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Knowledge and Awareness of Mothers about Lead Exposure in Infant Formula: A Cross-Sectional Study in Nalut City, Libya

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ABSTRACT

Lead exposure is a serious problem, especially for infants and young children. Lead can also reach infant formula and complementary food. This study has two aims; the first one focused on measuring lead levels in five types of infant formula that do mothers in the city of Nalut use most commonly: My Boy, Primalac, Bebelac, France Lait, and Silimil. The second aim is to assess mothers' knowledge and awareness regarding the lead exposure. The study followed a descriptive analytical approach in a cross-sectional study to collect data in the form of questionnaires from 356 mothers aged 20 years and above, who were randomly selected from schools, colleges, and other workplaces; 62 were excluded from the study. From October 2022 to July 2023. Statistical analysis (SPSS) version 26 was used to analyze the data. The results show that all infant formula samples in this study were free from lead after analyses; Delta Company analyzed them using an Atomic Absorption Spectrometer (AAS). 43.5% of the mothers were within the age group of 31-41 years. Most mothers (76.7%) had completed university education, and 39.9% of the participants were teachers. The monthly income for most mothers (74.7%) ranged between 500 and 2000 Libyan dinars. Additionally, it was found that the level of awareness of lead was low in 55% of mothers, medium in 40%, and high in 5%. Finally, there was a significant relationship between the level of education and mothers' occupation and mothers' awareness of lead, with p-values of 0.000 and 0.001, respectively.

INTRODUCTION

The safety of infant food is major concern for parental and healthcare providers, from the first days after birth until the age of three years, infants and young children are the most sensitive stage for the development of their brain, nervous system and vital organs. Therefore, they are particularly affected by bacterial infections and problems caused by chemical contaminations that may seep into their food. Hence, the safety of infant foods must give the highest priority to ensure their protection (GIFA, 2023).

Both the world Health Organization and UNICEF recommended exclusive breastfeeding for the first six months of child's life. One of the main concerns regarding infant milk is contamination with heavy metals such as lead, arsenic, and mercury that can has long-term health effects on infants, as these metals can accumulate in the body over time in addition, to causing many health problems and because their absorption of them is much higher than that of adult (Hill, 2023).

Undoubtedly lead; particularly harm the nervous system of infant, which is still developing, and it can accumulate in the body's vital organs, so even exposure to low concentrations of it can cause serious effect over time (Eticha *et al.*, 2018).

A study by AL-Miyah (2021) titled "Assessment of environmental and health risks of some heavy metals in infant milk and their food available for consuming" in Al-Kut City – Iraq. Hander and eight samples used an

Atomic Absorption Spectrometer (AAS) for analyses, including 36 types of infant milk; the results showed elevated levels of lead in all infant milk samples, exceeding the permissible limits set by WHO/FAO (0.02), with lead concentrations ranging from 0.07 to 0.43 mg/kg. Another study conducted in Lebanon aimed to measure heavy metal levels in infant formula, 78 samples of various types of infant formula were examined using inductively coupled plasma mass spectrometry (ICP-MS). The results showed that the lead concentration in 4% of the samples exceeded the permissible limits, ranging between 31-1,040 mg/kg (Elaridi *et al.*, 2021). In a study titled "Assessment of Assessment of Heavy Metal Properties in Infant Foods from Various Brands," six infant formula samples NAN, Cowbell, My Boy, Cerelac, Frisco Gold, and Nutrend were collected from local markets in Nigeria to assess heavy metal contamination. Using Atomic Absorption Spectrophotometry (AAS), the analysis revealed a significantly high lead concentration in Cowbell at 37.263 mg/kg, while NAN milk had the lowest at 0.38 mg/kg; both exceeded permissible limits, and the other samples showed no detectable lead (Onuorah *et al.*, 2019).

The study aimed to assess mothers' health habits and their knowledge about lead contamination in Mina Governorate, Egypt, and the number of mothers participating in the study reached 251, which used questionnaires as data collection. The result showed that 14% had previously heard about lead contamination, while 55.8% don't know about it. The study showed that

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56% had a low awareness regarding lead contamination. Also, there was a remarkable relationship between the level of awareness of mothers and their educational level (p -value = 0.002) and their age (p -value = 0.001) (Amer *et al.*, 2022). In a descriptive study that aimed to assess the level of awareness regarding the toxic effect of lead in Kabwe City in Zambia, data was collected from 86 participants. A questionnaire was used to collect data; 37% confirmed that they had heard about lead poisoning, while 25.5% were unsure. When participants were asked whether lead poisoning could cause kidney failure and high blood pressure, 36% agreed, 31% were unsure, and 28% disagreed. 44% of the participants agreed that lead could decrease the level of intelligence, whereas 2.3% disagreed (Enock, 2021). A study conducted in Pennsylvania measured the correlation between parents' demographic and social characteristics and their knowledge of lead exposure methods. A questionnaire was used to collect data from 124 participants; the results showed that 87% were aware that high levels of lead could affect children's learning ability. When asked if they believe that child had ever been exposed to lead, 61% answered no, while 19% did not know. It was found that there was no relationship between any of the parents' demographic and social characteristics and their knowledge of lead as p -value > 0.05 (Redford, 2020). The study sought to assess awareness about lead among parents of Afghan and Iraqi children residing in Dallas County; a questionnaire used to collect data from 24 mothers. The result confirmed a low level of awareness in mothers about lead, where only 46% believed that lead can affect a child's ability to learn, and 79% of the participants had a misconception about the possibility of removing lead from water by boiling it. Additionally, 21% of them believe that nutrition plays a role in reducing lead absorption in the body; only 21% know that a balanced diet free of fatty food can help reduce the amount of lead absorbed by the body. While 42% were aware that lead decreases when consuming

iron-rich foods, and 67% know that calcium also reduces its absorption (Yimer, 2020).

MATERIALS AND METHODS

This study was a cross-sectional study designed to assess the extent of mothers' awareness about the lead element in Nalut city in Libya, and a questionnaire was used to collect data and also to measure the lead level in five types of infant formula commonly used by mothers in Nalut city. The study was conducted with mothers aged 20 years and older; data were collected between December 2022 and July 2023, and the sample comprised 356 randomly selected mothers. The questionnaire was distributed in some schools, colleges, and other workplaces, and there was an electronic version of the questionnaire published on social media sites. Sixty-two samples were excluded for failing to answer the entire questionnaire, as approved by the Governing Council of Nalut University in 2022. Use the questionnaire as a 3-axis study instrument. The first theme addressed the participants' demographic characteristics, which included age, educational level, occupation, and family income; the second theme talked about general information on mothers' attitudes toward milk formula and included five questions. The third theme included three questions on the mother's knowledge of lead, and the fourth theme concerned the distribution of the mother's awareness of lead. Finally, the fifth theme included the correlation coefficient between study variables. The results were analyzed using the descriptive statistics SPSS (frequencies, percentages, and arithmetic mean) to describe the study variables. Using the Pearson correlation test and chi-square test to find out the relationship between the study variable considering a value of P -value > 0.05. Atomic Absorption Spectrophotometry (AAS) was used to analyze lead levels in five types of infant formula that are commonly used by mothers in Nalut City.

Table 1: Infant Milk Analysis Results

Sample	Unit of sample	Quantity
My Boy	ppm	0
Similac		0
Bebelac		0
Primalac		0
France Lait		0

RESULTS AND DISCUSSION

Table (1) shows the results of lead level analysis in the five collected infant milk samples intended for the age

from birth to 6 months, which indicated that all samples are free of lead.

Table (2) shows that 131 (36.8%) of mothers were within

Table 2: Socio Demographics characteristic of the study participants

Item	Demographics variables	Freq.	(%)
Age	20-30	131	36.8%
	31-41	155	43.5%
	More than 41	70	19.7%
Educational level	No qualification	1	0.3%
	Preparatory	4	1.1%

	Secondary	38	10.7%
	Under graduate	273	76.7%
	postgraduate	40	11.2%
Occupation	Unemployed	56	15.7%
	Teacher	142	39.9%
	employee	113	31.7%
	Others	45	12.6%
Family income by.	Less than 500	38	10.7%
D. L	500-2000	266	74.7%
	More than2000	52	14.6%

the age group of 20-30 years, while the number of mothers between the ages of 31 and 41 years reached 155 mothers, representing 43.5%, and 70 mothers (19.7%) were over 41 years old. In addition, it is clear that only one mother was unqualified (0.3%), while mothers with a preparatory certificate constituted 1.1%, numbering four mothers. The percentage of mothers with only a high school diploma was 38 (10.7%), which is the highest percentage, followed by mothers who graduated from university at 273 (76.7%), while 40 mothers completed their postgraduate studies at a rate of 11.2%. It appears

that 56 (15.7%) of mothers are unemployed, while 142 of the mothers are teachers, equivalent to 39.9%, and 113 (31.7%) are working; 12.6% of them practice other professions, and their number is 45. Regarding the value of income, there were 38 mothers (10.7%) whose income was less than 500 Libyan dinars, and most of them, totaling 266 (74.7%), had a monthly income ranging between 500 and 2000 Libyan dinars. Meanwhile, the income of 52 mothers (14.6%) was more than 2,000 Libyan dinars.

Table (2) shows that the number of mothers who have

Table 3: General Information

Mother's use of infant formula	Freq.	Freq.
Have you ever used infant formula to breastfeed one of your children?		
Yes	311	87.4%
No	45	12.6%
How many of your children depend on milk formula for their nutrition?		
One child	109	30.6%
Two children	99	27.8%
3 or more children	103	28.9%
How long did you rely on infant formula to breast feed your child?		
A few days	24	6.7%
A few weeks	16	4.5%
A few months	114	32%
1-3 years	157	44.1%
What do you rely on when choosing infant formula?		
Doctor's advice	204	57.3%
Price	20	5.6%
Friends or relative recommendation	57	16%
Information on television and social media	8	2.2%
Others	22	6.2%
Do you think infant formula is safe?		
Yes	211	59.3%
No	145	40.7%

used infant formula, indicating that most of them used milk formula to feed one of their children, numbers 311 mothers, representing 87.4%; meanwhile, 45 mothers (12.6%) had never used it. Additionally, it was found that 109 mothers (30.6%) relied on infant formula to feed one child, while 99 of them used formula to feed two children, constituting 27.8%. Meanwhile, 28.9% of the mothers indicated that three or more of their children relied on infant formula, numbering 103. During the period in which mothers relied on formula milk to feed their children, 24 mothers, representing 6.7%, used the milk for a few days, and 16 mothers (4.5%) used it for

a few weeks. Meanwhile, 114 mothers (32%) relied on formula milk for a few months; also, 157 mothers, making up 44% of the total mothers who turned to using formula milk, ranged between one and three years. Additionally, all mothers who participated in the study were asked whether infant formula is a safe food; the percentage of mothers who trust the safety of infant formula exceeded half, 59.3%, with their number reaching 211, while the number of mothers who had some doubts about its safety was 145, forming 40.7% of the total study sample. Regarding the effect of lead on the kidney, table (4)

Table 4: Mother's knowledge of lead

Item	I agree	I disagree	I don't know	total	(%)
Lead exposure					
Children are the most sensitive group to the effect of lead	176 (49.4%)	11 (3.1%)	169 (47.5%)	356	100%
Symptoms of lead poisoning include headache, abdominal pain, fatigue	78(21.9%)	4 (1.1%)	274(77%)	356	100%
Ingestion and inhalation are the most common methods of lead exposure	211 (59.3%)	12 (3.4%)	133 (37.4%)	356	100%
I believe my child has previously been exposed to lead	26(73%)	188 (33.1%)	212 (59.6%)	356	100%
potential health problems when a child exposed to lead					
Brain and nerve system damage	137 (38.5%)	6 (1.7%)	213(59.4%)	356	100%
Learning problems and increase risk of behavioral disorders	146 (41.0%)	18 (5.1%)	192 (53.9%)	356	100%
Decreased kidney function and kidney damage	151 (42.4%)	8 (2.2%)	197(55.3%)	356	100%
High blood pressure and heart disease	80 (22.5%)	25 (7.0%)	251(70.5%)	356	100%
Anemia incidence	88 (24.7%)	24 (6.7%)	244 (68.5%)	356	100%
Prevention and reduction of lead exposure					
The human body may need a small amount of lead for better nutrition	135 (37.9%)	52 (14.6%)	169(47.5%)	356	100%
The body absorbs less lead if the diet contains a lot of fatty foods	52 (14.6%)	25 (7%)	279(78.4%)	356	100%
Diet that contains calcium, helps prevent lead poisoning	139 (39%)	4 (1.1%)	213(59.8%)	356	100%
Diet that includes a good amount of irons will help reduce child's chance of lead poisoning	140 (39.3%)	9 (2.5%)	207(58.1%)	356	100%
Lead is removed from water if it is boiled	79(22.2%)	50 (14%)	227 (71.1%)	356	100%

shows that 151 (432.4%) mothers agreed with it, while 8 (2.2%) mothers denied the existence of a relationship between lead exposure and kidney disease. In addition, 197 (55.3%) mothers do not know about it. Moreover, the table shows that 52 (14.6%) mothers had incorrect information about consuming large amounts of fatty foods helping reduce lead absorption. Meanwhile, only 25 (7%) mothers were aware that fatty foods do not help reduce lead absorption. Most mothers, however, did not know about this relationship, accounting for 279 (78.4%). The number of mothers who agreed that diets that contain enough calcium help prevent lead poisoning is 139 (39%), while those who disagreed were 25 (7%), and those who did not know were 213 (59.8%). In addition, the participants were asked whether a diet that includes a good amount of iron will help reduce the chance of lead poisoning; 140 (39.3%) agreed about it, while 9 (2.5%) disagreed, and most of the participants did not know about it, representing 207 (58.1%). Regarding whether lead could be removed from water if it were boiled, 79 (22.2%) agreed, and 50 (14%) disagreed, while 227 (63.8%) do not know about it.

The previous figure illustrates the level of awareness

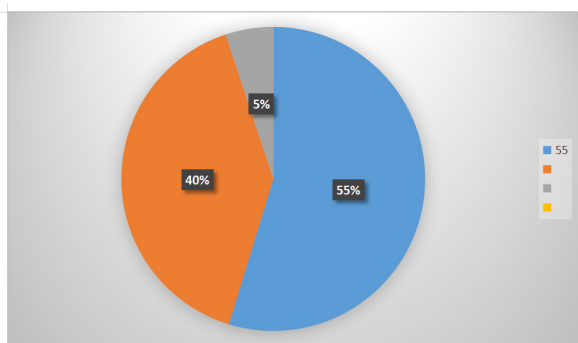


Figure 1: The distribution of mother's knowledge on lead

about lead among mothers, showing that 5% had a low knowledge, while 40.4% had medium knowledge, and 55% had high knowledge.

From the above table, it appears that there is no

Table 5: Infant Milk Analysis Results

Variables	Mother's awareness of lead	
	R- value	P- value
Use of infant formula	0.089	0.093
Age	0.066	0.215
Educational level	0.225	0.000
Occupation	0.172	0.001
Monthly income	0.056	0.292

statistically significant relationship between the use of infant formula and the mother's awareness, as the P-value = 0.093. Additionally, there is no relationship between the age of mothers and their awareness about

lead, where P-value = 0.215. It was found that there is a significant relationship between the level of education and the mother's awareness about the lead element, as the P-value=0.000, and also between the mother's profession and her awareness, as the P-value=0.001. It is noted that there was no relationship between mother's awareness and monthly income where the P-value = 0.2902.

Discussion

The study was conducted to determine mothers' awareness of the effect of lead in infant formula and to measure lead levels in five types of infant formula that do mothers in the city of Nalut use most commonly: My Boy, Primalac, Bebelac, France Lait, and Similac. Delta Company analyzed them using an Atomic Absorption Spectrometer (AAS). Demographic variables of study participants in a sample of 365: the average age ranged between 30 and 41 years. In the current study, the distribution of mothers' awareness showed that 55% of the participants had high knowledge of lead in milk formula, whereas, 40% had medium knowledge, and only 5.1% had low knowledge. this result conflicted with (Mehta et al., 1998). As 56% had low knowledge. Regarding the effect of lead exposure and the mother's awareness, 49% of the participants agreed that children are the most sensitive group to the effect of lead, and 3.1% disagreed, while 47.5% do not know about it; this result is consistent with (Amal & Salim, 2012). While, when asking mothers about the symptoms of lead poisoning, which include headache, abdominal pain, and fatigue, 21.9% agreed, 1.1% disagreed, and the majorities, 77%, do not know about it; this result is consistent with (Alhammad et al., 2019).

In addition, 53.9% of the study participants do not know that learning problems and increased risk of behavioral disorders are related to lead exposure, while 41.0% agreed with it; this result is consistent with both (Zhang et al., 2013) & (Sedeghi et al., 2014). When asking the mothers about the prevention and reduction of lead exposure, 47.5% do not know if the human body may need a small amount of lead for better nutrition, while 37.9% agreed and 14.6% disagreed with it. Moreover, 78.4% of the participants do not know that the body absorbs less lead if the diet contains a lot of fatty foods, and 14.6% agreed and only 7% disagreed; these results are similar to (Adebamowo et al., 2006). A diet that includes a good amount of iron will help reduce the chance of lead poisoning; 39.3% agreed, 2.5% disagreed, and 58.1% do not know about it. These results are consistent with (Mieczan, 2009).

In this study, there was a significant relationship between educational level and mothers' awareness of lead, as the p-value was 0.000; this result is consistent with (Mpokota, 2015). Moreover, the results in the study showed that there is a significant relationship between occupation and mothers' awareness of lead as the p-value = 0.001. This study conflicted with (Adebamowo et al., 2006). Regarding the relationship between monthly income and mothers' awareness, the results showed that there was

no significant finding between them as the P-value = 0.292; this result disagreed with (Aleksandrian, 2014). In addition, there is no relationship between mother's age and their awareness of lead, as the p-value was 0.093. This result inconsistent with (Elmorsy *et al.*, 2024). The results of lead level analysis in the five collected infant milk samples intended for the age from birth to 6 months, which indicated that all samples are free of lead.

CONCLUSION

Through this study, the results showed that most of the participants had poor knowledge about lead exposure. Therefore, from the results, we recommend that there is a need to educate the public, especially parents, because they are responsible for their children's health. The study has a limitation that was important for the responsiveness and answering the questionnaire: the sample size could have been greater, and 62 samples were excluded due to not answering the entire questionnaire. Inclusion focuses on conducting major awareness campaigns through traditional media and social media platforms. Encouraging mothers to exclusively breastfeed during the first six months after birth to avoid the risk that the child may face from consuming formula milk.

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