Section: Maternal

Original Research Article

EVALUATION OF A CAMPAIGN ON MILLET INTAKE EDUCATION (MILLIE) THROUGH PRE- AND POST-TEST ASSESSMENTS ACROSS 15 DISTRICTS OF INDIA

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ABSTRACT

Background: Despite their nutritional and environmental benefits, millet consumption has declined. Millets are nutrient-dense with a low glycaemic index, yet awareness and consumption practices remain limited. This study evaluated the impact of a community-based education intervention on improving knowledge, attitudes, and practices related to millet consumption among adults, pregnant women, and lactating mothers across 15 districts.

Materials and Methods: We used a pre-post-test study design using structured questionnaires administered before and after a two-month intervention. The study covered 80 randomly selected villages/slums across 15 districts. Five key intervention components included role plays and education sessions, stakeholder meetings, and recipe demonstrations. A total of 1,582 and 1,504 participants were surveyed during the pre-test and the post-test, respectively. Linear and logistic regression analyses were used to find the association between predictors (age, sex, pre-post stage, education status, and family income) and outcomes (total knowledge score, attitude score, and consumption of millets). Association expressed as beta coefficients or adjusted Odds Ratios (aOR) and 95% Confidence Intervals (CIs).

Results: The median (Interquartile Range) age of the participants was 32 (25-40) and 34 (26-42) years in pre-and post-test, respectively. The findings indicated an average 25-percent point increase in awareness and a 6-point increase in the positive attitude toward the health benefits of millets. Pearl Millet and Sorghum consumed the most. Millet consumption significantly increased post-intervention (aOR: 1.12; 95% CI: 0.96–1.29; $p < 0.001$).

Conclusion: The intervention successfully improved knowledge and consumption of millets. Continued community-based nutrition education can sustain the consumption of millets.

Keywords: Nutrition; Dietary; Non-communicable Diseases; Millets, Food Security.

INTRODUCTION

An alarming increase in the prevalence of non-communicable disease is noted globally. Non-communicable diseases, such as diabetes, cardiovascular diseases, cancers, etc., account for 75% of non-pandemic deaths globally, and 82% of the premature deaths due to non-communicable diseases occur in low- and middle-income countries. [1] Similarly, non-communicable diseases account for 60% of deaths in India.[2] Other lifestyle disorders, such as chronic constipation, equally contribute to a reduced quality of life. Most lifestyle disorders or non-communicable diseases are linked to poor dietary habits, including reduced fiber and calorie-rich food intake.[3]

Traditional grains like millets have gained momentum recently for their crucial role in preventing diseases and promoting health. Millets are rich in nutrients like essential amino acids, phenolic compounds, fiber, and micronutrients, such as iron, zinc, and magnesium.[4] Millets help regulate gut motility, bowel regularity, stool frequency, and promote microbiota diversity, thereby prevent constipation, and reduce the risk of colon cancer and inflammatory bowel diseases.[5] Millets have low glycaemic index and prevent spike in post-prandial blood glucose levels. Hence, millets are found useful in dietary management of type 2 diabetes mellitus.[6] There is empirical evidence on the cardio protective effect of millets by reducing oxidative stress, inflammation, and dyslipidaemia. Millets contain potential antioxidants, such as polyphenols and flavonoids, that help reduce the risk of cancers and chronic inflammation.[7] Furthermore, millets have proved beneficial in controlling blood pressure and reducing the incidence of hypertension in population-based studies.[8] The consumption of millets induces satiety and is evidenced to control weight gain, obesity, and the related non-communicable diseases.[9]

Beyond their nutritional benefits, millets are climate-resilient crops and adaptable to diverse conditions. They are naturally pest-resistant and can grow well in dry areas with poor soil. Their ability to grow with minimal water and fertilizer makes them environmentally well-suited.[10] In the context of climate change, when food systems and farming must become more sustainable, these characteristics make millets an ideal crop. Furthermore, millet cultivation contributes to the livelihoods of smallholder farmers by offering a higher cost–benefit ratio and acting as insurance against crop failure in unfavourable weather conditions.[11] Thus, millets not only provide nutritional security but also food and economic security.[12]

India is one of the largest producers of millets worldwide; however, it has witnessed a decline in its consumption in recent years. Production and consumption of millets has declined significantly post Green Revolution due to policy preferences for rice and wheat under the Public Distribution System (PDS), increased urbanization causing limited time, lack of awareness among communities regarding its culinary art, and a perception towards it as a "poor man's food."[13-15] With the launch of the 'International Year of Millets in 2023, the government of India nudged the production and consumption of millets locally and globally.[16] The National Food Security Mission and initiatives by the governmental and non-governmental institutions, and civil society organizations have helped in generating awareness about millets on their benefits and consumption.[17]

However, the consumption of millets remains low in India due to multiple factors, including decreased availability, high costs, poor taste, and lack of awareness of their benefits.[18,19] We lack studies that have assessed different parameters on the reduced consumption of millets and a scientific evaluation of awareness programs. Hence, we decided to conduct an intervention that aimed to generate awareness and promote the consumption of millets among adults in India. The objective of the present study is to assess the change in knowledge, perceptions, and practices of adults about the use of millets in their daily routine after the intervention across 15 districts of India.

MATERIALS AND METHODS

Study design

It was a pre-and post-test quantitative study. We randomly selected the sample at the beginning of the campaign and then again at the end of the campaign, who had been a part of the campaign. It was not the same cohort.

Study area and Sampling

The campaign and study were conducted in selected districts as they were the intervention areas in Project Jagriti (Rajasthan (Hanumangarh and Dholpur), Uttar Pradesh (Kaushambi, Chitrakoot, Bahraich, Varanasi), Maharashtra (Nagpur), Odisha (Bolangir, Kalahandi), Himachal Pradesh (Chamba and Mandi), Delhi (East Delhi), Bihar (Jamui and Khagaria), and Jharkhand (Sahebganj). One block in each district was selected as they were the intervention block for the project. Furthermore, 8-10 villages out of 40 in each block were selected randomly where the campaign was conducted.

The total sample size was distributed across villages proportional to the population. In each village, adults > 20 years old were selected from the list available with the staff. From the list, the first adult was selected randomly and the subsequent ones using systematic random sampling. The 'kth' sample was obtained by dividing the total number of adults in each village, with the required sample size to study. Hence, after selecting the first adult, the subsequent 'kth' adult was selected until the required sample size was obtained. In case the identified household was found locked or the adult refused to grant approval, the subsequent number in the list was interviewed. Roughly an equal number of adults were selected per village. The same sampling strategy was followed at the post-test.

Study population

At pre-test:

Inclusion Criteria: Adults > 18 years old living in the area for the past 6 months

Exclusion Criteria: Those who did not provide consent for the survey or migrated from the area

At post-test:

Inclusion Criteria: Adults > 18 years who were living in the area for 6 months and had been a part of the Millet campaign (attended events)

Exclusion Criteria: Those who did not provide consent and did not attend the event.

Sample size

$n= ([Z_{crit} \sqrt{2p_3(1-p_3)} + Z_{pwr} \sqrt{(p_1(1-p_1)) + p_2(1-p_2)}]2)/D^2$

Where,

n = required sample size

P_1= Pre-study estimate of the knowledge of millets (calculated from the previous study)

P_2= Post-study estimate of the knowledge of millets (assumption)

$P_3= (p_1+p_2)/2$

$D= P_1-P_2$

t = confidence level at 95% (standard value of 1.96)

Z_{cr}it = 1.96; standard normal deviate corresponding to 95% significant criteria

Z_{pwr} = 0.842; standard normal deviate corresponding to 80% statistical power

P_1=80% and P_2 =95%

Therefore, the sample size was calculated at 75 per district. So, approx. 1500 subjects were surveyed before and after the intervention. The intervention included 1.5-2 months of the campaign on millet awareness generation.

Study Duration

The pre-test study was conducted for one month, followed by 1.5-2 months of the campaign, and then one month of post-test. The quality checks were done simultaneously (5% forms randomly checked).

Study Instrument

The study questionnaire (both pre-test and post-test) consisted of questions related to

- Socio-demographic indicators: name, age, gender, education, family income, and expenditure on food
- Awareness about millets and their benefits
- Attitude (Perceptions) towards millets and their benefits
- Consumption (Practices) of millets

There were five specific questions about awareness on millets, including whether they had heard of millets, whether millets help control non-communicable diseases, how nutritious millets are compared to other grains, whether millets can be grown on poor soils, and if millets are healthy for consumption**.** The responses to all the questions were either yes, no, or do not know, except for "how nutritious millets are." The responses to the latter were more nutritious, less nutritious, or equally nutritious. The responses to the first four questions were labelled 0 for no or do not know and 1 for yes. The scores of all four questions were summed up to calculate the total knowledge score, such that the maximum score could be 4 and the minimum score could be 0. The reliability coefficient (Cronbach's alpha) was 0.76 for this knowledge scale.

There were nine statements to assess the attitude (perceptions) towards millets. The attitude scale was a 6-item Likert-based scale with responses ranging from strongly agree, agree, neutral, can't say, to disagree and strongly disagree. Since all none statements were in the positive direction, the strongly agree and agree were labelled 2, neutral/can't say 1, and disagree or strongly disagree 0. The individual scores of all nine statements were summed up to calculate a total attitude score, such that the maximum score could be 18 and the minimum could be 0. The reliability coefficient (Cronbach's alpha) was 0.85 for this scale.

Likewise, we asked questions about the consumption of millets. We asked seven consumption-related questions, including if they consume millets, which millet varieties did they consume, in which dishes did they use millets, how frequently did they consume millets, for how long they consumed millets, where they purchased millets, and the reasons for not consuming millets.

About the campaign

A short campaign of 2 months was conducted to generate awareness on millets in the community. The campaign consisted of conducting education sessions on the benefits of millets, types of millets, millet recipes, micronutrients in the millets, the effectiveness of millets in diabetes and other non-communicable diseases. Showcasing recipe demonstration using millets by the trained nutritionist/dietician. Community-based events like role-plays or road shows in the communities to disseminate messages to women and men. Organizing stakeholder meetings on improving the use of millets in villages in various forms and promoting their growth and cultivation. We conducted nearly 30-40 events per district across all 15 intervention districts.

The education material pertaining to millets, their use, benefits, consumption, and recipes was developed using the Government of India guidelines. The messages were designed to impart messages that were easy to understand and in the local language. During the campaign, 490 recipe demonstration sessions were attended by 19,234 participants while the 550 role plays reached an impressive audience of 83,354. About 100 traditional folk dances were attended by 11155 participants in Odisha, depicting local enthusiasm. Moreover, 80 road shows attracted 2342 participants. In the end, we obtained feedback from 3100 participants from all the activities. The ethical was obtained from the Mamta Internal Ethical Review Board (MIRB/May-2023/004).

Statistical Analysis

The numerical data and categorical data were expressed as median (Interquartile Range; IQR) and frequency (percentage), respectively. The data were dichotomized into pre- and post-test. The data were normally distributed. Linear regression was used to find the association between the predictors (age, sex, pre-post stage, education status, and family income) and outcomes (total knowledge score and attitude score). The strength of association was expressed as a beta coefficient (β) and a 95% confidence interval (CI). The adjusted regression coefficient of determination (R^2) depicted the percentage variation in the outcome explained by the predictors in the model. Similarly, binomial logistic regression was used to find associations between the same predictors

and the consumption of millets (yes/no). The strength of association was expressed as an adjusted odd ratio (aOR) and 95% CI. A p-value <0.05 was considered a statistically significant value. All the analyses were performed in STATA (StataCorp. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC; 2019).

RESULTS

At the pre-test, there were 1582 adults, and at the post-test, there were 1504 adults (Table 1). Around two-thirds of the participants had heard of millet before the intervention, which increased to 95.5% after the campaign. There was a 42% increase in the percentage of people consuming millet at the post-test compared to the pre-test. Nearly 50% of participants at the pre-test and 47% at the post-test were not buying millets. Cost and unavailability were the main reasons for not buying millets.

There was an increase of 23.3% in the percentage of people consuming millets at the post-test compared to the pre-test (Table 2). Pearl millet was consumed mostly, followed by sorghum and proso millet, both at the pre- and post-test. Nearly 87% of participants at the post-test realised the health benefits of consuming millets compared to 58% at the pre-test. Around 10% increase in the consumption of millets can be attributed to the recent shift.

An increase of 24.3% for sorghum and 13.3% for pearl millets was noted in the percentage of population aware of the cultivation of millets near their area locally at the post-test compared to the pre-test (Fig 1). The percentage was nearly similar at pre- and post-test for the rest of the millets (proso millet, finger millet, foxtail, barnyard, little, and browntop). An average 6-point increase in the positive attitude toward the health benefits of millet was found (Table 3).

There was a 1.8-unit increase in the knowledge score post-test compared to the pre-test (β (95% CI); p-value: 1.80 (1.73, 1.87); <0.001) (Table 4). Similarly, there was a 4-unit increase in the attitude score post-test compared to the pre-test after adjusting for sex, age, education status, and family income. Lastly, there was a 1.12 odds increase in the consumption of millets post-test (aOR (95% CI); p-value: 1.12 (0.96, 1.29); <0.001) compared to the pre-test. The participants who had graduated and above had increased knowledge and attitude scores compared to those who were illiterates or could read and write. Likewise, an increase in knowledge and attitude scores was noted with increasing age. Out of 1504 participants at the post-test, 91% found the MILLIE campaign useful in raising awareness about millets and their benefits. The remaining 4.5% did not find the campaign useful, and 4.6% did not answer.

Table 1: Distribution of the socio-demographic indicators and knowledge about millets at the pre-test and post-test

Indicators	Pre-test (n=1582) N(%)	Post-test (n=1504) N(%)
Sex		
Men	789 (49.9)	696 (46.3)
Women	793 (50.1)	808 (53.7)
Age (years); Median (IQR)	32 (25, 40)	34 (26, 42)
Annual family income (Rs.), Median (IQR)	75000 (40000, 110000)	80000 (56000, 98000)
Monthly expenditure on food (Rs.), Median (IQR)	4000 (3000, 5000)	4000 (3000, 6000)
Education		
Illiterate or read and write	237 (15.0)	345 (22.9)
Primary (1^{st}-4^{th})	95 (6.0)	127 (8.4)
Middle (5^{th}-8^{th})	363 (22.9)	362 (24)
high school (9^{th} – 12^{th})	693 (43.8)	557 (37.0)
graduate and above	194 (12.2)	113 (7.5)
Heard of millets		
Yes	1041 (65.8)	1437 (95.5)
No	541 (34.2)	67 (4.5)
Millets control NCD		
Yes	670 (42.3)	1464 (97.3)
No	912 (57.6)	40 (2.7)
Millet nutritious than grains		
More healthy	632 (40)	1278 (85)
Less nutritious	125 (7.9)	18 (1.2)
Equally nutritious	321 (20.3)	204 (13.5)
Do not know	504 (31.8)	4 (0.3)
Millet can be grown on less nutritious soil		1145 (76.1)
Yes	375 (23.7)	359 (23.9)
No	1207 (76.3)	
Consumption of millets healthy		
Yes	852 (53.9)	1442 (95.9)
No	730 (46.1)	62 (4.1)
Can you buy millets from the market? 1.No, they are expensive and we cannot buy	458 (28.9)	394 (26.2)

2. Yes, we can buy them because they are cheap	540 (34.1)	571 (37.9)
3. Yes, we can buy them even if they are expensive/costlier	115 (7.3)	276 (18.3)
4. No, we don't buy them as they are not available in our area	256 (16.2)	207 (13.7)
5. No, we can buy but we don't want to buy them	86 (5.4)	55 (3.7)

Abbreviations: IQR: Interquartile Range; NCD: Non-Communicable Diseases

Table 2: Practices related to millet consumption and use at pre-and post-test

Indicators	Pre-test (n=1582) N(%)	Post-test (n=1504) N(%)
Do you consume millets?		
Yes	914 (57.8)	1220 (81.1)
No	668 (42.2)	284 (18.9)
Type of millets consumed		
Sorghum (yes%)	479 (52.4)	832 (68.2)
Proso Millet (Chena / Barri) (yes%)	431 (47.1)	353 (28.9)
Pearl Millet (Bajra) (yes%)	670 (73.3)	864 (70.8)
Foxtail Millet (Kakum / Kangni) (yes%)	17 (1.8)	21 (1.72)
Finger Millet (Ragi) (yes%) (yes%)	129 (14.1)	245 (20.08)
Browntop Millet (Korle) (yes%)	5 (0.5)	9 (0.74)
Barnyard Millet (Sanwa) (yes%)	2 (0.2)	1 (0.08)
Little Millet (Moraiyo) (yes%)	2 (0.2)	2 (0.16)
Reasons of millet consumption		
Health benefits	536 (58.64)	1058 (86.72)
Cultural significance	94 (10.28)	244 (20.0)
Taste	264 (28.9)	338 (27.7)
Availability	187 (20.45)	18 (10.5)
Millet-based dishes used		
Chapati	565 (61.8)	874 (71.6)
Laddoo	346 (37.8)	510 (41.8)
Ready to eat food like chocolate bar, snacks, etc.	135 (14.8)	125 (10.2)
Biscuits	176 (19.3)	162 (13.3)
Porridge (dalia)	433 (47.4)	761 (62.4)
Sweets (in any form)	55 (6.0)	145 (11.9)
Frequency of consumption of millets		
Often	180 (19.7)	100 (8.2)
Never	14 (1.5)	7 (0.6)
Sometimes	353 (38.6)	468 (38.3)
Once a week	230 (25.2)	287 (23.5)
Fortnightly	90 (9.85)	273 (22.4)
May be	47 (5.1)	85 (7.0)
Since how long you have been consuming millets?		
Since childhood	423 (46.3)	528 (43.3)
More than 6 Year	154 (16.8)	198 (16.2)
Between 0-2 Years	228 (24.9)	231 (18.9)
Since the Last One Year	109 (11.9)	263 (21.5)
From where do you purchase millets?		
Supermarket (yes%)	127 (13.9)	244 (20.0)
Healthy food store (yes%)	107 (11.7)	43 (3.5)
Online (yes%)	129 (14.1)	54 (4.4)
Farmers market (yes%)	353 (38.6)	648 (53.1)
Local shop near home (yes%)	605 (66.2)	843 (69.1)

Abbreviations: IQR: Interquartile Range

Table 3: Perception on the millet consumption during pre-and post-test among participants

Statements	Pre-Test (n= 1582) N(%)	Post-Test (n= 1504) N(%)
Millets are healthy for diabetic patients		
disagree	78 (4.9)	5 (0.5)
Cannot say	470 (29.7)	57 (3.8)
neutral	132 (8.3)	11 (0.7)
completely disagree	20 (1.3)	1 (0.1)
fully agree	227 (14.3)	606 (40.3)
Agree	655 (41.4)	824 (54.8)
Millets are good for women during pregnancy		
disagree	87 (5.5)	12 (0.8)
Cannot say	514 (32.5)	59 (3.9)

neutral	114 (7.2)	58 (3.9)
completely disagree	12 (0.8)	1 (0.1)
fully agree	211 (13.3)	549 (36.5)
Agree	644 (40.7)	825 (54.8)
Millets are rich in iron and calcium		
disagree	77 (4.9)	20 (1.3)
Cannot say	496 (31.4)	59 (3.9)
neutral	157 (9.8)	61 (4.1)
completely disagree	12 (0.8)	9 (0.6)
fully agree	223 (14.1)	515 (34.2)
Agree	617 (39)	840 (55.9)
You can make a variety of dishes from millet		
disagree	99 (6.3)	19 (1.3)
Cannot say	456 (28.7)	51 (3.4)
neutral	183 (11.6)	73 (4.8)
completely disagree	17 (1.1)	9 (0.6)
fully agree	163 (10.3)	477 (31.7)
Agree	664 (42.0)	875 (58.2)
Millets can easily mixed with common foods		
disagree	177 (11.2)	98 (6.5)
Cannot say	414 (26.2)	5 (0.3)
neutral	191 (12.1)	140 (9.3)
completely disagree	38 (2.4)	9 (0.6)
fully agree	153 (9.6)	439 (29.2)
Agree	609 (38.5)	813 (54.1)
Only one millet should be eaten at a time		
disagree	162 (10.2)	83 (5.5)
Cannot say	473 (29.9)	22 (1.5)
neutral	181 (11.4)	187 (12.4)
completely disagree	68 (4.3)	48 (3.2)
fully agree	145 (9.2)	400 (26.6)
Agree	553 (35.0)	764 (50.8)
Millets are costlier than rice/wheat		
disagree	174 (11.0)	120 (8.0)
Cannot say	469 (29.6)	62 (4.1)
neutral	136 (8.6)	95 (6.3)
completely disagree	78 (4.9)	28 (1.9)
fully agree	158 (10.0)	395 (26.3)
Agree	567 (35.9)	804 (53.4)
Millets contain more fibre than many staple grains		
disagree	149 (9.4)	23 (1.5)
Cannot say	588 (37.2)	94 (6.3)
neutral	209 (13.2)	73 (4.8)
completely disagree	29 (1.8)	65 (4.3)
fully agree	202 (12.8)	511 (34.0)
Agree	405 (25.6)	738 (49.1)
Millet prevents cancer		
disagree	184 (11.6)	43 (2.9)
Cannot say	666 (42.1)	158 (10.5)
neutral	177 (11.2)	79 (5.3)
completely disagree	53 (3.4)	39 (2.6)
fully agree	92 (5.8)	426 (28.3)
Agree	410 (25.9)	759 (50.4)
Attitude score; Median (IQR)	9 (12-15)	15 (18-18)

Abbreviations: IQR: Interquartile Range

Table 4: Linear and logistic regression analysis to explore associations between predictors and outcomes (knowledge score, attitude score, and consumption of millets)

Variable	Knowledge score[¥] β (95% CI); p-value	Attitude score[µ] β (95% CI); p-value	Consumption of millets[#] (Yes) aOR (95%CI)
Education			
1st-4th std	0.01 (-0.14, 0.17); 0.87	-0.38 (-0.88, 0.12); 0.14	**0.65 (0.24, 1.05); 0.002**
5th-8th std	0.01 (-0.09, 0.13); 0.76	**-0.49 (-0.85, -0.13);0.007**	**-0.32 (-0.58, -0.07),0.010**
9th -12th std	**0.27 (0.17, 0.38); <0.001**	-0.25 (-0.59, 0.08); 0.14	0.008 (-0.23, 0.25); 0.95
Graduation	**0.54 (0.39, 0.69); <0.001**	**0.85 (0.37, 1.33); <0.001**	-0.08 (-0.41, 0.25); 0.63
Illiterate and read write	*Reference*	*Reference*	*Reference*
Sex			
Women	0.004 (-0.07, 0.08); 0.92	0.001(-0.23, 0.23); 0.99	0.04 (-0.12, 0.20); 0.62
Men	*Reference*	*Reference*	*Reference*
Age (years)	**0.014 (0.011, 0.018); <0.001**	**0.02 (0.01, 0.03); <0.001**	-0.003 (-0.01, 0.004); 0.40
Annual family income (Rs.)	$-2.27*10^{-7}$ ($-5.38*10^{-7}$, $8.4*10^{-8}$); 0.15	**$1.13*10^{-6}$ ($1.48*10^{-7}$, $2.11*10^{-6}$); 0.024**	$4.46*10^{-8}$ ($-6.57*10^{-7}$, $7.47*10^{-7}$); 0.90
Pre-post			

Post test Pre-test	**1.80 (1.73, 1.87); <0.001** *Reference*	**3.97 (3.74, 4.20); <0.001** *Reference*	**1.12 (0.96, 1.29); <0.001** Reference

¥Adjusted R^2: 44.15%; ᵘAdjusted R^2: 28.4%; #No was the reference category

Abbreviations: β: Beta Coefficient; CI: Confidence Interval; aOR: Adjusted Odds Ratio; std: standard; Rs: Indian Rupees

p-value<0.05 was considered statistically significant value; statistically significant associations were highlighted in bold

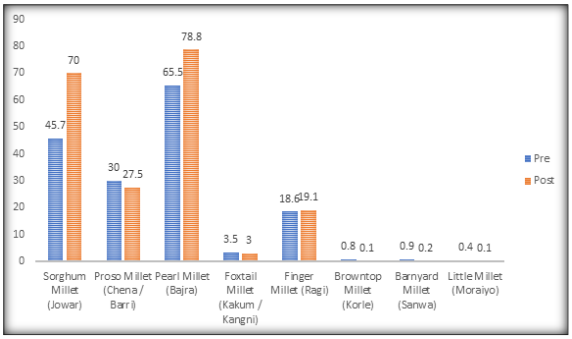

Figure 1: Percentage of adults informing if the different types of millets are grown in their areas before and after the intervention

*All figures are in percentages

DISCUSSION

The present study conducted a millet-based campaign comprising multiple interventions to generate awareness among adults in the community. We conducted a pre-post evaluation of the program across 15 districts of India. After the intervention, we concluded that the campaign helped in increasing the awareness of millets and their health benefits in preventing and managing non-communicable diseases, which improved significantly. There was an increase in millet awareness, with recognition of the term millets rising from 65.8% to 95.5% and its consumption rising from 57.8% to 81.1% post-intervention. The higher recognition of millets among young people might also be due to the increased marketing and promotions of millets in recent years using various platforms.[20] These findings suggest that community-based education strategies, when contextualized culturally, can be effective in promoting positive dietary change. Using locally relevant approaches, such as street plays in regional languages, folk songs and dances, and recipe demonstrations using seasonal and locally available ingredients.

The current study reported an increase in knowledge about the role of millets in controlling and managing non-communicable diseases such as diabetes, hypertension, and cancer from pre- to post-test, i.e., 42.4% to 97.3%. Similarly, a systematic review and meta-analysis suggested that incorporating millets into the diet can effectively manage hyperlipidaemia, hypertension, and obesity.[21] There was an increase in the perception towards millets, such as being more nutritious than other grains (increased from 39.9% to 85%) and requiring minimal external inputs for cultivation (increased from 23.7% to 76.1%), as reported in the study. These findings align with previous research that underscores positive perceptions of millets as being highly nutritious and beneficial for health.[22]

The current study reported an increase in the response of the participants citing "health benefits" as a reason for consuming millets (from 58.6% to 86.7%), followed by "cultural significance" (from 10.3% to 20%), post-intervention. In contrast, the proportion citing "availability" as a reason decreased, while "taste" remained unchanged. These shifts might be influenced by the seasonal and cultural changes in dietary choices. The findings align with previous evidence, where "suffering from health conditions (including diabetes, heart conditions, bone health, and general health)", "it is healthy", and "being traditional family food" were the key motivation factors for millet consumption.[20,23,24] The intervention also helped in decreasing the reasons for not consuming millets, including "non-availability" (from 37% to 3.5%), and "family members not eating" and "taste" as barriers came down to 0.4% from 22.8% and 26.9% respectively. Some previous studies reported "limited availability of millet-based products," "prevailing consumption norms," "not heard about millets," and "taste of millet" as barriers to millet consumption.[22,23,25]

The overall consumption of millets increased post-intervention. However, daily, and weekly consumption dropped from 19.7% to 8.2% and 25.2% to 23.5%, respectively, and fortnightly consumption rose from 9.8% to 22.4%. These changes may also be influenced by seasonal availability, festivals, or local practices. Research suggests that millet consumption was reported to be more frequent on a fortnightly and occasional basis.[24] The present study reported similar results on the frequency of the consumption of millets. The current study was implemented in 15 districts of 6 states and 1 Union Territory. According to a study, a few recipes are commonly used in communities to consume millets, including finger millet malt, millet chapattis/rotis, finger millet balls, and finger millet porridge.[20] Similarly, millets were most used in making rotis, porridge, and laddoos in the current study.

Our findings align with previous studies, which underscore the role of nutrition education and community-based interventions in encouraging the consumption of millets in the community. Evidence suggests that the behaviour change communication intervention conducted for three years through women's self-help groups resulted in better anthropometric outcomes, increased understanding, and better diets for mothers and children.[26]

Similarly, a previous study evaluated a community-based intervention that improved dietary diversity and nutrition knowledge among adolescents while simultaneously improving their dietary patterns and nutritional self-efficacy.[27] In our study, we also used digital media to generate awareness as part of the intervention among participants; however, there is limited evidence on the effectiveness of digital platforms in raising awareness regarding millets and encouraging their consumption.

Our results of the pre-test assessment are congruent with the findings by *Prashantha* et al. that reported a low prevalence of millet awareness among children (56.25%). Only one-fourth of the children were aware of sorghum, pearl millet, and finger millets.[28] Furthermore, the study found that among all the millets, sorghum is the most consumed, followed by pearl and finger millets. Most millets were consumed occasionally, except sorghum, and the consumption was poor in the urban areas compared to the rural areas.[28]

Similarly, Pathak et al. reported that only 30% of people consumed millets frequently, and awareness and consumption of millets are associated with each other. Cultural influences are the most common reasons for millet consumption, followed by health benefits and taste. Furthermore, the study stated that finger and pearl millets are commonly used millets. Three major factors highlighted by the study that affected millets' consumption included lower prices, increased availability, and awareness.[29]

Our results were contrary to the findings of a study by Rizwana et al. that reported a high prevalence of awareness of millets among women (80%) and their increased consumption (63%). This difference could be plausible due to higher education qualification and incomes of the study participants, as the study was conducted in urban Bangalore.[30]

A large-scale survey among 15,139 adults expressed a low level of awareness about millets (23%), perception that millets are healthy (40%), knowledge that millets are good for diabetes (12.5%), and awareness that millets are rich in iron and zinc (15-20%). Less than half of the participants consumed millets frequently. Reasons commonly identified for increased millet consumption were its health benefits, taste, weight loss, and low cost. Reasons that demotivated millet consumption included high prices, limited availability, taste dislikes, and cultural preferences.[31]

Another study revealed a high awareness about millets (62%). The majority (96.7%) of the respondents consumed millets in various forms, but frequent consumption of millets was done by only one-fourth of the participants (25%). Positive attitude, subjective norm, perceived behavior control, and pride significantly influenced the purchase intention of millet and millet food products.[32] Priya et al. suggested similar consumption patterns of millets. The study reported that participants had a positive attitude toward millet consumption. Participation suggested to share with them ready-to-cook and ready-to-eat value-added millet products, such as millet dosa batter, noodles, flakes, breads, and millet-based beverages. Furthermore, millets were reported to be affordable, and the income of the family was a major reason for their consumption.[33]

The strengths of our study lie in its multi-centric design, reducing the chances of bias due to a single geographical area or differential availability of food items. The use of culturally appropriate interventions with multiple touchpoints ensured better retention of messages. The interventions were offered to the larger community in addition to the study participants, which increased community ownership and participation. Moreover, feedback from the participants was also collected. However, the study's limitations include the short intervention period and reliance on self-reported responses, which could be affected by social desirability and recall bias. The study suggests that further research needs to be conducted to evaluate the intervention's long-term retention in dietary and behavioural changes. Also, the studies assessing the scalable strategies to improve knowledge, perception, and practices for millet consumption with a control group are recommended.

CONCLUSION

The intervention successfully improved knowledge and consumption of millet among women and their families. These findings suggest the need for continued nutrition education-based and community-based efforts focusing on promoting the consumption of millets using different behaviour change approaches. This approach can support better understanding and acceptance of health-promoting behaviours.

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