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Socio-demographic and socio-economic determinants of adults' knowledge on fungal and aflatoxin contamination in the diets.

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ABSTRACT

Objective: The occurrence of food contaminants such as aflatoxin in the foodstuffs has been reported widely. Unfortunately, only a few know about the impact of aflatoxin to human health and this phenomenon let us to question the extent of public's knowledge on fungal and aflatoxin contamination in the diets. Thus, this study aimed to investigate determinants of adults' knowledge on fungal and aflatoxin contamination in the diets based on two factors namely socio-demographic and socio-economic factors. **Method:** A questionnaire was self-administered to 160 respondents from a faculty in Universiti Putra Malaysia. **Results:** Most of respondents had low level of knowledge in regard to fungal and aflatoxin contamination. Besides, the total score of knowledge on fungal and aflatoxin contamination was significantly and positively correlated (r=0.340, $P<0.0001$). The multivariate analysis indicated that personal income (below US $487) was the only predictor of respondent's knowledge ($\beta=-0.288$, $P<0.001$) [Odds ratio (OR)=4.996]. Nonetheless, being male and single, divorced or widowed had significant OR of 2.040 and 0.313 respectively as predictors of low level of knowledge. **Conclusions:** Income inequalities may have impact to the respondents in acquiring knowledge on fungal and aflatoxin contamination in the diets. Additionally, an extensive survey on aflatoxin should be warranted in order to assess the public awareness and knowledge about this food contaminant.

1. Introduction

Fungi produced thousands of toxic compounds and one of them is aflatoxin. This toxin is found commonly in the diets and long term exposure to aflatoxin is associated with health deterioration. In addition, the International Agency of Research on Cancer (IARC) has classified aflatoxin B1 as Group 1 carcinogen, primarily affecting liver and is linked to the development of liver cancer[1]. Aflatoxin production is fostered by the hot and humid conditions, which are favorable conditions for the growth of fungi in the foodstuffs[2-4]. Besides, improper storage of food commodities during pre- and post-harvest is also associated with the occurrence of fungi and aflatoxin[2]. Although many strategies are developed to counteract the contamination, there is still a small "gap" in the implementation as people are directly or indirectly exposed to this contaminant. In fact, the occurrence of aflatoxin in the food commodities is continuously reported locally in Malaysia[2,4,5] as well as around the globe[6]. In addition, aflatoxicosis cases involving humans and animals are also documented. For example, the consumption of afltoxin-contaminated noodles has resulted in acute hepatic encephalopathy among children in Malaysia[7]. Despite the legislation and law enforcement set by the policy maker to minimize the contamination, it is believed that there must be some underlying factors that contribute to "the creation of this phenomenon". An argument can be made that the public lack information and knowledge about this incidence; however the roots of this problem should be

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investigated first in order to find the solutions.

Since aflatoxin is ubiquitous and cannot be completely eliminated from the diets, its level in the food commodities can be minimized to an acceptable level for humans and animals through an early intervention. Increased public awareness for instance through the knowledge enrichment could be one of the initial ways to educate the public about the presence of aflatoxin in our daily diet. Myerowitz and Chaiken[8] highlighted that one of the mechanisms of which health communication could alter health habits is by transmitting information (i.e knowledge) on how habits affect health. In fact, based on the Socio Cognitive Theory (SCT), the knowledge of health risk and benefits of different health practices is illustrated as one of the five core sets of SCT's determinants[9]. Bandura[9] also added that individual's knowledge on health risk and benefits creates the precondition for change. Additionally, it was also found that knowledge and attitude were interdependent and influenced behavioral action[10]. Hence, these findings [8-10] allow us to postulate that knowledge, which can be influenced by many factors such as socio-demographic and socio-economic factors, influences individuals' awareness and attitude and subsequently their actions. Indeed, a study showed that the socio-demographic and socio-economic variables are inter-connected to knowledge and linked to the action on controlling aflatoxin contamination in the groundnut[11].

In this study, we examined the knowledge of adults on fungal and aflatoxin contamination in the diets. The purpose of this study was to investigate the determinants of respondents' knowledge on fungal and aflatoxin contamination in the diets based on two factors; socio-demographic and socio-economic factors. Furthermore, it is believed that the public should be educated and made known about aflatoxin and its significance health effects. Thus, through a simple questionnaire survey, the extent on respondents' knowledge on fungal and aflatoxin contamination was also determined.

2. Method & Materials

2.1. Respondents

Ethical approval was obtained from the Medical Research Ethics Committee of Universiti Putra Malaysia. Data from this study was collected through a survey administered to 160 non-academic staffs working in a faculty at Universiti Putra Malaysia. Prior to data collection, signed informed consent form was obtained from the respondents.

2.2 Questionnaire instrument

The questionnaire was self-administered and consisted of two sections namely socio-demographic and socio-economic backgrounds and knowledge of fungal and aflatoxin contamination. The socio-demographic factors investigated were age, gender, marital status and educational level whereas respondents' personal and household incomes were the socio-economic variables. In regard to the knowledge of fungal and aflatoxin contamination, a number of statements was created and they were measured on a three-point scale (0=do not know, 1=not sure and 2=know). All statements were created with the reference and information of aflatoxin occurrence in Malaysia through the literature review. To test the reliability of the questionnaire, a pre-test was conducted among 31 non-academic staffs from a different faculty and the Crobach's alpha for 8-item questionnaire was 0.766. A closer examination of the questionnaire item-total statistic indicated that alpha would increase if statement 2 "some fungi are used in fermentation" was removed. Therefore, only 7-items questionnaire was used to assess respondents' knowledge on fungal and aflatoxin contamination in the diets.

2.3 Data analysis

Data was analyzed using SPSS version 17.0 software. Descriptive statistics (mean and standard deviation) was used to describe features of the samples. To investigate the underlying structure of a 7-item questionnaire, factor analysis was adopted and data collected from 160 respondents were subjected to principal component analysis with varimax rotation. Factors were determined based on the Eigenvalues greater than 1, Scree Plot and factor loading above 0.40.

The differences in mean total score of knowledge between the socio-demographic and socio-economic factors were determined by t-test. All the data were made into categorical variables and chi-square (χ^2) was used to see if significant relationships exist between the total knowledge score and the variables. On the other hand, multiple regression analysis and logistic regression was used to predict the contribution of socio-demographic and socio-economic factors on the knowledge level of fungal and aflatoxin contamination among the respondents. The median total score of 8 was set as a benchmark of respondents' knowledge level as total score of 8 and below was considered as low and vice versa.

3. Results

3.1 Socio-demographic and socio-economic background

There were 160 respondents who participated in this survey and male and female respondents comprised of

46.3 and 53.7% respectively of the total respondents. The respondents' ages ranged from 23 to 57 years with the mean age of 35.2 ± 10.1 years. Most of the respondents had attended at least secondary school and 65.6% (n=105) of them were married. With regard to the socio-economic factors, 40.0% (n=64) and 81.9% (n=131) of respondents respectively had personal and household income above US $487 (RM 1,500). The classification of income level was made according to the Malaysian Economic Planning Unit where income approximately US $487 represented the bottom 40% of Malaysian gross household income in 2009 [24].

3.2 Analysis of questionnaire

The Cronbach's alpha of 0.776 from the 7-item questionnaire completed by the 160 respondents indicated the consistency of the questionnaire. Besides, the output of factor analysis; the Kaiser-Meyer-Olkin (KMO) value of 0.760 and the significance of Bartlett's Test (P<0.000) confirmed the suitability of data. Two factors (with Eigenvalues exceeding 1 and factor loading above 0.4) were identified as underlying factors of the seven questionnaire items. In total, these factors accounted for 64.4% of the variance in the questionnaire data (Table 1).

3.3 Knowledge on fungal and aflatoxin contamination in the diets

Of 160 respondents who completed the questionnaire, 10% (n=16) had maximum score of 14, which indicated that they knew about fungal and aflatoxin contamination in the diets. Ironically, 52.5% (n = 84) of respondents had low level of knowledge (total score of 8 and below). As shown in Table 2, the mean total score of knowledge was 8.51 ± 3.19. In general, it can be assumed that the respondents had low level of knowledge on fungal and aflatoxin contamination in the diets. Additionally, the total score of knowledge was significantly different between gender and personal income level. However, when analyzing according to factors; female, respondents with tertiary educational level and with personal and household income above US $487 had significantly high total score of knowledge on fungal contamination in the diets. In contrast, only respondents with personal income above US $487 were found to have significantly high total score of knowledge about aflatoxin contamination in the diets. It was also interesting to note that the total score of knowledge on fungal and aflatoxin contamination was positively and significantly correlated (r=0.340, P<0.0001). In other words, when respondents knew about fungal contamination in the diets, they were more likely to have knowledge or heard about aflatoxin.

3.4 Association between socio-demographic and socio-economic variables and knowledge on fungal and aflatoxin contamination in the diets

Table 3 shows the correlation between socio-demographic and socio-economic factors with the total score on knowledge. Since there were three factors that had significant correlation with the knowledge level, hierarchical multiple regression analysis (MRA) were chosen to determine factors that influenced respondent's knowledge level. On step 1 of the hierarchical MRA, gender, and marital status (socio-demographic factors) accounted for a non-significant 3.2% of the variance in knowledge level (R^2=0.032, F (2, 157)=2.594, P=0.078). On step 2, personal income (socio-economic factor) was added to the regression equation, and accounted for an additional 7.4% of the variance in knowledge level (R^2_{change}=0.074, F_{change} (1, 156)=12.880, P< 0.000). In combination, the three predictor variables explained 10.6% of the variance in knowledge level (R^2 = 0.106, adjusted R^2=0.089, F=6.154, P< 0.001). Although the preliminary model showed that gender was the determinant of the knowledge, the final model indicated that only personal income was statistically significant (β =-0.288, P< 0.001) in predicting the knowledge level of fungal and aflatoxin contamination in the diets (Table 4). Based on the model, having low personal income was the determinant of respondents' knowledge on fungal and aflatoxin contamination in the diets. Thus, the equation from the analysis can be derived as follows:

Table 1

Varimax rotated factor structure of the seven items of knowledge on fungal and aflatoxin contamination.

Statements	Loadings	
	Factor 1[a]	Factor 2[b]
1. The hot and humid climate of Malaysia may promote the growth of fungi	0.833	
2. Improperly stored food can be contaminated by fungi	0.830	
3. Fungi can produce a variety of toxic compounds	0.432	
4. Aflatoxin is produced by fungi		0.879
5. Aflatoxin is a type of mycotoxin		0.890
6. Aflatoxin can be found in our daily diets		0.892
7. Long term exposure to fungi and aflatoxin can be harmful to the health		0.627

[a]Knowledge about fungal contamination. [b]Knowledge about aflatoxin contamination. All factor loadings had value above 0.4.

Table 2

Independent t-test on socio-demographic and socio-economic characteristic on knowledge of fungal and aflatoxin contamination in the diets.

Variables	*n*	Knowledge score[a]					
		Fungal		Aflatoxin		Total	
		Score	*P*-value	Score	*P*-value	Score	*P*-value
Socio-demographic							
Age							
39 and below	114	5.29 ± 1.10	0.051	3.28 ± 2.73	0.585	8.57 ± 3.31	0.720
40 and above	46	4.87 ± 1.49		3.50 ± 2.10		8.37 ± 2.92	
Gender							
Male	74	4.92 ± 1.95	0.021	3.01 ± 2.49	0.130	7.93 ± 3.25	0.033
Female	86	5.38 ± 0.97		3.63 ± 2.59		9.01 ± 3.08	
Marital status							
Married	105	5.16 ± 1.25	0.923	3.18 ± 2.62	0.267	8.34 ± 3.19	0.355
Single/divorced/widow	55	5.18 ± 1.23		3.65 ± 2.41		8.84 ± 3.21	
Education status[b]							
Low	66	4.85 ± 1.46	0.010	3.14 ± 2.37	0.391	7.98 ± 3.19	0.080
High	94	5.39 ± 0.99		3.49 ± 2.68		8.88 ± 3.16	
Socio-economic							
Personal income[c]							
Below US $487	64	4.69 ± 1.44	0.000	2.78 ± 2.44	0.023	7.47 ± 3.18	0.001
Above US $487	96	5.49 ± 0.96		3.72 ± 2.57		9.21 ± 3.03	
Household income[c]							
Below US $487	29	4.55 ± 1.68	0.027	3.14 ± 2.26	0.633	7.69 ± 3.46	0.126
Above US $487	131	5.31 ± 1.07		3.39 ± 2.62		8.69 ± 3.12	
Mean±SD (Range)	160	5.17 ± 1.24[d] (0 − 6)		3.34 ± 2.55[d] (0 − 8)		8.51 ± 3.19 (0 − 14)	

[a]Score on Factor1 (statement 1 − 3), Factor 2 (statement 4 − 7) and Total (statement 1 − 7)

[b]Low education status = secondary, primary or not attending school; high education status = tertiary

[c]Classification based on the Malaysian Economic Planning Unit (2012)

[d]The total score on knowledge of fungal contamination was significantly correlated with the total score of aflatoxin contamination (Pearson's correlation coefficient, r = 0.340, $P < 0.0001$)

Knowledge level = 9.258 − 1.87 (Low Personal Income)

Table 3

Correlation between socio-demographic and socio-economic with total score of knowledge.

Variables	Pearson chi-square (X^2)	Correlation[a]
Socio-demographic		
Age	0.162	0.032
Gender	6.697*	0.205
Marital status	5.251*	−0.181
Education status	1.957	0.111
Socio-economic		
Personal income	9.227**	0.240
Household income	0.101	0.025

[a]Correlation based on Phi-value of association

*P-value < 0.05, **P-value < 0.01

Apart from that, the logistic regression analysis showed that being single, divorced or widow had significant odds ratio of 0.313 as predictor of low level of knowledge among the respondents. Conversely, the male respondents were 2.04 times more likely to have low level of knowledge compared to female respondents. Moreover, the odds ratio of 4.699 indicated that respondents with personal income below US $487 were 4.699 times more likely to have low level of knowledge than those who had income above $ 487 (Table 5).

Table 4

Unstandardised (B) and Standardised (β) for each predictors variable on each step of hierarchical multiple regression predicting knowledge level of fungal and aflatoxin contamination in the diets

Variables[a]	B	β	t
Step 1			
Gender	−1.045*	−0.164	−2.076
Marital status	0.394	0.529	0.745
Step 2			
Gender	−0.697	−0.109	−1.407
Marital status	0.945	0.141	1.776
Personal income	−1.870**	−0.288	−3.589

*P-value < 0.05, **P-value < 0.001

All the variables are dichotomous and coded as follows; Gender: Male = 1, Female = 0; Marital status: Single, divorced or window = 1, Married = 0; Personal income: Below US $487 (Low) = 1, Above US $ 487 = 0.

Table 5

Logistic regression of low knowledge level as function of socio-demographic and socio-economic variables.

Variables[a]	Odds Ratio (95% CI)
Socio-demography	
Age	1.351 (0.509 − 3.584)
Gender	2.040 (0.973 − 4.277)*
Education status	0.951 (0.363 − 2.494)
Marital status	0.313 (0.134 − 0.731)**
Socio-economic	
Personal income	4.996 (1.868 − 13.361)***
Household income	0.519 (0.161 − 1.673)

*P-value < 0.05, **P-value < 0.01, ***P-value < 0.001

[a]Variables are coded either 1 or 0. Age: 39 years and below = 1, 40 years and above = 0; Gender: Male = 1, Female = 0; Education status: Low = 1, High = 0; Marital status: Single, divorced or widow = 1, Married = 0; Personal income: Below US $487 = 1, Above US $487 = 0; Household income: Below US $ 487 = 1, Above US $487 = 0.

4. Discussion

A questionnaire survey was conducted to assess respondents' knowledge on fungal and aflatoxin contamination in the diets. Aflatoxin is a toxic compound produced by pathogenic fungi from species of Aspergillus and ubiquitously contaminated foodstuffs [4]. Although aflatoxin is a controllable risk factor in the diets, people are still not aware about its presence and consequences to the health. Our study found that most of the respondents knew about the presence of fungal infection in the foodstuffs, and yet they did not know about aflatoxin. This observation is supported as a large number of people in both developing and developed countries are not aware of risk associated with contaminated food[12].

In this study, two determinants namely socio-demographic and socio-economic factors were investigated to find their association on the knowledge level of fungal and aflatoxin contamination. Toh and Birchenough [10] found that knowledge and attitude were interdependent and influenced behavioral actions. Besides, if people perceive the problem and become aware of the possible risk associated with the ingestion of unsafe food, they will seek knowledge and develop an attitude that will foster proper action to minimize the effects of contamination [11]. It is indeed concordant with our findings that the score of knowledge on fungal contamination was correlated with the score of knowledge on aflatoxin. Since public exposure to information of aflatoxin effects is limited as the symptoms of aflatoxicosis are only reported when animals and humans ingest large amount, and illness and death occur [11] obtaining information on fungal contamination in the diets and its related health effects may probably open new opportunity of acquiring knowledge on aflatoxin and subsequently creates the awareness among the public.

The present study found that women had higher knowledge level of fungal and aflatoxin contamination compared to men. Such existence of gender gap in the knowledge level has also been reported [11][25]. For example, Osaili *et al.*[13] showed that women in general had a sound knowledge and practice in regard to food safety. Besides, women also had strongest reaction to low-visibility food safety risk [14]. Conversely, a recent study by Ilesanmi and Ilesanmi [15] did not find any significant differences regarding knowledge of aflatoxin between men and women. Although such discrepancy is still reported in the literatures, one study pointed out that male are more concerned with the cost of reducing aflatoxin levels; whereas female showed greater awareness and greater perceived benefits from action [11]. In addition, male and female also have different perceptions on what to consider being as food safety [25].

Education is positively related to awareness, knowledge and perceived benefits [11]. It is understood that people with higher education level are likely to be better informed, and therefore, may be more aware of some types of risk of food additives or pesticides in foods than those with less education [16]. Additionally, Baker [14] stated that those with highest levels of education were more willing to pay for food safety. In this study, we found that respondents with high education status had significantly high level of knowledge on the occurrence of fungal infections in the diets compared to those with low education status. This observation clearly indicated that education is an important mode to disperse information and knowledge to the public. In the case of aflatoxin contamination in the foodstuff, there was a tendency for those with primary or no education to be twice as likely to have high AFB1 levels compared to those with secondary education or above [17]. It is thus believed that the educated individuals are more likely to seek information about aflatoxin and consequently develop an action plan to prevent them from being exposed to aflatoxin. Nevertheless, a particular attention should be given to those with low education level in order to raise their awareness and knowledge on fungal and aflatoxin contamination in the food commodities. It is believed that through comprehensive educational program such as campaign and advertisement, the public generally can be educated and made known about the presence of aflatoxin in the diets and its detrimental health effects.

Our analysis also showed that being single, divorced or widow may contribute to low level of knowledge among the respondents. Once an individual is in a relationship or married, there is a possibility that knowledge of some particular diseases is exchanged between partners, in which lead to the increasing level of awareness. Indeed, studies have shown the influence of marital status on health promotion and disease prevention. For instance, being divorced resulted in higher odds for poor self-rated health [18]. Besides, a recent study showed that unmarried migrant women were vulnerable to sexual and reproductive

health problems due to low level of knowledge compared to the married ones [19]. Even though, the importance of knowledge for health promotion and disease prevention in these examples is indirectly explained, it can be said that knowledge is easily accessible through the supports and communications between the partners.

As a single variable (socio-demographic factor), we found only gender influenced the knowledge level of fungal and aflatoxin contamination in the diets among the respondents. Though when taking account both variables (socio-demographic and socio-economic factors) into the model, a notable finding is the significant determinant of personal income status with the knowledge level of fungal and aflatoxin contamination in the diets. The respondents with higher income were knowledgeable compared to lower income respondents. Inevitably money appears to matter because it is a marker of something else [20]. For example, Marmot [20] explained that money and technical knowledge have allowed the community to invest in conditions that favor an alleviation of the conditions that lead to high infant mortality. Besides, income is also related to an individual's ability to seek a better health support as evidences showed that the richer ones are always getting healthier relative to the poor people [21]. In the case of the effects of aflatoxin on human health, those who had better income are more likely to have more access to knowledge compared to those with low income status. Furthermore, fearing the lack of information and knowledge about the adverse effects of aflatoxin allows the people to try to access knowledge about food safety from the available experts, which can be expensive and costly. To some extent, the option might be unbearable for individuals with low income status. One of the reasons is the transaction cost in the search of knowledge will increase when the symptoms of the problem are not obvious and not well known, and the experts and professionals themselves are not totally committed to the problem [11].

Since the main route of aflatoxin exposure is through the diets, it is assumed that those with better income and knowledgeable will opt to buy high quality foods, which are normally expensive rather than purchasing foods that are cheap and low in quality. Walker et al. [22] indicated individual income is one of the most salient factors that influencing food buying practices. Those with limited income do not have high purchasing power to buy high quality foods. They in turn will opt to buy low quality of foods, which are somewhat questionable in term of hygiene and safety. In fact, these foods may be vulnerable to be contaminated by contaminants and bacteria. Rodrigues, Venancio and Lima [23] for example explained that food contaminants such as aflatoxins are commonly found in variety of food commodities especially in low quality products such as processed nut. Since afltoxins are colorless, odorless, tasteless and invisible through the naked eye the aflatoxin-contaminated foods may be perceived as safe and edible if there are no sign of defects or contaminations. A survey conducted by Jolly et al. [17] revealed that most of the participants do not identify fungal contamination of grains until there are obvious signs of spoilage such as discoloration, insect infestation or rotting. Based on the explanation, it can be said that individuals with low income status are presumed to have limited knowledge on fungal and aflatoxin contamination. Furthermore, due to financial burden, they will probably opt to purchase low quality of products that are cheap but potentiated to be infected by fungi and subsequently aflatoxin.

5. Conclusion

In essence, our findings showed that socio-demographic and socio-economic factors had effect on respondents' knowledge of fungal and aflatoxin contamination in the diets either directly or indirectly. In particular, income was the most significant determinant of respondents' knowledge on fungal and aflatoxin contamination. The respondents with income below US $487 were found to have low level of knowledge. However, in general, the respondents had low level of knowledge as it was reflected on the total score of knowledge. Income inequality might be one of the reasons for the respondents to have lack of knowledge and information about aflatoxin. Several other interrelated factors such as low exposure to aflatoxin in the diet might contribute to such observation as found in this study.

Since this study was specifically focused toward the non-academic and support staffs in a faculty, the finding did not represent the knowledge level of public regarding fungal and aflatoxin contamination in the diets. The academicians, experts, health practitioners and other professionals might have better understanding and knowledge about fungal and aflatoxin contamination in the diets. Hence, it is understood that when they are educated and aware about the gravity of problem associated with aflatoxin, the information will be easily diffused to the public. In fact, it is a win-win situation as when the public is made known about the occurrence of fungi and aflatoxin in the diets, people will become more aware and actions can be taken to control the contamination in the food chain.

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Conflict of interest

All the authors have declared that they do not have any potential conflicts of interest.

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