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Assessment of Dietary Intake and Food Consumption Pattern in the Reproductive Age Group of Women in the Arsenic Prone Area of Ballia District, India

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A B S T R A C T

Arsenic, a chemical element, is present in groundwater in many countries, including India, exceeding its permissible limit. Ballia district is also where Arsenic level is found, with more than 50 ppb in groundwater. Long-term exposure to Arsenic from drinking water and contaminated foods are associated with various type of cancer, skin lesions, Cardiovascular Disease, diabetes, kidney and liver-related problems, and many other problems. Arsenic contamination has also been found in irrigated crops such as rice, pulses, green vegetables, and fruits grown in arsenic-affected areas. Rice has found with a high level of Arsenic contamination. It is known that the good health of an individual depends on a good diet, and only good health gives the power to fight against various diseases. The good health of women is an indicator of a healthy and developed nation because the health of their children and the whole family depends on the good health of women. This cross-sectional observational study studied the dietary pattern and BMI levels of 400 women from Arsenic affected area of the Ballia district. The results showed that most of the respondents were non-vegetarian females, and their BMI level was found in the obese category, which considers a significant factor in the prevalence of chronic diseases. Obesity and Arsenicosis were found to be interrelated with each other. Therefore, the problem of growing obesity in women and the knowledge of a good diet are significant, which can help reduce the risk of Arsenic.

Keywords

Arsenic, skin lesions, Cardiovascular Disease, Ballia, Arsenicosis

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Introduction

Arsenic is a naturally occurring metalloid component of the Earth's crust. Arsenic (As) contamination is widely spread in many parts of the world, including India. Many states of India, such as West Bengal, Bihar, Assam, Uttar Pradesh, Jharkhand, Chhattisgarh, and others, have found a dangerous level of Arsenic in groundwater and foods. Ballia district is one of the contaminated places in Uttar Pradesh state. According to WHO (2022), Arsenic, with its inorganic form, is found to be very highly toxic. The Arsenic contaminated groundwater used for drinking, food preparation, and irrigation of food crops is considered very harmful and the most significant concern for public health. The International Agency for Research on Cancer (IARC) has classified arsenic and arsenic compounds as carcinogenic to humans. Long-term exposure to high levels of inorganic Arsenic through drinking water and food may cause skin, bladder, and lung cancers. In addition, long-term ingestion of

inorganic Arsenic may be associated with diabetes, pulmonary disease, cardiovascular disease, adverse pregnancy outcomes, and infant mortality, impacting child health. Respiratory distress, gastrointestinal effects, anemia, and leucopenia are also associated with long-term exposure to Arsenic. 'Arsenicosis' is a medical term used for Arsenic poisoning, and it occurs due to the synthesis of a large amount of Arsenic in the human body. Arsenicosis produces harmful health effects by disallowing necessary enzymes responsible for death from multisystem organ failure. The Arsenic permissible limit is 0.01 mg/l (ppm) or 10 µg/L (ppb) in drinking water under the BIS standards (IS 10500: 2012). According to Central Ground Water Board, Arsenic with more than 10 µg/L(ppb) is found in groundwater samples spreading over 153 districts in parts of 21 States/UTs of India**.** Most Arsenic affected areas are found in the Ganga basin's middle, lower, and deltaic parts ("Arsenic Mitigation, Department of water resources, RD & GR, Ministry of Jalshakti," n.d.). In Uttar Pradesh, many places in Ballia, Gazipur, and Varanasi districts had more than 10 µg/liter arsenic in the groundwater (Ahmed *et al.*, 2006). Arsenic contamination was found between 0-370 mg/l in shallow water samples and 0-13 mg/l in the deeper groundwater samples in Ballia districts (Singh and Singh, 2015).

A study in West Bengal to study the nutritional factors and susceptibility to Arsenic caused risk factors suggested that low consumption of vegetable fiber, calcium, folate, and animal protein may play a significant role in enhancing the risk of Arsenic caused diseases. This study supports an approximate doubling of risk for those with the lowest consumption of nutrients (Mitra *et al.*, 2004). The consumption of some nutrients such as protein, vitamins, folic acid, minerals, fibers, and other nutrients is associated with lower concentrations of Arsenic in blood and urine and minor dermatological lesions (Monroy-Torres, 2018). In parts of Bangladesh afflicted by arsenic contamination, the effects of exposure to arsenic were significantly mitigated by consuming riboflavin, pyridoxine, vitamins A, C, and E, as well as folic acid. The study advocated a diet high in vitamins and antioxidant nutrients, more significant than the recommended daily supply of nutrients, to reduce the severity of arsenic-related issues. The study's results supported the theory that nutrients essential for arsenic metabolism and antioxidants may reduce the risk of arsenic toxicity (Zablotska *et al.*, 2008). In this regard, hardly many studies have been conducted. Therefore, the current study aims to evaluate the dietary intake and food consumption habits of women in the reproductive age group in a few Ballia district locations that are arsenic-prone.

Materials and Methods

Study area and sampling

In this cross-sectional study, 400 women aged 15 to 49 who had resided in the rural Ballia region for at least five years were interviewed. Simple random sampling techniques were used to select samples for the present study from arsenic-contaminated areas of the Ballia district's Belahari block.

Dietary assessment

The nutritive value of Indian foods was used to record the respondents' dietary habits using the 24-hour dietary recall procedures. The amounts of food eaten were converted into raw quantities using standardized utensils. Then, using food composition tables, the average daily intake of nutrients was determined (Gopalan *et al.*, 2018), and the results were compared to the Recommended Daily Allowances by ICMR 2010.

Data Collection

A self-designed questionnaire and interview schedule were used to get the data from the respondents. Through questionnaire-cum-interview schedules from the respondents, the general characteristics of the respondents, such as age; caste; marital status; family structure; occupational; education; and other information, were also evaluated. B. G. Prasad's 2017 modified standard

scale for socioeconomic categorization was used to determine the socioeconomic status of the sample. The WHO categorization of BMI was used to determine the respondent's BMI.

Statistical Analysis

Data were gathered, collated, and categorized according to quantity, frequency, and percentage. Then, the chi-squares test, t-test, F-test, and other applicable statistical procedures were implemented to interpret the data and ascertain the significance between various variables' mean. Finding the various correlations between the parameters also used the Pearson correlation coefficient. The Statistical Package of Social Sciences (SPSS) Version 16.0 was used for statistical analysis.

Results and Discussion

The distribution of respondents' BMI by WHO categorization is shown in Table No. 1. It is evident that the majority of respondents (53.2%) were normal in terms of BMI status, whereas 27.1% were overweight. Despite this, 1.8% of respondents and 8.2% of respondents, respectively, were classed as first-class obese and second-class obese, respectively, by the WHO. It was evident that 9.7% of respondents fell into the underweight group. Few studies proves that Arsenic exposure and obesity are diffused and widespread (Eick and Steinmaus, 2020).

According to their various caste groups, the respondents in the current study are distributed according to their eating habits, frequency of meal consumption, and inclusion of salads in table no. 2.

Food habits

A total of 73.3% of the 400 respondents were not vegetarians, compared to 24.2% who were vegetarians and 2.5% who were Eggetarian. The majority of respondents from the SC/ST caste (89.6%), the OBC caste (73.5%), and the general caste (56.4%) were all classified as non-vegetarians. Also, the OBC caste group had the most significant number of vegetarian respondents (45.3%), followed by the general caste group (39.8%), while the SC/ST caste group had the lowest rate (5.2%). However, just 1.2% of respondents from the OBC caste group and 5.2% of respondents from the SC/ST caste identified as Eggetarian. It was shown that there was a strong correlation ($P<0.001$) between the respondents' food preferences and their caste group.

Food consumption frequency

A maximum of 81.5% of the 400 respondents reported eating three times daily, 15.5% reported eating just twice daily, and 3% reported eating more than three times daily. A maximum of 87.8% of OBC respondents across different caste groups consume their meals three times, followed by 74.4% of general caste respondents and 68.8% of SC/ST respondents. On the other hand, 24.7% of respondents who reported eating barely twice as much as usual belonged to the SC/ST caste followed by 24.3% of general caste respondents and only 9.8% of OBC respondents. Food consumption was about three times the average among respondents from the SC/ST caste group (6.5%), general caste (2.4%), and OBC (1.3%). A statistically significant difference existed between the respondents' caste group and their daily meal frequency ($P<0.001$).

Inclusion of salad in their meal

A total of 65% of respondents included salad in their meals at least sometimes, 26.2% never included it, and just 8.8% included it regularly. A maximum of 73.4% of the OBC caste group sometimes included salad in their lunch, followed by 66.6% of the general caste group and only 36.4% of the SC/ST caste group, respectively. While a maximum of 61% of SC/ST caste members never included salad in their meals, only 18.4% of OBC caste members and 16.7% of general caste members did the same. There was a significantly significant correlation between respondents' inclusion of salad in their meals and their caste group ($P<0.001$).

Addiction Habit

It was clear from the table no. 3 that maximum of 371(92.7%) respondents had not any addiction habit, of which 97.4% belonged to the general caste group, 93.5% were OBC, and 85.7% were SC/ST caste group. The table also shows that 22 (5.5%) respondent's addiction habit was occasional while 7(1.8%) respondent's addiction habit was daily. There was a significant difference found between respondent's various caste group and their addiction habits ($P<0.05$).

Doing fast

It was observed that out of total of 400 respondents, maximum of 349 respondents were keeping fast occasionally, of which 79.5% were general, 89.8% were OBC and 87% were SC/ST caste group while 28 respondents were never keep any fast, 11 respondents used to have fasting monthly and 12 respondents were keeping fast weekly. There was also significant correlation found between respondents various caste group and their fasting habit ($P<0.01$).

Intake of fast food

It was found that out of total 400 respondents, maximum 149 (37.2%) respondents were take fast food occasionally in which 51.9% were SC/ST, 38.4% were OBC and 19.2% were belonged to general caste group. Besides it, 139 (34.8%) respondents fast food intake was weekly in which maximum respondents were general (43.6%) while 80 (20%) respondents fast food intake was monthly. While 32(8%) respondents never take any fast food, 14.1% of them were general caste group, 6.9% were OBC and 5.2% were SC/ST caste group. There exists a significant correlation between respondents various caste group and their fast food intake ($P<0.01$).

Above table depicts about the average BMI status of the respondents with respect to their food habits, meal frequency and inclusion of salad, fast food intake, addiction habit and fast practices. It was clear from the table that:

Food habits

Highest mean score was found by non-vegetarian group (23.99) and other similar mean score was 23.76 by vegetarian and 22.94 by Eggetarian respectively. There was insignificant difference found between respondent's food habit and their average BMI.

Frequency of meal

There was no significant difference found between respondent's food frequency and their mean BMI level. Highest mean score 24.16 was found by those respondents who take their meal two times in a day while minimum mean score 22.66 was found by those respondents which food frequency was more than three times.

Inclusion of salad

Respondents, who take salad some times in their meals, average BMI was found highest with 24.25 score. Apart from this, minimum average 23.87 was observed by those respondents who never consume salad in their meal. There was insignificant difference found between respondent’s salad intake and their average BMI status.

Intake of fast food

No significant difference was found between respondent’s fast food intake and their average BMI status. Maximum average BMI 44.24 incorporated with those respondents which fast food intake was monthly while minimum average was found by those respondents who consumed fast food occasionally with 23.30 mean score.

Addiction habit

Maximum average BMI (24.04) was found by never addicted respondents as well as other mean score

22.87 found by addicted respondents. There was statistically insignificant difference found among respondent's addiction habit and their average BMI.

Doing fast

Respondents, who used to have fasting weekly, their average BMI found highest (25.41) while, who were keeping fast monthly, their mean BMI was 24.30 and similarly 23.96 mean score was also found in those respondents, who used to have sometimes respectively. Besides it, minimum average BMI 22.40 was found in those respondents who never used to have fasting. There was no significant difference between respondents average BMI and their fasting habit.

Table no. 5 represent about the respondents food consumption pattern distribution which was based on the categorization of daily, weekly, monthly, sometimes and never. It was observed that:

In Cereals

Wheat

All of the respondents (100%) consumed wheat's flour daily in their diet.

Rice

Out of total 400 respondents, 93.1% respondents consumed rice daily, while 4.2% respondents consumed sometimes, 2% consumed weekly and 0.5% never consumed rice in their diet respectively.

In pulses and legumes

Maximum 61.2% respondents included pulses and legumes like Arhar, chana, matar, masoor, urad etc. daily in their diet, 33.8% of them took weekly while 5% of them included monthly in the diet.

In Vegetables

Green leafy vegetables

Out of total 400 respondents, maximum 49.8% respondents consumed green leafy vegetables (like spinach, Bathuaa saag, green gram-pea saag, radish leaves, cabbage etc.) sometimes, 29.7% of them weekly, 13.5% monthly, and 5.2% daily respectively. 1.8% of them never included green leafy vegetables in their diet.

Other vegetables

Maximum 57.6% of the respondents consumed other vegetables like cauliflower, brinjal, ladyfinger, parwal, sweet gourd, bitter gourd, jack fruit, tomato, pumpkin, drum stick etc. weekly in their diet, 29.2% of them included daily and 13.2 % included sometimes in their meal.

Table.1 Distribution of respondents according to their level of BMI status

BMI Classification (kg/m^2)	No.	%
Underweight (<18.5)	39	9.7
Normal (18.5-24.9)	213	53.2
Overweight (25.0-29.9)	108	27.1
Obese class I (30.0-34.9)	33	8.2
Obese class II (35.0-39.9)	07	1.8
Obese class III (>40.0)	-	-
Total	**400**	**100.0**

Source: WHO classification of BMI 1995, 2000 and 2004

Table.2 Distribution of respondents based on their dietary habits, dietary intake frequency, and consumption of salad

Food Habit	Caste group							
	General		OBC		SC/ST		Total	
	No.	%	No.	%	No.	%	No.	%
Vegetarian	31	39.8	62	45.3	04	5.2	97	24.2
Non vegetarian	44	56.4	180	73.5	69	89.6	293	73.3
Eggetarian	03	3.8	03	1.2	04	5.2	10	2.5
Total	**78**	**100.0**	**245**	**100.0**	**77**	**100.0**	**400**	**100.0**
χ^2= 29.60, df= 4, P<0.001								
Frequency of food intake/day								
Two times	19	24.3	24	9.8	19	24.7	62	15.5
Three times	58	74.4	215	87.8	53	68.8	326	81.5
More than three times	01	1.3	06	2.4	03	6.5	12	3.0
χ^2= 20.60, df= 4, P<0.001								
Inclusion of salad in their meal								
Daily	13	16.7	20	8.2	02	2.6	35	8.8
Sometimes	52	66.6	180	73.4	28	36.4	260	65.0
Never	13	16.7	45	18.4	47	61.0	105	26.2
χ^2= 65.50, df= 4, P<0.001								

Fig.1 Respondent's BMI Status

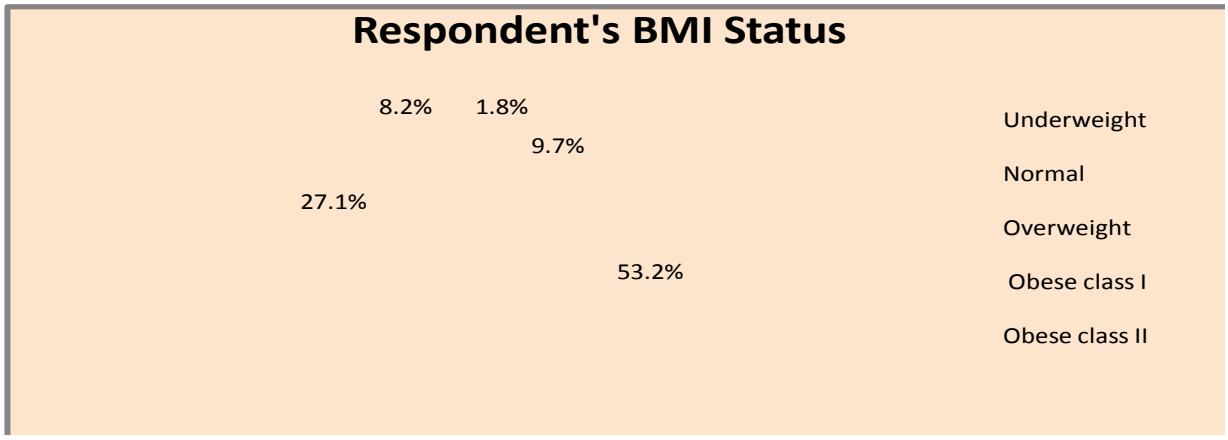


Table.3 Caste-wise distribution of respondents based on addiction habits, doing fast, and intake of fast food materials

Addiction Habit	Caste group							
	General		OBC		SC/ST		Total	
	No.	%	No.	%	No.	%	No.	%
Yes	00	0.0	06	2.4	01	1.3	07	1.8
Sometimes	02	2.6	10	4.1	10	13.0	22	5.5
Never	76	97.4	229	93.5	66	85.7	371	92.7
Total	**78**	**100.0**	**245**	**100.0**	**77**	**100.0**	**400**	**100.0**
χ^2= 12.71, df= 4, P<0.05								
Doing fast								
Weekly	06	7.7	05	2.0	01	1.3	12	3.0
Monthly	05	6.4	06	2.5	00	0.0	11	2.8
Sometimes	62	79.5	220	89.8	67	87.0	349	87.2
Never	05	6.4	14	5.7	09	11.7	28	7.0
χ^2= 16.98, df= 6, P<0.01								
Intake of fast food								
Weekly	34	43.6	84	34.3	21	27.3	139	34.8
Monthly	18	23.1	50	20.4	12	15.6	80	20.0
Sometimes	15	19.2	94	38.4	40	51.9	149	37.2
Never	11	14.1	17	6.9	04	5.2	32	8.0
χ^2= 20.23, df= 6, P<0.01								

Fig.2 Respondent's Food Habits

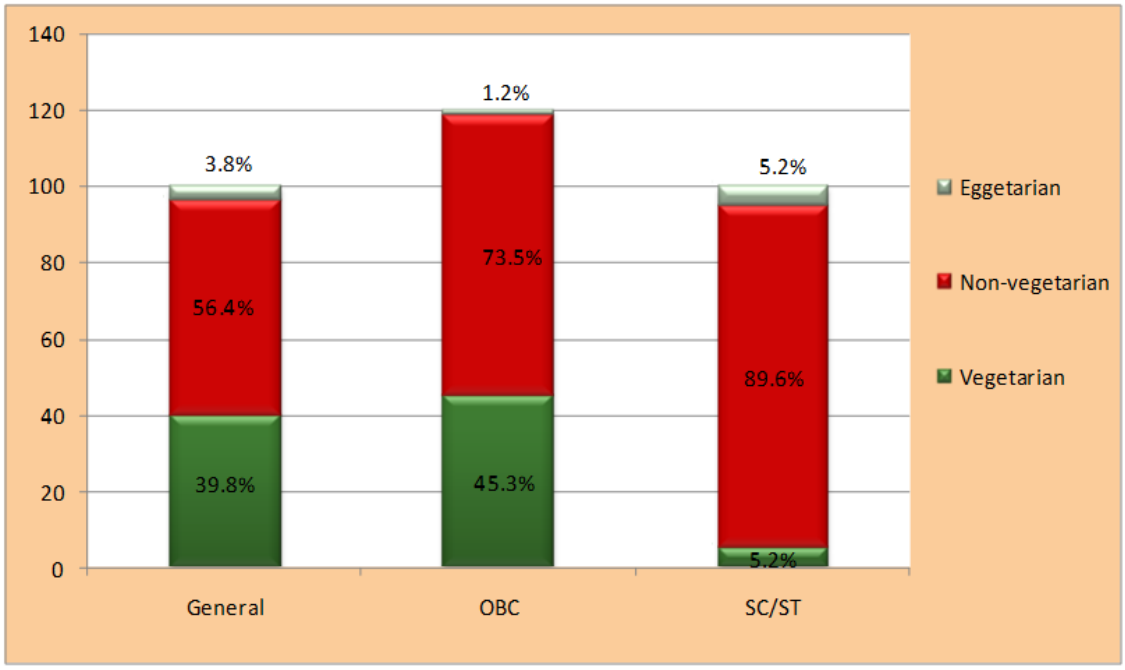


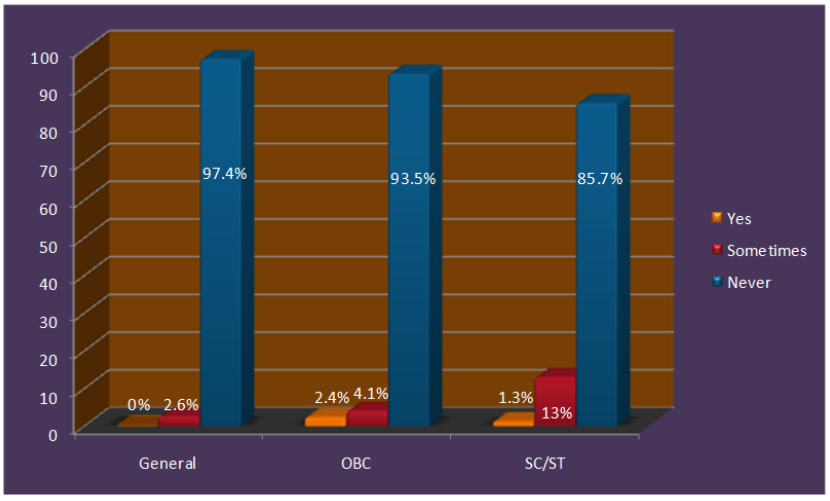
Table.4 Average BMI status of respondents according to their food habit, frequency of food intake, inclusion of salad and fast food items as well as drug addiction and fast practices

Food Habits	BMI status			
	No.	**Mean**	**SD**	**Statistical Test**
Vegetarian	97	23.76	4.17	F= 0.33, P>0.05
Non vegetarian	293	23.99	4.70	
Eggetarian	10	22.94	3.81	
Total	**400**	**23.91**	**4.55**	
Frequency of meal				
Two times	62	24.16	4.94	F= 0.55, P>0.05
Three times	326	23.91	4.49	
More than three times	12	22.66	4.22	
Inclusion of salad				
Daily	35	23.87	3.96	F= 2.50, P>0.05
Sometimes	260	24.25	4.58	
Never	105	23.08	4.61	
Intake of fast food				
Weekly	139	24.41	4.41	F= 1.63, P>0.05
Monthly	80	44.24	5.01	
Sometimes	149	23.30	4.30	
Never	32	23.74	4.98	
Addiction habit				
Yes	07	22.87	5.03	F= 2.11, P>0.05
Sometimes	22	22.08	4.08	
Never	371	24.04	4.56	
Doing fast				
Weekly	12	25.41	3.06	F= 1.51, P>0.05
Monthly	11	24.30	5.15	
Sometimes	349	23.96	4.50	
Never	28	22.40	5.35	

Table.5 Distribution of respondents according to their various type of food consumption pattern

Food items	Food consumption pattern									
	Daily		Weekly		Monthly		Sometimes		Never	
	No.	%	No.	%	No.	%	No.	%	No.	%
Cereals										
Wheat	400	100.0	-	-	-	-	-	-	-	-
Rice	372	93.1	08	2.0	01	0.2	17	4.2	02	0.5
Pulses and legumes	245	61.2	135	33.8	20	5.0	-	-	-	-
Vegetables										
Green leafy vegetables	21	5.2	119	29.7	54	13.5	199	49.8	07	1.8
Other vegetables	117	29.2	230	57.6	-	-	53	13.2	-	-
Roots and tubers	272	68.0	114	28.5	01	0.2	13	3.3	-	-
Fruits	75	18.8	108	27.0	39	9.7	170	42.5	08	2.0
Milk / Milk Products	197	49.2	31	7.8	09	2.2	103	25.8	60	15.0
Non-Veg food										
Egg	05	1.3	166	41.5	76	19.0	56	14.0	97	24.2
Fish	-	-	83	20.7	134	33.5	76	19.0	107	26.8
Meat	-	-	68	17.0	147	36.7	78	19.5	107	26.8
Cooking medium										
Mustard oil	400	100.0	-	-	-	-	-	-	-	-
Ghee/Refine oil	14	3.5	155	38.8	33	8.2	174	43.5	24	6.0
Sugar and jaggery	95	23.8	130	32.5	07	1.8	159	39.7	09	2.2
Tea	325	81.2	03	0.8	-	-	42	10.5	30	7.5

Fig.3 Respondent's Addiction Habit



Roots and tubers

Out of total 400 respondents, 68% of them consumed roots and tubers (like potato, radish, onion, carrot etc.) daily, 28.5% of them weekly, 3.3% sometimes, and 0.2% monthly in their meal respectively.

In Fruits

Maximum 42.5% of the respondents consumed fruits sometimes, 27% of them weekly, 18.8% of them daily, and 9.7 % of them monthly in their diet while 2% of them did not consume fruits in their diet.

In Milk/Milk product

Out of the total respondents, 49.2% of them included milk and milk products like paneer, curd, butter milk, lassi, khoa etc. daily in their meal. 25.8% of them sometimes while 15 % of them never included milk and milk products in their meal.

Non-veg food

Egg

Maximum 41.5% respondents included egg weekly in their diet, 19 % of them included monthly, 14% respondents included sometimes and 1.3% of them included daily. In spite of these, 24.2% respondents never included egg in their diet.

Fish

Out of total 400 respondents, maximum 33.5% respondent monthly included fish in their diet, 20.7 % respondents weekly, 19% respondents sometimes while 26.8% respondents never included fish in their meal.

Meat

Maximum 36.7% respondents included meat monthly, 19.5% respondents included sometimes, 17% respondents included weekly in their meal while 26.8% respondents never include meat in their meal.

Cooking medium

Mustard oil

All of the total respondents 400(100%) used to cook their food in mustard oil daily.

Ghee/Refine oil

Out of the total respondents, maximum 43.5% of them included ghee/refine oil sometimes in their diet, 38.8% of them consumed weekly, 8.2% of them consumed monthly and 3.5% of them consumed daily while 6% of them never included ghee/refine oil in their diet.

Sugar and jaggery

Maximum 39.7% of the respondents consumed sugar and jaggery sometimes, 32.5% respondents consumed weekly, 23.8% respondents consumed daily while 1.8% respondents consumed monthly and 2.2% respondents consumed never in their diet.

Tea

Maximum 81.2% respondent consumed tea daily, 10.5% respondent consumed sometimes while 7.5 % respondent never consumed it.

The present study shows the prevalence of obesity in the arsenic affected areas. Out of total respondents, 37.1% respondent’s BMI found high with comparison to normal BMI. As a result of India's increased integration into global food markets, unhealthy, processed foods are now considerably more available.

The average calorie consumption per person in middle-class and high-income households is rising as a result of this and rising middle-class incomes (Gulati & Misra, 2017). Obesity or an elevated BMI

may have a significant role in illness vulnerability. Excess weight is the factor of different types of diseases like cardiovascular disease, hypertension, diabetes and more other chronic diseases. Diabetes, lung, and kidney-related problems, cardiovascular diseases, and many others problems are also associated with long term exposure of arsenic (World health organization, 2022).

Women should be educated about their healthy diet and various aspects of health and nutrition which could be helpful in reducing the risk factors of Arsenicosis and obesity. Some literature shows that there is limited clear evidence that arsenic directly contributes to human obesity. Even though, the impact of obesity as a moderator of arsenic-induced disease is still poorly understood and will require further investigation. More research and more attention to obesity in arsenic regulation could have a big effect on reducing diseases caused by arsenic.

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