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Awareness and attitude assessment regarding toxic metal-contaminated rice based on the Health Belief Model

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Original Article

Abstract

Given the presence of toxic metals in some local Iranian as well as some imported rice varieties, it may be of help to focus on public awareness for the implementation of educational interventions. This study aimed to assess awareness and attitudes of women in Sanandaj, Iran, regarding toxic metal-contaminated rice based on the Health Belief Model (HBM). This cross-sectional study was conducted on 1450 women aged 18 and above. The questionnaire used in the study consisted of three parts; demographic information, awareness assessment, and HBM constructs. Data were analyzed using chi-square test, t-test, ANOVA, and the logistic regression analysis in SPSS. The mean age of the study participants was 40.55 ± 13.8 years. The level of awareness regarding the presence of toxic metals in daily-consumed rice was low in 78.2% and moderate in 21.8% of the participants. Among the attitude factors, risk perception was the only one that increased the probability of falling in the group with moderate awareness instead of the group with low awareness by 1.37 times. The results support the necessity of raising public awareness and increasing risk perception in the population about the adverse effects of toxic metals.

KEYWORDS: Awareness, Attitude, Food Contamination, Heavy Metal Toxicity, Health Belief Model

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Introduction

The contamination of agricultural crops with toxic metals has become a global concern in recent decades.[1] Long-term exposure to food contaminated with arsenic, especially inorganic arsenic, is harmful for human health. The presence of toxic metals in agricultural crops has endangered food safety and individuals' health.[2] Rice is a widely-used agricultural crop in Asian countries, and contamination of some varieties of rice with toxic metals has recently become evident.[3]

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Arsenic often enters the human body through contaminated water; however, recent studies show that the consumption of some food products, especially Asian rice, may also cause arsenic exposure.[4] Existence of dimethyl arsenic has been reported in 86-99% of Asian rice crops.[5] The results of studies have revealed the presence of toxic metals (arsenic, lead, and cadmium) in some Iranian and imported rice crops.[6-9]. The continuous use of rice crops contaminated with toxic metals endangers human health due to the bioaccumulation of these metals in the body.[10] Problems caused by the continuous consumption of these rice crops include behavioral disorders, learning

disabilities, concentration difficulties, and lung, stomach, bladder, kidney, and skin cancer, and bone injuries.[11]

There is no suitable control over the rice crops imported to Iran. Furthermore, failure to check for adherence to the authorized levels of toxic metals in imported and Iranian rice crops is associated with the consumption of rice crops contaminated with toxic metals. These rice crops have been well-received by Iranians, most likely due to their lower prices, better textures when cooked, and also the lack of public awareness about the adverse health effects of toxic metals in rice crops. Given the country's need for importing large amounts of rice, it does not suffice to measure the toxic metals of imported and local rice crops and put a brief stop to rice imports to resolve the issue of rice toxicity. An appropriate strategy for the current situation is to raise public awareness about the adverse effects of the consumption of food products contaminated with toxic metals. Raising public awareness requires the assessment of the current level of awareness, understanding of the barriers to the consumption of toxic metal-free rice crops, and assessment of risk perception in the public regarding contaminated food products consumption.

Behavioral change theories and models increase the chance of success of educational programs aiming to raise public awareness about the harms of the consumption of food products contaminated with toxic metals.[12] The Health Belief Model (HBM) is an effective model for understanding the factors influencing nutritional health behaviors. The model has been effective in promoting healthy nutrition behaviors, such as a better adherence to the recommended diet in diabetic patients and to a low-salt diet in patients with cardiovascular diseases (CVDs).[13,14] The HBM is based on the assumption that individuals perform preventive health behaviors when they believe that they are in danger and can sense the risk of a serious problem or disease. The problem can be prevented or controlled through practicing protective behaviors and if individuals are confident about the likelihood of their successful practice of those behaviors.[15] The HBM is constituted of several constructs, including perceived susceptibility, severity (risk perception), barriers and benefits, and cues to action.[15] According to HBM, an increase in the perceived risk of consuming contaminated rice is probably followed by a decrease in its consumption rates and the substitution of contaminated rice with non-contaminated alternatives. An increase in the perceived risk of the adverse effects of contaminated rice could lead to more protective actions. The HBM addresses the perceived self-efficacy or perceived ability to accomplish the behavior successfully. Self-efficacy may be defined as one's degree of confidence in one's own ability to perform a behavior in the face of various obstacles or challenges, including intrapersonal, interpersonal, and environmental barriers.[15]

The current study is the first investigation in Iran on assessment of awareness and attitude regarding toxic metal-contaminated rice according to a behavioral change theory. No similar research was found in the literature. Therefore, the results of the present study will propose a new point of view toward the application of HBM in the assessment of awareness and attitude regarding toxic metal-contaminated rice. The present study examined the general awareness and some constructs of HBM (perceived risk, barriers, and self-efficacy) regarding the use of rice crops contaminated with toxic metals among women in Sanandaj, Iran. The study population was considered as only women because they are more often responsible for buying and cooking than men. The purposes of the current study were to examine differences in demographic variables across awareness level and the relationship between perceived threat, barriers, and self-efficacy across demographic variables, and determine the predictive power of demographic variables

and attitudes studied for assigning participants to one of the two groups of low or moderate awareness.

Materials and Methods

The present descriptive-analytical, cross-sectional study was conducted in 2014 on 1450 women aged 18 and above and residing in Sanandaj, in Kurdistan Province of Iran. Given the lack of similar studies conducted in Iran, a pilot study was conducted on 30 women to estimate the level of public awareness on metal toxicity in rice using an inventory. The results of the pilot study showed that 32% of the women had a moderate awareness of the issue. Sample size was estimated as 973 subjects with a confidence interval of 95% and an accuracy of 0.03. Participants were selected through random cluster sampling. The sample size was multiplied by 1.5, and 1450 women were ultimately selected for examination. Using the family medical records registered in the healthcare centers of Sanandaj, which covered over 98% of the families in the city, cluster heads were selected through random cluster sampling. Then, 30 women who met the inclusion criteria (female in gender and aged 18 and above) of the statistical population were selected from each cluster and studied. All healthcare centers of Sanandaj (n = 48) were considered in this study. For each healthcare center, according to random numbers table, the first cluster was selected, and then, sampling was continued until obtaining the estimated sample size for each cluster. Data collection lasted from April 30 to June 30, 2014. The Ethical Committee of Kurdistan University of Medical Sciences approved the study. For the data collection, the interviewer visited the families in their homes and briefed them on the objectives of the study, and then, selected one person who met the inclusion criteria from each family for the interviews.

The data collection tool was a researcher-made questionnaire consisting of three parts. The first part of the inventory assessed participants' demographic information through 7 items on the topics of age, level of education, marital status, number of children, employment status, and family income. The second part included 25 items assessing awareness. The score of this section ranged from 0 to 25; scores lower than 8 indicated a low awareness, scores between 9 and 16 indicated moderate awareness, and scores between 17 and 25 indicated a high awareness. The last part of the inventory consisted of the HBM constructs, including risk perception, perceived barriers, and perceived self-efficacy. An example of risk perception is: it is likely that I will get cancer due to consumption of rice contaminated with heavy metals. An example of perceived barriers is that imported rice is cheaper than Iranian rice. Risk perception, perceived barriers, and perceived self-efficacy were measured with 7, 9, and 9 items, respectively. An example of perceived self-efficacy is that individuals buy Iranian rice despite its high price. Each item was scored on a 5-point Likert scale ranging from 1 (absolutely wrong) to 4 (absolutely right). The mean score of each subscale was used in the analyses. The total scores were determined by dividing the sum of the items by the number of items for each scale. Both qualitative and quantitative methods were used to assess content validity. In the qualitative evaluation, the validity of the questionnaire was assessed through a review of relevant scientific texts and feedback from the expert panel (2 environmental health experts, 2 health education and health promotion experts, and one health psychology expert). To ensure the easy comprehensibility and the fluency of the inventory, it was examined in a sample of 30 women, who found the items to be comprehensible and clear. In the quantitative evaluation, the content validity index (CVI) was applied. To test the CVI, 4 measures of easiness, relevancy, and clearness were distinctly investigated. Experts were asked to evaluate each item on a 4-point scale

(4 = very relevant, 3 = relevant with some adjustment as to phrasing, 2 = only relevant if phrasing is profoundly adjusted and 1 = irrelevant). CVI was calculated by the aggregation points to agree to any variables that had obtained a score of 3 or 4 divided by the number of expert panel individuals (n = 5). The CVI of more than 0.81 was considered to approve the content validity of the scale.[16] The reliability of the awareness inventory was determined as 0.84 using the test-retest method with a one-week interval on a random sample of 50 women. Cronbach's alpha was measured to assess the reliability of the inventory, and was calculated as 0.72 for risk perception, 0.82 for perceived barriers, and 0.79 for perceived self-efficacy.

Data were analyzed in SPSS software (version 16, SPSS Inc., Chicago, IL, USA). The chi-square test was used to assess differences in demographic variables (age, education level, marital status, and employment status) across knowledge level. The relationship between perceived threat, barriers, and self-efficacy across participants' demographic variables was evaluated using t-test and ANOVA. The logistic regression analysis was performed to determine the predictive power of the demographic variables and attitudes studied in assigning participants to one of the two groups of low or moderate awareness. The women were asked to sign a consent form if they were interested in participating.

Results and Discussion

The participants of the present study had an average age of 40.55 ± 13.8 years (age range = 18-80). According to the results, none of the participants had a high level of awareness; 1132 (78.2%) and 316 (21.8%) subject had low and moderate levels of awareness of toxic metal-contaminated rice, respectively. The low and moderate levels of awareness were not significantly different from one another with regard to all demographic characteristics examined. A greater number of women (24%) aged 40-59 years reported a moderate level of awareness. Women over 60 had the lowest level of awareness compared to the other age groups (Table 1). The highest level of awareness was found in women with under diploma education (22%), and the majority of women with academic education (82%) had the lowest level of awareness. Marital status was not correlated with the level of awareness.

Table1. Awareness level and attitudes across socio-demographic characteristics

Characteristic	Low awareness level [n (%)]	Moderate awareness level [n (%)]	P
Age			0.001
< 40	584.00 (79.00)	151.00 (21.00)	
40-59	410.00 (75.00)	130.00 (25.00)	
> 60	135.00 (80.00)	32.00 (19.00)	
Education level			0.001
Under diploma	759.00 (82.00)	168.00 (18.00)	
Higher than diploma	276.00 (78.00)	75.00 (22.00)	
Academic	111.00 (70.00)	48.00 (30.00)	
Marital status			
Married	763.00 (73.00)	277.00 (27.00)	0.001
Other (single, widowed, divorced)	137.00 (77.00)	41.00 (23.00)	
Employment Status			0.001
Yes	103.00 (82.00)	23.00 (18.00)	
No	999.00 (78.00)	302.00 (29.00)	
Perceived threat	3.90 (0.63)	4.06 (0.54)	0.001
Perceived barriers	3.70 (0.61)	3.63 (0.57)	0.001
Perceived self-efficacy	3.38 (0.70)	3.38 (0.64)	NS

NS: Not significant

Table 2. Awareness level across the awareness items of contamination of consumed rice with toxic metals

Awareness items	Moderate awareness [n (%)]	Low awareness [n (%)]
Awareness about toxic metals (arsenic, lead, and cadmium)	207 (14.3)	1243 (85.7)
Awareness about the potential contamination of daily consumed rice with toxic metals	31 (2.0)	1419 (98.0)
Awareness about the ways through which agricultural crops can be contaminated	22 (1.5)	1428 (98.5)
Awareness about the adverse effects of toxic metals on the body (the risk of certain types of cancer)	59 (4.0)	1391 (96.0)
Awareness about the adverse effects of arsenic on the body	146 (10.0)	1304 (90.0)
Awareness about the adverse effects of lead on the body	204 (14.0)	1246 (86.0)
Awareness about the adverse effects of cadmium on the body	273 (19.0)	1177 (81.0)

The mean score of risk perception was not significantly different in terms of demographic characteristics except marital status ($P < 0.001$). The rate of perceived risk was lower among married women than unmarried women. The mean score of the perceived barriers was significantly diverse across all demographic characteristics ($P < 0.001$) except marital status. The highest rate of barriers was seen in women above 60 years of age. Women with academic education reported the least perceived barriers compared with the other groups. Table 1 shows that the mean score of perceived self-efficacy varied in terms of age and educational level ($P < 0.001$). Women below 40 years of age showed the highest self-efficacy. The women with academic education reported a higher self-efficacy compared with the others ($P < 0.001$).

Table 2 presents participants' level of awareness of toxic metals, including arsenic, lead, and cadmium, the potential toxic metal contamination of imported and domestic rice crops, ways through which agricultural crops could be contaminated with toxic metals, and their adverse effects. The highest level of awareness was on the varieties of toxic metals (arsenic, lead, and cadmium; 14.3%) and the lowest awareness was on the ways through which agricultural crops could be contaminated with toxic metals (1.5%). For the specific signs of metal toxicity in the body, the highest awareness was related to cadmium (19%) and the lowest to arsenic (10%). The level of awareness about toxic metals in rice crops and its adverse effects was low in 89.9%, moderate in 10.1%, and high in 0% of the participants.

Table 3 presents the proportion of agreement and lack of agreement across the barrier items.

Table 3. Agreement/lack of agreement proportion across the barrier items

Barrier items	Absolutely disagree [n (%)]	Disagree [n (%)]	Neutral [n (%)]	Agree [n (%)]	Absolutely agree [n (%)]
High prices of toxic metal-free rice crops	93 (6.4)	133 (9.2)	152 (10.5)	439 (30.3)	633 (43.6)
Unawareness about the risks of using toxic metal-contaminated rice crops	54 (3.7)	215 (14.8)	358 (24.7)	480 (33.1)	343 (23.7)
Less than perfect texture of toxic metal-free rice crops when cooked	90 (6.2)	200 (13.8)	221 (15.3)	619 (42.7)	320 (22.0)
The lower likelihood of toxic metal-contaminated rice crops to be plagued by pests	40 (2.8)	142 (9.8)	416 (28.7)	659 (45.4)	193 (13.3)
Appearing to be a better cook with the use of contaminated rice crops	40 (2.8)	120 (8.3)	180 (12.4)	790 (54.5)	320 (22.0)
The failure to differentiate between contaminated and non-contaminated rice crops	101 (7.0)	217 (15.0)	219 (15.1)	596 (41.0)	317 (21.9)
The family members' preference for the toxic metal-contaminated varieties of rice due to their better texture	153 (10.6)	215 (14.8)	163 (11.3)	520 (35.8)	399 (27.5)

Table 4. Odds awareness level by socio-demographic and attitude

Socio-demographic factors	Significant contracts	OR	CI	P
Age				
< 40	Low versus moderate	1.09	0.71-1.66	NS
40-59	Low versus moderate	1.33	0.86-2.06	NS
> 60				
Education level				
Under diploma	Low versus moderate	1.34	0.86-2.08	NS
Higher than diploma	Low versus moderate	1.27	0.78-2.05	NS
Academic				
Marital status				
Married	Low versus moderate	1.06	0.72-1.54	NS
Other (single, widowed, divorced)				
Employment status				
Working	Low versus moderate	0.79	0.49-1.27	NS
Not working				
Attitude				
Perceived threat	Low versus moderate	1.37	1.06-1.78	0.01
Perceived barriers	Low versus moderate	1.20	0.91-1.57	NS
Perceived self-efficacy	Low versus moderate	1.03	1.76-1.40	NS

Estimated OR and 95% CI are presented for each 2-level comparison (P < 0.01-0.001). NS: not significant; OR: Odds ratio; 95% CI: Confidence interval

There was little willingness in the society to use toxic metal-free rice crops. The main barrier to the use of safe rice (43.6%) was its high cost. About 55% of participants stated that one of the main barriers against their use of safe rice crops was the better texture of cooked toxic metal-contaminated rice. The results revealed that 45.4% of the participants agreed that the contaminated rice crops were less likely to be plagued by pests, and therefore, they may be stored longer. Regarding the texture of cooked rice, 42.7% of the participants expressed the less than perfect texture of toxic metal-free rice as a perceived barrier.

The results of logistic regression analysis showed that age, level of education, marital status, and employment status did not predict a higher or lower awareness of metal toxicity in rice crops (Table 4). Perceived barriers and self-efficacy did not have a significant predictive power for assigning participants to one of the two groups, although perceived risk was significantly different (P < 0.001).

The level of awareness regarding toxic metals, the potential contamination of daily-consumed rice, and the ways through which agricultural crops can be contaminated, and the adverse effects of toxic metals on the body were low among the residents of Sanandaj. One of the main nutritional problems is the lack of nutritional awareness, and consequently, poor nutritional performance, which results in malnutrition and the development of various non-communicable diseases. Studies conducted in Iran have revealed the poor knowledge and performance of families with regard to the different aspects of nutrition.[17-19]

Age did not influence awareness level. The results showed that unhealthy nutrition changed toward a healthy one with age.[20] In the present study, women of over 40 years of age had a higher level of awareness regarding the contamination of their daily-consumed rice with toxic metals compared to women in the other age groups. Sanchez-Villegas et al. also showed that older women with a history of obesity and high blood lipids were less likely to have unhealthy diets.[21] The examination of the risk factors associated with heart diseases in men and women in the Netherlands revealed that the highest score of adherence to diets containing fruits pertains to the elderly.[22] In a study conducted by Park et al., the consumption of fruits, vegetables, and milk was shown to

increase with age.[23] Given this low awareness and the concerns about the outcomes of the continuous consumption of contaminated rice by families in their regular diets, it is essential to raise awareness of the issues among all groups of society. The results of the present study showed that individuals with university education have lower awareness than those with under diploma education. However, Sajadi et al. revealed a significant relationship between nutritional awareness and the level of education.[24] Another finding showed that individuals with higher levels of education tend to adhere to healthier diets than those with lower levels of education.[20] A study conducted on women with thyroid cancer revealed that women with higher levels of education have a greater knowledge about low-iodine diets.[25] In a study conducted on Korean women residing in the United States, Yang et al. found a positive correlation between the level of education and food patterns (fruits and vegetables).[26]

The results of other studies have showed that individuals with higher levels of education attributed a particular importance to healthy diets.[22] Unlike the findings of Jafari,[27] higher levels of education did not predict the level of awareness. This result may be related to the novelty of the issue, toxic metals, and the potential contamination of consumed rice. The researchers proposed the level of education as a determinant of the level of awareness before and after the training.[28] It is necessary to further explore the relationship between the levels of education and the awareness of toxic metal-contaminated rice in this population.

In terms of the connection between age and self-efficacy, it seems that women in higher age groups need to promote self-efficacy in order to overcome the barriers of consuming uncontaminated rice. In addition, older women require more help to reduce perceived barriers compared to younger women. Education level showed appositive contribution to reduced perceived barriers and increased self-efficacy. Therefore, women with lower education could be helped regarding changes in attitudes toward decreasing their barriers and increasing self-efficacy.

In the present study, a higher risk perception increased the probability of falling in the group with moderate awareness by 1.37 times. This finding was consistent with the theoretical principles of the HBM. An increased risk perception will therefore result in a higher awareness in individuals, and consequently, change their behavior and promote their protective behaviors against the adverse effects of toxic metals. Contento et al. demonstrated a positive correlation between awareness, perceptions, and nutritional health behaviors in children.[29] According to Zalilah et al., nutrition training improved knowledge, attitudes, and nutritional health behaviors in Malaysian students.[30] The families' attitudes and performances with regard to nutrition were also among the determinants of nutritional status. Understanding such determinants allows the use of better interventions.[31] The contribution of the mass media (TV and radio channels), training courses through healthcare centers, the contribution of NGOs, and the distribution of instructional pamphlets would be effective in increasing risk perception with regard to the adverse effects of toxic metals, public awareness, and adherence to healthy diets. The findings of Lotfi and Rakhshani showed that awareness is directly correlated with risk perception, and students with higher nutritional awareness showed more favorable nutritional behaviors.[32] Studies conducted on students' awareness of the importance of having breakfast in the morning indicated that increased awareness results in a favorable performance with regard to the consumption of fruits and vegetables.[33] The results of the present study showed that one barrier against the consumption of toxic metal-free rice crops was their high prices. Pawlak and Colby also proposed the costs of healthier food options as the main barrier

against their consumption.[34] Trainings should be focused on encouraging the population to use less rice in their diets, to replace rice with other food products, and to use foods containing higher amounts of antioxidants in order to reduce the accumulation of toxic metals in the body.[35] Changing cooking techniques and draining rice instead of steaming it might also reduce toxic metal concentrations in the cooked rice.[36] Nutrition training aiming at the better use of the available food resources is the main practice for the prevention of malnutrition.[37] The first and most accessible source of information and imitation is comprised of one's parents, especially the mother. Hence, increasing this group's awareness about healthy nutrition and its functions in the body through the media, the publication of educational books, or holding free public courses should be adopted as a national health policy. In the domain of nutrition health, monitoring nutrition conditions in the society through the periodical collection of information, examination of nutritional change processes at the macro level, and reporting all findings to the relevant authorities can be used as strategies for promoting public health.

Setting strict standards for the reduction of arsenic contamination in rice crops is necessary.[38] According to Argos et al., adherence to a healthy, balanced diet can reduce the risk of arsenic toxicity.[39] The Food and Drug Administration recommends parents to pay more attention to food labels on rice packages.[38]

The present study had several limitations. First, participants' performance in terms of their amount of consumption of contaminated rice was not examined. The research team intended to characterize those rice brands that contained toxic metals. Second, the side effects of toxic metal-contaminated rice depended on the rate of toxic metals in rice. Therefore, their measure was an essential factor. The variation in imported rice consumed by participants and project budget limitation did not allow the study of these factors. The present study did not examine participants' performance regarding the amount of consumed contaminated rice. Thus, future studies are recommended to take the exact amount of consumed toxic metal-contaminated rice as an indicative of participants' performance in order to determine the HBM constructs affecting the consumption of toxic metal-contaminated rice.

Conclusion

The findings of the present study revealed the necessity of raising public awareness and increasing risk perception regarding the adverse effects of toxic metals. Increased risk perception, and subsequently, increased public awareness about the adverse effects of toxic metals result in behavioral changes and promote protective behaviors against the adverse effects of toxic metals, such as reduced consumption of toxic metal-contaminated rice or its substitution with toxic metal-free varieties.

Conflict of Interests

Authors have no conflict of interests.

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