The effectiveness of an intervention in reducing risk of dioxin exposure in Da Nang: Changes in community knowledge, attitudes and prevention practices after 2.5 years

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Abstract

**Introduction:** Environmental and biological samples taken around Da Nang Air Base have shown elevated levels of dioxin over many years [1-3]. A pre-intervention knowledge, attitudes and practices (KAP) survey (2009), a risk reduction program (2010) and a post intervention KAP survey (2011) were undertaken in four wards surrounding Danang Airbase. A follow-up evaluation was undertaken in 2013.

**Methods:** A KAP survey was implemented among 400 randomly selected food handlers. Eleven indepth interviews and four focus group discussions were also undertaken.

**Results:** The knowledge of respondents remained positive and/or improved at 2.5 years follow-up. There were no significant differences in attitudes toward preventing dioxin exposure across surveys; most respondents were positive in all three surveys. An increase in households (69.5%) undertaking measures to prevent exposure was observed, which was higher than in the pre-intervention survey (39.6%) and post- intervention survey (60.4%) ($\chi^2 = 95.6; p < 0.001$). The proportion of respondents practicing appropriate preventive measures was also significantly improved.

**Conclusions:** Despite most of the intervention program’s activities ceasing in 2010, the risk reduction program has resulted in positive outcomes over the longer-term, with many knowledge and attitude measures remaining stable or imporving. Some KAP indicators decreased, but these KAP indicators were still significantly higher than the pre-intervention levels.

*Key words: Da Nang Airbase, KAP, dioxin, dioxin exposure through foods*

1. **Introduction**

Dioxin was a byproduct present in Agent Orange (AO) and other herbicides used by the American military in the Vietnam War. There are currently 28 identified potential dioxin hot spots in Vietnam including Da Nang Airbase, a bulk of storage and supply facility for AO
during Operation Ranch Hand. Da Nang Airbase, is one of the two most severe dioxin hot spots. Elevated levels of dioxin, especially 2,3,7,8-Tetrachlorodibenzo-p-dioxin, have been reported in soil, sediment, some types of local foods, and human blood in these areas [1-3]. People who live at An Khe, Hoa Khe, Thanh Khe Tay and Chinh Gian wards, surrounding the airbase were at risk of exposure to dioxin in the environment, particularly through the consumption of dioxin in contaminated foods [4]. In 2009, a pre-intervention survey on the KAP of householders living near the airbase was undertaken. The results showed that the knowledge and practices of the local residents on dioxin and preventive measures were very limited [5]. Only 15.9% of respondents knew that dioxin could be present in foods. The knowledge of dioxin, potentially high-risk foods and measures to prevent dioxin exposure was also very limited. Among the minority (39.8%) who said they practiced some prevention, some were using practices unlikely to be protective. Therefore, potentially high risk foods were consumed frequently on a weekly basis [4].

In response, an intervention program, comprised of education, communication, and policy advocacy components was implemented by Vietnam Public Health Association and its provincial branch in 2010 to reduce the risk of dioxin exposure through the food chain for people living in the four wards near Da Nang Airbase [4, 6]. A post-intervention survey in 2011 revealed that the knowledge of respondents on dioxin and dioxin exposure prevention was significantly improved. Generally, more people were aware of where dioxin could be present in the environment. The knowledge of the existence of dioxin in food was more than doubled compared to pre-intervention levels (16.1% to 37.1%, $\chi^2 = 35.2$, $P<0.001$) [4]. The percent of respondents who believed that dioxin could enter the human body through food increased from 78.9% to 90.7% ($P <0.001$). Accurate understanding of high risk foods such as fatty meat, freshwater fish, shrimps, crabs, snails, viscera, as well as knowledge about preventive measures increased significantly [4]. The intervention was
associated with an increase from 39.8% to 60.3% in the number of households who undertook exposure preventive measures to reduce exposure [4]. This study was undertaken to assess the continued effectiveness of the intervention. This article reports a follow-up KAP survey conducted two and a half years after the intervention program with the purpose of assessing the long-term effectiveness.

2. Material and methods

This survey using a KAP questionnaire of approximately 10 pages long on dioxin and on measures to reduce dioxin exposure was implemented from March until May 2013. This survey was implemented approximately 2.5 years after the intervention. The results were compared with those of the pre-post intervention KAP surveys implemented in 2009 and 2011, which were in the same intervention wards. The surveys were designed to evaluate changes in the knowledge, attitude and practices of preventing dioxin exposure through consuming contaminated foods among food handlers in 400 households in four intervention wards located near by Da Nang Airbase. Sampling frames of the surveys were listed as of the households living in the four wards in 2009, 2011 and 2013 (approximately 16,000 households). Sampling units were households, which were systematically randomly selected from the lists. Food handlers, aged 18-65 also selected randomly from the lists, were invited to participate in the surveys.

Sample sizes of the three KAP surveys were calculated based on the hypothesized change in health behavior before and after the interventions. Since there was no observed reference number from previous studies, the estimated change in food safety selection expected to be 50%. The sample sizes were estimated, using equation 1:

Equation 1. Formula used for sample size estimation

\[
\begin{align*}
n & = \frac{p_o(1-p_o) \left(Q_2^{(1-\alpha)} + Q_2^{(1-\beta)} \left( \frac{p_A(1-p_A)}{p_o(1-p_o)} \right)^2 \right)}{(p_o - p_A)^2} \\
\end{align*}
\]
Note:

\( n = \text{sample size}; \ alpha = \text{level of significance}; \ Beta = \text{power of the study}; \ p_0 = \text{the anticipated population proportion had safe food selection before intervention}; \ p_A = \text{the anticipated population proportion had safe food selection after intervention}. \)

The authors assumed that \( \alpha = 0.05; \ Beta = 0.9, \) and that the current and expected population who had safe food selection before and after the intervention was greater than 40%. From equation 1 and using software Power and Sample Size Calculation, it was estimated that 500 or 218 subjects were needed for 50% or 55% improvement in behavior. A sample size of 400 subjects for each survey in 2009, 2011 and 2013 was selected to ensure 50% improvement. Given the 10% sampling fraction, individual households were unlikely to have been selected in the pre and post intervention surveys, and some overlaps may have occurred. Data was entered using Epi-data 3.2 and analyzed using SPSS 18.0 software. In addition to the KAP survey, eleven indepth interviews and four focus group discussions with representatives of Da Nang Public Health Association, Thank Khe District People Committee, Thanh Khe District Department of Preventive Medicine, People Committees, commune health centers and collaborators at the four program wards were undertaken for qualitative assessment. The research protocol was approved by the Ethics Committees at the Hanoi School of Public Health and the Queensland University of Technology.

3. Results and discussion

3.1. Knowledge on dioxin risk reduction

The knowledge of respondents on dioxin and prevention of dioxin exposure was improved significantly after the intervention program and remained at 2.5 years follow-up. In general, more people were aware of where dioxin could be present in the environment, except for their
knowledge on the presence of dioxin in water when it is attached to suspended particles (Figure 1). Awareness of this aspect reduced to 67.8% in 2013 and was significantly lower than those in pre-intervention (80.3%) and post-intervention surveys (76%) ($\chi^2 = 15.9, P < 0.001$). In contrast, residents’ knowledge of dioxin existence in soil was significantly higher, 71.4% in 2013 compared with 54.9% in 2009 and similar to the rate in 2011 of 69.4% ($\chi^2 = 22.2, P < 0.001$). Knowledge of dioxin in food post intervention increased more than two-fold compared to the pre-intervention (16.1% to 37.1%, $\chi^2 = 35.2, P < 0.001$), and increased to 50% in 2013 ($P<0.001$). Knowledge of dioxin attached to particles in air (13.6%) decreased but was not significantly different from that observed in the pre-intervention (15.3%) and post intervention (16.8%) ($\chi^2 = 1.6, p = 0.5$). The proportion of residents who did not know where dioxin exists in the environment (11.6%) was similar to the post-intervention survey (12.7%) and was significantly lower than the pre-intervention survey (27.7%, $\chi^2 = 45.2, p < 0.001$).

Awareness of routes of exposure to dioxin significantly improved after the intervention and remained 2.5 years later (Figure 2). The proportion of participants who were aware of the main route of dioxin exposure through food consumption in 2013 was 84.1%. This was somewhat lower than that in the post intervention survey (90.6%), but still slightly higher than the rate in the pre-intervention survey (79%; $\chi^2 = 17.6, p < 0.001$). Knowledge of the routes of exposure through respiration and dermal absorption did not change significantly from 2011. Knowledge of exposure through consuming breast milk increased significantly from 1.1% in 2011 to 8.6% in 2013 ($p < 0.001$); however, these rates remained remarkably low (Figure 2). The proportion of respondents aware of dioxin pollution in and around Da Nang Airbase in 2013 was 70.9%. This percentage of was not significantly different from the percentage in 2011 (69.2%), but it was significantly higher than that of the pre-intervention survey in 2009 (44.7%; $\chi^2 = 98.1, p < 0.001$).
The proportion of respondents aware of potentially high risk foods increased compared to the pre and post intervention surveys (Figure 3). The most high risk foods in dioxin hot spots are fresh water fish, shrimps, crabs (especially the bottom mud feeders). In 2013, the number of respondents who were aware of the potentially high risk foods was 65.6% and this number was significantly higher than those in the pre and post intervention surveys ($\chi^2 = 117.8$, $p < 0.001$). Vegetables are usually low risk foods, except for carrot, pumpkin and lotus which the roots have the ability to uptake dioxin from the soil, and thus be contaminated with dioxin [1, 7]. In dioxin hot spots, leaf vegetables can result in high-risk consequences if people do not wash them carefully before using. The proportions of respondents who thought vegetables were potentially high risk foods if grown in polluted areas were not significantly different across the three surveys: 79.6% (2009); 76.8% (2011); and 79.2% (2013) ($\chi^2 = 3.7$, $p = 0.16$). Knowledge of respondents regarding other high-risk foods such as animal fat, viscera, eggs and breast milk did not change significantly compared to the pre and post intervention surveys, and actually it still remained low (Figure 3). Risk communication activities in the future should focus more on raising awareness of local residents on these potentially high-risk foods.
Respondents’ knowledge regarding practical ways to reduce the risk of dioxin exposure improved across the 3 surveys. In 2013, 46.7% of respondents were aware that they should not eat freshwater fish and aquatic products harvested from ponds and lakes inside and surrounding the airbase. This was significantly higher than those in the pre-intervention survey (2.6%) and post intervention survey (20.8%) ($\chi^2 = 198.3, p < 0.001$). The proportion of respondents reported that they should wash vegetables before using carefully in 2013 (60.6%) was significantly lower than the pre-intervention (74.7%) and the post intervention surveys (68.5) ($\chi^2 = 17, p < 0.001$). However, knowledge of other preventive measures, such as reduction in consumption of animal fat, eggs, and breastfeeding less in the first few weeks after giving birth, was low in all three surveys with the proportions of respondents ranging from 0% to 16.8%. These results were similar to those observed in the pre and post intervention surveys in Bien Hoa dioxin hot spot in 2007 and 2009 [8, 9].

3.2. Attitudes toward dioxin risk prevention

There were no significant differences in attitudes toward preventing dioxin exposure across surveys; most respondents’ attitudes were positive in all three surveys. In 2013, 86% of the respondents were confident that they could reduce the risk of dioxin exposure in the contaminated areas, which was similar to that of the post intervention survey in 2011 (86.6%), but was significantly higher than when the intervention occurred (77.3%; $\chi^2 = 19.3, p = 0.01$).
Before the intervention, 96.9% of respondents were willing to quit some of their favorite foods if they knew that these foods were contaminated with dioxin at a high risk and was equivalent to the result of the pre-intervention (95.8%). The rate in 2013 was significantly lower than those in 2009 and 2011, however, still remained at 89.5% ($\chi^2 = 48; p <0.001$). The number of respondents willing to buy uncontaminated foods with higher prices (87%) was significantly lower compared to those in the pre-intervention survey (92.1%) and the post-intervention survey (95.1%; $\chi^2 = 35.2; p < 0.001$).

3.3. Practices to reduce the risk of dioxin exposure

The survey in 2013 showed that the proportion of households that self cultivated foods in Da Nang in the preceding 2.5 years remained low (e.g., only 18 households or 4.5%). This was not significantly lower than what was found in the pre and post-intervention surveys (6.9% and 4.9%, respectively; $\chi^2= 2.6, p= 0.3$). There was a significant increase in the number of households (69.5%) that already undertook exposure preventive measures, compared to that of the pre-intervention survey (39.6%) and the post-intervention survey (60.4%; $\chi^2 = 95.6; p < 0.001$). The proportion of the respondents practicing appropriate preventive measures was also significantly improved compared with the pre- and post-intervention surveys. Specifically, in 2013, 73% of the respondents reported that they have consumed less freshwater fish, shrimps and crabs. This was significantly higher than those reported in 2011 (38.4%) and 2009 (15.7%; $\chi^2 = 146.6; p < 0.001$). Other practices included: (1) avoid foods of unclear origin (58.6%); (2) consume less carrot, pumpkin and lotus grown at the local areas (44.9%); (3) consume less free range chickens and ducks (35.4%); and (4) filter water before using (49.1%). These practices increased significantly compared to those in the pre- and post-intervention surveys. The proportion of the respondents who consumed less fat and viscera in 2013 was also significantly higher than those in the pre- and post-intervention surveys; however, it still remained low (10.2%) (Figure 4).
In 2013, potentially high-risk such as freshwater fishes, chicken eggs, duck eggs, and pumpkin had quite low rates of daily consumption ($\leq 2.5\%$) and were significantly lower than those of the pre-intervention survey. The weekly consumption frequencies of some potentially high-risk foods in 2013 were slightly higher than those in the post-intervention survey. However, the consumption frequencies still decreased compared to those in the pre-intervention survey (Figure 5). The following reduction in consumption was observed from 2009 to 2011, and to 2013: pumpkin on a weekly basis from 63.7\% to 34.5\% and 37.5\% ($p < 0.001$); freshwater fish from 51.4\% to 17.4\% and 32\% ($\chi^2 = 105.4; p < 0.001$); wild goose, duck meat from 15.3\% to 5.6\% and 2.7\% ($\chi^2 = 46.4; p < 0.001$); and viscera from 6.3\% to 2.9\% and 2.5\% ($\chi^2 = 8.8; p = 0.01$) (Figure 5). Other foods such as beef, buffalo meat, pork, and seafood had high weekly consumption frequencies; however, these were listed as low risk foods because the activities of raising cattle and pigs were not observed in Da Nang in 2013.
4. Some challenges and opportunities for sustainability of the program

According to the qualitative interviews and focus group discussions, migration and rapid changes in land use may significantly affect the results of the intervention. People who become aware of dioxin exposure may move to other areas and new people unaware of the problems could move into the high risk areas. Therefore, it is important to continue the risk reduction strategies: “Communication activities should be continued as people’s knowledge and practices may decrease as time passes; we also have a large number of people who move in and out as you see rapid development in this area...” (in-depth interview, representative, District People Committee). An increase in fish density at local ponds and canals due to the reduction in fishing activities by local residents and the release of fish on special occasions for wishing luck and happiness (traditional Vietnamese beliefs) can lead to potential hazards for people who are not aware of the risk. In addition, the Environmental Remediation of Dioxin Contamination at Danang Airport Project may have an effect. The cleanup work is expected to be completed at the end of 2016. On the one hand, cleanup work is important in treating the contaminated soil inside the airbase to prevent further spread of dioxin. On the other hand, the limitations of this project is that some residents might not appreciate. Some interviewed residents thought that the Project would help to clean up dioxin completely in the areas.
surrounding the Airbase. Therefore, so they anticipated that they could start growing vegetables, raising chickens and fishing at local ponds. A local male resident from Da Nang said “I heard that there is a huge American cleanup project with millions of dollars to completely solve this problem; so it is very good that from now on, we can live in a safer environment and the foods will be safe.”

Indepth interviews and focus group discussions also indicated that most of the information-education-communication activities implemented in 2010 had ceased by 2013 and only few activities remained. Some collaborators recognised the risk for local residents and due to their enthusiasm, they continued to communicate information on preventive measures whenever appropriate. However, they shared their concerns regarding the sensitive political-social-economic-health aspects of the dioxin issue and suggested an important role of the City People Committee and Party’ guidances and directions. For example, they said there are opportunities to integrate communication activities into monthly/quarterly meetings of community and social organization. To facilitate this, the collaborators advised that: “... it tends to require the directions from the upper government level, the City People Committee. Otherwise, if we organize meetings to discuss the issues of dioxin, the commune people committee and people will question us in terms of who or what guideline/policy/ direction allows us to do so? So you see it is not just about the money, and dioxin is a very sensitive issue” (FGD, collaborators, Da Nang).

Another important factor that supports the maintenance of residents’ awareness of dioxin and practices in prevention is that the words “dioxin/Agent orange” are prominent in public awareness and still evoke a strong emotional reaction, usually fears of severe health impacts such as birth defects and cancers. In this context, the benefits of health communication programs persist over many years: “Oh, people would remember information for years. You see, there are so many people having cancers, like at the 22nd and 23rd blocks,
so many people died from cancers, and you know, most of them are quite young; and children are born with birth defects too. In the past, people caught fish in these ponds, raised chickens and grew vegetable here for consumption and due to the poison of dioxin now they are sick and their children and grand children are having birth defects” (FGD, collaborators, Da Nang City).

5. Conclusion

These findings indicate that the Public Health intervention program implemented in Da Nang dioxin hot spot is effective in improving knowledge, attitudes and practices among local people and its outcomes have been sustained for 2.5 years after the intervention. In 2013, residents remained aware of health risks associated with dioxin exposure and many applied recommended methods to prevent exposure through food. However, it is important to emphasize that the problem has not been solved entirely. Qualitative assessment showed that most of the program activities have ceased. Moreover, due to migration and changes in land use, an increase in fish density in local ponds, and some misunderstanding about the scale of the Environmental Remediation Project, the risk communication activities need to be continued and integrated into routine health activities. Residents and collaborators believe that this requires direction from the Provincial People Committee due to the sensitivity of the dioxin issues.

In 2014, deeper analysis of findings from this research project – including laboratory analysis of dioxin concentrations in foods in Da Nang and Bien Hoa dioxin hot spots - will be integrated to provide a comprehensive assessment of the sustainability of the intervention program. The outcome of this research may provide useful evidence to expand the prevention model to other dioxin hot spots in the country.

Conflict of interest

The authors declare no conflict of interest.
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