death. The disease is highly contagious and caused near-panic in places where it was discovered. It was first found in Guangdong Province (in South China) and later was traced to a wild animal (a cat-like civet) that is served as a delicacy food in southern China. Soon, the World Health Organization (WHO) classified SARS as an epidemic in Hong Kong, Singapore, Toronto, Hanoi, Taiwan, as well as in Guangdong and Shanxi provinces. The WHO reported that 349 persons died from SARS on the Chinese mainland and 4941 had the disease but were rehabilitated (WHO, 2004).

Influenza A (H1N1) virus, often called swine flu by the public media, spread worldwide and was declared a pandemic by the WHO on June 11, 2009. Almost immediately, Chinese authorities imposed strict quarantine procedures for anyone who may have been in contact with infected persons. All incoming international airline passengers were monitored and all passengers who sat near any person with elevated temperature were compelled to spend at least 7 days in confined hospitals.

3. Methods

3.1. Survey procedures

Eight research assistants (in groups of two) were stationed in the entrances of seven major supermarkets in Hohhot on two Saturdays and two Sundays of September 2009 between 10:00 and 17:00 when the supermarkets were very busy. As hundreds of shoppers passed by each hour, a few (chosen randomly but not systematically) were approached and asked if they would be willing to participate in the survey. The questionnaire was
explained clearly to each potential respondent to minimize ambiguity and misunderstanding about the questions.

Data were collected from 350 respondents over the two-week period. The city of Hohhot is divided into four separate administrative districts and the number of questionnaires collected in each district of the city was somewhat proportional to the population: 105 in Xincheng (with 320,000 population), 96 in Saihan (population 360,000), 76 in Huimin (population 220,000) and 73 in Yuquan (population 190,000).

### 3.2. Questionnaires

Shoppers were asked if they reduced the consumption of dairy products from the 22 implicated companies in the wake of the melamine disclosure and whether or not they increased, or intend to increase, the consumption of dairy alternatives such as soya milk, tofu, almonds, oats and other protein sources. Those with children under the age of six were asked if they breast-fed or bottle-fed their infants. Those who purchased milk for their children were asked if they bought fresh fluid milk, domestic infant milk formula or imported infant milk formula prior to September 2008. They were then asked whether (and by approximately how much) their household had reduced its consumption of dairy products and were asked to explain why. They were asked if they purchased imported products to replace the domestic dairy products and which dairy products (domestic and imported) they currently used for feeding their children. Those in the sample were asked about how their confidence in the domestic dairy industry had changed in the year since the initial disclosure of melamine contamination. They were asked how the melamine-contaminated food scare compared to seven other recent food safety scares as well as two serious communicable diseases: SARS and H1N1 influenza. They also were asked questions related to their overall level of knowledge and understanding of the Food Safety Law that went into effect three months prior to the survey. Finally, they were asked questions about their age, ages of their children, education, monthly income categories, usual purchase patterns of dairy products and other personal characteristics.

### 4. Results

#### 4.1. Characteristics of sample

Of the 350 respondents to the survey, 273 had no young children in the household while 77 had children that were less than six years of age: 15 were breast feeding, 60 were feeding milk to their young children by bottles or cups, and two were not feeding milk (Table 1). Almost 3/4 of the sample respondents were female (Table 1), perhaps reflecting the main person in most households who does the grocery shopping (as the survey was conducted at the entrances to supermarkets). Nearly 2/3 of the sample respondents were between 18 and 35 years of age and 1/3 were between 36 and 60 (Table 1). Forty-two percent of sample respondents had fewer than 12 years of formal education while 54% had between 12 and 16 years of formal education. This is broadly in line with the population of Hohhot, where a recent census showed that 47.4% of those aged between 15 and 65 had from 12 to 16 years of education (IMAR, 2010). One-third of the respondents earned 1000 Yuan/month (about US$150) or less, 41% earned between 1001 and 2000 Yuan/month and 24% earned 2000 Yuan/month or more (Table 1). This is in line with the average per capita disposable income of urban residents in Hohhot of 1323 Yuan/month during the first nine months of 2009, as reported by the Inner Mongolia Bureau of Statistics (IMARBS, 2010).

#### 4.2. Consumer’s confidence

About 13% of the sample reported reducing their consumption of fluid milk in the year after first learning about the melamine contamination (Table 2). A slightly higher percentage of households without young children than those with young children reported a decrease in consumption of fluid milk though the difference was not statistically significant. The vast majority of those who reported a reduction in consumption of fluid milk had gone away from consuming that product altogether, i.e., zero consumption of the product at the time of the survey in September 2009. Half of the respondents reported that they had increased their consumption of dairy alternatives such as soy milk and tofu in the year following the melamine safety scare (Table 2). A slightly higher percentage (though not statistically significant) of those without young children indicated that they increased their consumption of dairy alternatives. More than half the sample indicated that they expect to consume about the same quantity of dairy and dairy alternative products in the future with no significant difference between those with and without young children (Table 2). A significantly higher percentage of those without young children than those with young children indicated that they intend to increase consumption of dairy products in the future (Pearson’s Chi-Square \( p < 0.01 \)).

When asked about their level of confidence in the Chinese dairy industry, 63% indicated that they had high confidence, 23% moderate confidence, 8% low confidence, and the remaining 6% expressed no opinion (Table 3). Reasons given for the high level of confidence included support for domestic enterprises and the perceived need for domestic production of an important nutritional food. Several respondents thought that government measures to control food safety would be effective and the big domestic dairy companies would impose sufficient controls in the future. Some respondents mentioned that domestic enterprises cannot be blamed for the melamine scandal as there was no quality testing requirement prior to the food safety event.

---

2 Six respondents were between the ages of 15 and 18.

### Table 1

| Characteristic of sample | No children \((n = 273)\) | With children* \((n = 77)\) |
|--------------------------|--------------------------|--------------------------|
|                         | \(n\) | %  | \(n\) | %  | \(n\) | %  |
| Gender                  |       |    |       |    |       |    |
| Male                    | 82    | 30 | 17    | 27 | 3     | 20 |
| Female                  | 191   | 70 | 45    | 73 | 12    | 80 |
| Age                     |       |    |       |    |       |    |
| 15–35                   | 173   | 63 | 37    | 60 | 13    | 87 |
| 36–60                   | 90    | 33 | 25    | 40 | 2     | 13 |
| 61–82                   | 6     | 2  | 0     | 0  | 0     | 0  |
| Education               |       |    |       |    |       |    |
| Less than 12 years      | 112   | 41 | 31    | 50 | 5     | 33 |
| 12–16 years             | 146   | 53 | 27    | 44 | 10    | 67 |
| More than 16 years      | 14    | 5  | 4     | 6  | 0     | 0  |
| Income                  |       |    |       |    |       |    |
| Below 1000/mo           | 96    | 35 | 15    | 24 | 3     | 20 |
| 1001–2000/mo            | 111   | 41 | 24    | 39 | 7     | 47 |
| Above 2000/mo           | 61    | 22 | 21    | 34 | 3     | 20 |
| Occupation              |       |    |       |    |       |    |
| State officials         | 24    | 9  | 9     | 15 | 3     | 20 |
| Professional and technical | 15   | 5  | 4     | 6  | 1     | 7  |
| Business and service    | 123   | 45 | 25    | 40 | 0     | 0  |
| Unclassified            | 109   | 40 | 23    | 37 | 11    | 73 |

* Children are defined as being less than six years of age at the time of the survey.

b Includes two households with small children who were not being fed milk.

---

IMARBS: Inner Mongolia Bureau of Statistics

**References**

[1] G. Qiao et al. / Food Control 26 (2012) 378–386
4.3. Milk source and consumption expectations

Of the 77 children less than six years of age, 36 (47%) were being fed fluid milk purchased in stores (Table 4). Another 24 of the children (31%) were being fed infant milk formula (18 using infant milk formula from domestic dairy companies and 6 using infant milk formula that had been imported from abroad). As noted above, 15 children were being breast-fed. Two responded that they fed their young children no milk.

Following disclosure of the melamine contamination, 49 of the respondents reporting young children reported decreasing their consumption of dairy products, consisting of fluid milk, yogurt, milk powder (for adults) and ice cream: the main categories of dairy products sold in China. Nineteen (39%) cut out dairy products altogether from their child’s diet, another 9 (18%) reported reducing their child’s consumption of dairy products by more than half, and the remaining 21 (43%) reported reducing their child’s consumption of dairy products by at least one-third (Table 4). When asked the reasons why they had reduced consumption of dairy products for their children, 16 (33%) indicated that they had lost confidence in the safety of all dairy products while a further 41% indicated that they had lost confidence in the safety of some dairy products. Also, 18% of respondents with young children indicated that they were willing to purchase dairy products from abroad.

Of the 36 that had been feeding their young children fluid milk, 22 (61%) reported a reduction in their children’s consumption of dairy products following the report of melamine contamination (Table 5). Six (17%) cut out consumption of dairy products altogether. Of the 24 households that had been using infant milk formula to feed their young children, 16 (67%) reduced their consumption of dairy products; nine (38%) reported no consumption of dairy products following the news about the melamine contamination. Two-thirds of those who were breast feeding their children reduced their children’s consumption of dairy products (Table 5).

4.4. Comparison of food safety and health incidents

Questions related to perceptions of the food safety and health incidents were open-ended, allowing respondents to identify as many of the incidents to be of serious concern as they wanted.

---

**Table 2**

Consumers’ confidence of dairy products and dairy alternatives.

| Source of milk | No children (n = 273) | With children* (n = 77) | Total |
|---------------|-----------------------|-------------------------|-------|
|               | n | % | n | % | n | % | n | % |
| Reduced consumption of fluid milk from 22 implicated dairy companies | 40 | 15 | 6 | 10 | 2 | 13 | 13 | 13 |
| Increased consumption of dairy alternatives | 141 | 52 | 29 | 47 | 5 | 33 | 50 | 50 |
| Future intentions regarding consumption of dairy products | | | | | | | | |
| Reduce | 59 | 22 | 13 | 21 | 4 | 27 | 22 | 22 |
| Purchase the same | 137 | 50 | 38 | 61 | 7 | 47 | 52 | 52 |
| Increase | 52 | 19 | 4 | 6 | 4 | 27 | 17 | 17 |
| Future intentions regarding consumption of dairy alternatives | | | | | | | | |
| Reduce | 48 | 18 | 12 | 19 | 3 | 20 | 18 | 18 |
| Purchase the same | 136 | 50 | 35 | 56 | 10 | 67 | 52 | 52 |
| Increase | 56 | 21 | 8 | 13 | 1 | 7 | 19 | 19 |

* Children are defined as being less than six years of age at the time of the survey.

**Table 3**

What is your level of confidence in China’s dairy industry?

| Confidence | Main reason | n | % |
|------------|-------------|---|---|
| High       | Support national domestic enterprises and their dairy products | 219 | 63 |
| Moderate   | Cannot blame enterprises | 81 | 23 |
| Low        | No reason | 27 | 8 |
| Do not care | | 22 | 6 |

**Table 4**

Number and percentage of households with young children by milk source and consumption.

| Feeding patterns | n | % |
|------------------|---|---|
| Fluid milk       | 36 | 47 |
| Infant milk formula | 24 | 31 |
| Breast-fed       | 15 | 19 |
| Other            | 2  | 3  |
| Consumption was reduced following melamine | | |
| Cut out milk altogether | 19 | 39 |
| More than half   | 9  | 18 |
| At least one-third | 21 | 43 |

**Table 5**

Number of households with young children* that reported reductions in children’s consumption of dairy products in the immediate aftermath of their knowledge of the melamine contamination.

| Source of milk for children | Reduced consumption | Same consumption | Total with young children |
|-----------------------------|---------------------|------------------|---------------------------|
| Fluid milk                  | 22                  | 14               | 36                        |
| Reduce by 1/3               | 4                   |                  |                           |
| Reduce by 1/2               | 6                   |                  |                           |
| Reduce by 2/3               | 6                   |                  |                           |
| Infant milk formula         | 16                  | 8                | 24                        |
| Reduce by 1/3               | 5                   |                  |                           |
| Reduce by 1/2               | 1                   |                  |                           |
| Reduce by 2/3               | 1                   |                  |                           |
| Breast-feeding              | 10                  | 5                | 15                        |
| Reduce by 1/3               | 2                   |                  |                           |
| Reduce by 1/2               | 2                   |                  |                           |
| Reduce by 2/3               | 2                   |                  |                           |
| No consumption              | 4                   |                  |                           |
| No milk provided            | 1                   | 1                | 2                         |

* Children are defined as being less than six years of age at the time of the survey.
Respondents, on average, were much more concerned with the H1N1 influenza than they were with any of the food safety scares: 61% indicated that the H1N1 influenza seriously affected their lives (Table 6). The other communicable disease, SARS, was chosen by close to half (46%) of the sample respondents. More than half (53%) responded that meat injected with water seriously affected their lives. The recent melamine in milk and Clenbuterol in pork food safety scares were chosen by 38% and 39%, respectively. These food safety incidents were followed in concern by Trace Sudan in chicken (31%), chicken eggs with red yolks (30%) and inferior milk powder (22%). The incidents involving excess iodine in milk powder and expired fluid milk were selected by 15% and 10% of the respondents, respectively (Table 6).

Since respondents who had no young children chose an average of 3.6 food safety and health incidents of concern and those with children chose an average of just 2.7 incidents, the numbers and percentages were normalized (so they added approximately to 100%), thus allowing direct two-way comparisons between households with and without young children. Those with young children were significantly more concerned about melamine in milk (Pearson’s Chi-Square < 0.01), SARS (Pearson’s Chi-Square < 0.01), and H1N1 influenza (Pearson’s Chi-Square < 0.05) than were those without young children. On the other hand, households without young children indicated they were significantly more concerned with Trace Sudan in chicken (Pearson’s Chi-Square < 0.01), Clenbuterol in pork (Pearson’s Chi-Square < 0.05), expired fluid milk (Pearson’s Chi-Square < 0.1), and excessive iodine in milk (Pearson’s Chi-Square < 0.1) than were households that contained young children. There were no statistically significant differences in responses to the inferior milk powder, chicken eggs with red yolks or injected water in meat incidents.

In an effort to determine if there were any relationships between the responses to post-melamine consumption of fluid milk (as detailed in Table 2) and the seriousness that individual households reported for the various food safety and health issues, the data from Tables 2 and 6 were cross-tabulated with the results shown in Table 7. It is clear that those households that reduced the consumption of fluid milk in response to the melamine contamination also were much more concerned about the other food safety and health issues. Of the 273 households that had no children, 40 reported that their households had reduced the consumption of fluid milk (most to zero quantity). A higher normalized percentage of those that had reduced consumption of fluid milk than those that did not reduce consumption of fluid milk reported concern with all the food safety and health scares identified in Table 7 except for chicken eggs with red yolks. Households without young children that had reduced consumption of fluid milk were significantly more concerned with Trace Sudan in chicken (Pearson’s Chi-Square < 0.01) and SARS (Pearson’s Chi-Square < 0.01) than were childless households that had not reduced their consumption of milk.

Households with young children that had reduced consumption of fluid milk had a higher level of concern about melamine, Trace Sudan in chicken, Clenbuterol in pork, inferior milk powder, chicken eggs with red yolks, injected water in pork, excess iodine in milk powder and SARS than did households with young children that did not reduce fluid milk consumption. However, there were only 8 households in that category (having young children and subsequently reduced consumption of fluid milk) so the differences were not statistically significant.

From the data collected, it was evident that melamine was of significantly greater concern (Pearson’s Chi-Square < 0.01) to those that had young children: both among those that had reduced consumption of fluid milk and those that had not. In addition to their concern about the effects of melamine, a significantly higher percentage of households with young children that did not reduce consumption of fluid milk were more concerned with H1N1 influenza (Pearson’s Chi-Square < 0.01) and SARS (Pearson’s Chi-Square < 0.01) than were households with no young children (Table 7). On the other hand, a significantly higher percentage of households with no young children and did not reduce their consumption of fluid milk were concerned with Trace Sudan in chicken (Pearson’s Chi-Square < 0.01), Clenbuterol in pork (Pearson’s Chi-Square < 0.01), chicken eggs with red yolks (Pearson’s Chi-Square < 0.01), expired fluid milk (Pearson’s Chi-Square < 0.1) and excessive iodine in milk powder (Pearson’s Chi-Square < 0.05) than were households with young children that did not reduce their consumption of fluid milk (Table 7).

### 4.5. Knowledge of Food Safety Law

In response to a question on their level of knowledge of the Food Safety Law, nearly half of the entire sample reported no knowledge whatsoever, 37.1% reported that they knew a little, and just over 12% felt they knew and understood the new law (Table 8). Surprisingly, a significantly higher percentage of those who fed their children milk from a bottle or cup indicated they had no knowledge of the new Food Safety Law than did those who had no young children in the household (Pearson’s Chi-Square < 0.05). Only 6.5% of those who had young children and fed them milk from a bottle or cup indicated that they understood or were well-aware of the new law. A significantly higher percentage (13.5%) of those without young children indicated they understood or were well-aware of the new law.

There appear to be income and education linkages to these results; however, the broad categories of income and education used to characterize the respondents in this study preclude definitive analyses. Of the households with no young children, 37% of the respondents who reported no knowledge of the new law had monthly income of less than 1000 Yuan whereas only 25% of the households with no young children who reported they knew and understood the new law was in this income category. The same percentages (21%) of those with no knowledge and those who knew and understood the new law were in the high income category of earning more than 3000 Yuan/month. In the smaller sub-sample of those with young children, 22% of those households that reported

### Table 6

| No children (n = 273) | With children* (n = 77) | Total |
|----------------------|------------------------|-------|
|                       | n   | %      | N%  | n   | %      | N%  | n   | %      | N%  |
| Melamine in milk      | 103 | 37.7   | 10.3| 31  | 40.3   | 14.8| 38  |       |
| Trace Sudan in chicken| 97  | 35.5   | 9.7 | 12  | 15.6   | 5.7 | 31  |       |
| Clenbuterol in pork   | 118 | 43.2   | 11.8| 18  | 23.4   | 8.5 | 36  |       |
| Inferior milk powder  | 63  | 23.1   | 6.3 | 14  | 18.2   | 6.6 | 77  |       |
| Chicken eggs with red yolks | 88 | 32.2 | 8.8 | 14  | 18.2   | 6.6 | 102 |       |
| Injected water in meat| 155 | 56.8   | 15.5| 34  | 44.2   | 16.2| 189 |       |
| Expired fluid milk    | 31  | 11.4   | 3.1 | 3   | 4.9    | 1.4 | 34  |       |
| Excess iodine in milk powder | 46 | 16.8 | 4.6 | 5   | 6.5    | 2.4 | 51  |       |
| SARS                  | 125 | 45.8   | 12.5| 36  | 46.8   | 17.2| 161 |       |
| H1N1                  | 170 | 62.3   | 17.0| 43  | 55.8   | 20.5| 213 |       |

* Children are defined as being less than six years of age at the time of the survey.

b Percentages have been weighted (normalized) by the number of food safety and health issues checked by each respondent. Totals may not add to 100% due to rounding.
no knowledge of the new law were in the high income category (greater than 3000 Yuan/month) while 50% (three households out of six) that reported they knew and understood the new law were in the high income category. In the “no young children” group, 42% who reported they knew and understood the new law had more than 12 years of education while only 27% of those who reported knowing nothing about the new law had more than 12 years of education. Of those with children, 16% of those with greater than 12 years of education reported they knew nothing about the new law and 16% claimed to know and understand it.

5. Discussion

Findings from this study confirm that households with young children reacted differently to the melamine contamination of dairy products in China than did those without young children. Conducted one year after the public was told of the melamine contamination, this study found that a significantly higher percentage of households with young children of less than six years of age at the time of the survey.

### Table 7

| Melamine in milk | Trace Sudan in chicken | Clenbuterol in pork | Inferior milk powder | Chicken eggs with red yolks | Injected water in meat | Excess iodine in milk powder | SARS | H1N1 |
|------------------|------------------------|---------------------|---------------------|-----------------------------|------------------------|-----------------------------|------|------|
|                   |                        |                     |                     |                             |                        |                             |      |      |
| n                | N (%)                  | n                   | N (%)               | n                           | N (%)                  | n                           | N (%) | N (%) |
| No children (n = 273) |                       |                     |                     |                             |                        |                             |      |      |
| Did not reduce fluid milk (233) |                   |                    |                     |                             |                        |                             |      |      |
| 85               | 10.0                   | 17                  | 11.6                | 10                          | 14.6                   | 4                           | 18.4 |
| Trace Sudan in chicken | 79                    | 9.3                 | 18                  | 12.3                        | 12                     | 5                           | 9.1  |
| Clenbuterol in pork | 100                    | 11.8                | 18                  | 12.3                        | 15                     | 8.1                         | 13.8 |
| Inferior milk powder | 52                    | 6.1                 | 11                  | 7.5                         | 12                     | 6.5                         | 9.1  |
| Chicken eggs with red yolks | 78                   | 9.2                 | 10                  | 6.9                         | 12                     | 6.5                         | 9.1  |
| Injected water in meat | 129                   | 15.2                | 26                  | 17.8                        | 29                     | 15.7                        | 18.4 |
| Expired fluid milk | 25                     | 2.9                 | 5                   | 3.4                         | 3                      | 1.6                         | 0    |
| Excess iodine in milk powder | 38                   | 4.5                 | 8                   | 5.5                         | 4                      | 2.2                         | 4.6  |
| SARS | 98                    | 11.5                | 27                  | 18.5                        | 31                     | 16.7                        | 22.9 |
| H1N1 | 144                   | 16.9                | 26                  | 17.8                        | 40                     | 21.6                        | 13.8 |
| With children (n = 77) |                       |                     |                     |                             |                        |                             |      |      |
| Did not reduce fluid milk (68) |                   |                    |                     |                             |                        |                             |      |      |
| 27               | 40.3                   | 11                  | 16.2                | 5.9                         | 15                     | 20.6                        | 27.0 |
| Trace Sudan in chicken | 104                    | 38.1                | 20                  | 32.3                        | 40                     | 53.3                        | 52.6 |
| Clenbuterol in pork | 37                     | 13.5                | 4                   | 6.5                         | 13                     | 17.9                        | 17.9 |
| Inferior milk powder | 13                     | 4.3                 | 0                   | 0.0                         | 0                      | 0                           | 0    |
| Injection water in meat | 1                      | 0.1                 | 0                   | 0.0                         | 0                      | 0                           | 0    |
| Excess iodine in milk powder | 1                     | 0.1                 | 0                   | 0.0                         | 0                      | 0                           | 0    |
| SARS | 1                      | 0.1                 | 0                   | 0.0                         | 0                      | 0                           | 0    |
| H1N1 | 273                   | 100                  | 62                  | 100                         | 15                     | 100                         | 100  |

a Children are defined as being less than six years of age at the time of the survey.

b Includes two households with small children who were not being fed milk.

Though the differences were not statistically significant in all cases. This minority of households indicated they had reduced consumption of fluid milk, most to zero quantity, following the melamine incident. And, melamine was of significantly greater concern to those that had young children than those without young children: both among those that had reduced consumption of fluid milk and those that had not.

When the Chinese government announced a recall of infant milk formula due to melamine contamination in September 2008, parents with young children faced a nightmare scenario and most greatly reduced their purchases and consumption of commercial milk products, though Qiao et al. (2010) found that consumption of dairy products had recovered strongly two months later. Results from this study reinforce that finding: one year later, 61% of the households with young children (who were not breast-fed) indicated that they expected to consume about the same quantity of dairy products in the future as they did prior to September 2008. Furthermore, 19% of the households without young children indicated they intended to increase future consumption of dairy products but only 6% of those who had young children who were not being breast-fed indicated that they intended to increase consumption.

In the case of melamine contamination of dairy products, actions undertaken by dairy companies and the government, including introduction of a new Food Safety Law, improved inspection procedures, and the setting of lower tolerance for melamine in milk (Xiu & Klein, 2010), appear to have mitigated the long-term effects on consumer confidence from the melamine contamination. Eighty-six percent of the sample indicated they had high or moderate confidence in China’s dairy industry, partly because they support domestic enterprises generally and, also, because they felt that the dairy enterprises themselves should not be blamed since they were inadequately regulated prior to the melamine incident.

Results found in this study add evidence to that found by Zhang, Bai, Lohmar, and Huang (2010), in their study of consumers in Beijing that was conducted prior to the melamine contamination, that for households with children the reputation of milk producers had a relatively higher importance in determining milk safety than households without children. Quan, Zeng, Yu, and Liu (2010) also found that trust and knowledge were important in reestablishing previous consumption patterns following the melamine contamination.

While a significantly higher percentage of households with young children indicated that the melamine contamination, as well as the two communicable diseases SARS and H1N1 influenza, seriously affected their lives than did households with no young

### Table 8

| No children | With children* | Total |
|-------------|----------------|-------|
|            | Bottleb       | Breast|       |
| N          | n              | n     | %     |
| None       | 124            | 45.4  | 37    | 59.6 | 7 | 46.7 | 48.0 |
| Know a little | 104        | 38.1  | 20    | 32.3 | 6 | 40  | 37.1 |
| Know and understand | 37       | 13.5  | 4     | 6.5  | 2  | 13.3 | 12.3 |
| Well-aware | 1              | 0.4   | 0     | 0    | 0  | 0   | 0.1 |
| No answer  | 7              | 2.6   | 1     | 1.6  | 0  | 0   | 2.3 |
| Total      | 273            | 100   | 62    | 100  | 15 | 100 |      |

* Children are defined as being less than six years of age at the time of the survey.

b Includes two households with small children who were not being fed milk.
children, the reverse was true for several of the other food safety scares that occurred recently in China. Significantly higher percentages of households with no young children indicated they were seriously concerned with Trace Sudan in chicken, Clenbuterol in pork, expired fluid milk and excess iodine in milk powder than were households with young children. This result might partly be related to the open-ended questions that were posed. Those with young children in the household selected significantly fewer food safety incidents to be of major concern than did those with no young children, possibly due to their focus on getting their families through the two most recent crises: melamine contamination of milk and the H1N1 influenza. Trace Sudan in chicken occurred in a popular fast-food chain of stores, a place where households with small children might be less inclined to visit. Clenbuterol in pork is known to have serious adverse health effects and, since it has been found almost every year in every part of China, has received widespread publicity. Findings from the survey revealed that this food safety issue is more “top-of-mind” for those without young children than those with young children, understandable perhaps because most urban families eat pork every day. And, although those with no young children selected expired fluid milk and excess iodine in milk powder more often than did those with young children, overall, only a small percentage of respondents responded that these two food safety incidents caused them much anxiety. Due to the dominance of locally-based Mengniu and Yili dairy companies, sales of products from Bright Dairy Company (headquartered in Shanghai), which was associated with the expired milk problem, are not large in Hohhot so fewer households were affected. In the case of the excess iodine in Nestle’s milk powder, the price of imported milk powder always has been much higher than that of domestic products, again resulting in less concern about that incident among the public.

Zhou and Wang (2011) reported an inverse relationship between level of education and concern about the melamine scandal from their survey of consumers in Nanjing, China. In other words, the less educated respondents had more concern about melamine and the more educated had less concern. Results from our study provide mild (but statistically insignificant) support for their results. In our study, 38% of respondents with less than 12 years of education selected melamine to be of concern as compared to 35% of those with more than 12 years. We found strong direct correlation between income and expressed concern about melamine: 36% of those earning less than 1000 RMB per month indicated they were concerned about melamine, 44% of those who earned between 1000 and 2000 RMB indicated they were concerned, and 49% of those in the highest income category indicated they were concerned.

A surprising result from this study was the relatively low level of knowledge by households of the Food Safety Law that had gone into effect on June 1, 2009, just over three months before this survey was conducted. Almost half of the entire sample (and 60% of respondents who had bottle- or cup-fed children in their homes, a significantly higher percentage than households with no young children) indicated they had no knowledge of the contents of the new law. Only 44 out of the entire sample of 350 (12.4%) indicated that they knew and understood the contents of the new law. There appeared to be a positive relationship between level of education and knowledge of the Food Safety Law and between income and knowledge of the Food Safety Law but this could not be substantiated due to the broad categories of education and income used to characterize the sample.

While food safety undoubtedly remains an important concern of Chinese consumers, most seem to trust government and major food-producing enterprises to ensure the availability of healthy, clean and safe food products though many realize they might have to pay more to receive this assurance. In a large study conducted in seven metropolitan areas of China, Ortega, Wang, Wu, Bai, and Olynk (2011) found that Chinese consumers would be willing to pay a high premium to assure that their food is safe, especially for a government certification program. Wang, Yuan, and Gale (2009) noted that increasing concerns of food safety by Chinese consumers with rising incomes and access to improved information may push more companies to implement hazard analysis critical control point (HACCP) systems for products marketed domestically, though the costs of implementing such systems require major up-front investments and substantial operational costs. In a survey of Beijing consumers, it was found that less than 20% were aware of what HACCP represented, and most who had heard of HACCP had learned about it within the previous year (Wang, Mao & Gale, 2008).

Results from this study confirm what many suspected: that many Chinese households with young children react differently to food safety and health scares than do households with no young children. However, further investigation could be made into several important issues that were not investigated in this study. One is the role of media in publicizing food safety and health scares as well as corrective actions by government agencies and enterprises. Brady, Li, and Brown (2009) found that the media had a huge influence in shaping consumers’ attitudes and behaviours following two well-publicized outbreaks of Escherichia coli 0157:H7 in the United States in 2006 as those who listened more to news reports had larger changes in their attitudes and behaviours than did those who listened less. Media blitzes that accompanied recent food safety and health scares in China alarmed many households and resulted in significantly changed behaviours in the short run but, as shown by Qiao et al. (2010) and also in this study, a high percentage of households had resumed their earlier consumption levels of dairy products only two months after the initial publicity was delivered.

Second, further investigation is warranted into consumer attitudes and knowledge of food safety laws and actions by government agencies and food-producing enterprises. There appears to be a lot of trust by a high proportion of households (including many with young children in the home) that governments and businesses will employ the necessary procedures to protect the safety of their food products. This trust has proven misplaced time and again in recent years during the rapid growth of the Chinese economy.

Food safety continues to be a concern in China. Just days before the end of 2011 (and three years after the melamine scare), Mengniu, one of the largest dairy companies in China, admitted that a batch of its products was contaminated with flavacin M1, which can cause liver cancer. It blamed the contamination on “mouldy and deteriorated” fodder (Best, 2012). As incomes of most Chinese consumers have increased quickly with the rapidly growing economy and they have expressed increased demand for a greater variety of healthful and safe foods, the seeming repetitiveness of food safety scares in China demonstrates that the Chinese food industry and government agencies that regulate the industry still have a ways to go to provide the level of food safety that increasingly knowledgeable and sophisticated Chinese consumers desire.

References

An, Y., Jiang, L., Cao, J., Geng, C., & Zhong, L. (2007). Sudan I induces genotoxic effects and oxidative DNA damage in HepG2 cells. Mutation Research, 627, 164–170.

Areddy, J. (2010). World news: More tainted-milk cases are highlighted in China. New York: Wall Street Journal. 26 January: A13.

Asia Times. (2005). China’s dairy industry reeling after scandal. Asia Times Online. [July 1]. Accessed June 23, 2010 at. http://www.atimes.com/atimes/China/GG01Ad01.html.

Baker, G. A. (2003). Food safety and fear: factors affecting consumer response to food safety risk. International Food and Agribusiness Management Review, 6(1).
