Original Article

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A Cross-sectional Study on Digital Health Approaches to Maternal Nutrition: Assessing the Role of mHealth Applications among Pregnant Women in Tamil Nadu, India

Nursing Section

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ABSTRACT

Introduction: Maternal nutrition is a key determinant of pregnancy outcomes and child health. Mobile health (mHealth) applications have emerged as supportive tools for improving nutritional awareness and dietary practices among pregnant women. However, evidence on their utilisation and association with nutritional outcomes in Tamil Nadu remains limited.

Aim: To assess the utilisation of mHealth applications and examine their association with nutritional awareness and dietary practices among pregnant women in a selected community in Chennai, Tamil Nadu.

Materials and Methods: A cross-sectional study was conducted among 158 pregnant women at Apollo College of Nursing maintains a formal collaboration with Kollumedu Primary Health Centre (PHC), Chennai, Tamil Nadu, from October 2023 to November 2023 using consecutive sampling. Data were collected using structured questionnaires and dietary checklists. Descriptive statistics (frequency, percentage, mean and standard deviation) and inferential statistics (Chi-square test) were applied using Statistical Package for the Social Sciences (SPSS), with statistical significance set at $p<0.05$.

Results: Among the participants, 108 (68.4%) possessed cell phones, whereas 56 (35.4%) indicated consistent utilisation of mHealth applications. Frequently utilised applications comprised mMitra 22 (13.9%), Pregnancy+ 18 (11.4%) and My Diet Coach 12 (7.6%). App users exhibited markedly greater nutritional awareness than non-users (40 (71.4%) vs 38 (37.2%), $p<0.001$), with a mean awareness score of 10.48±6.09 (out of 25). App users exhibited improved dietary patterns, characterised by increased consumption of protein-rich meals, fruits, vegetables and iodised salt. The average dietary practice score was 9.0±0.72 for individuals with healthy habits, compared to 6.4±0.88 for those with unhealthy practices. Nutritional parameters, including Body Mass Index (BMI) and haemoglobin levels, were markedly associated with mHealth utilisation. The educational status, number of antenatal visits and residential location were strongly associated with awareness and dietary habits ($p<0.05$).

Conclusion: Use of mHealth applications was significantly associated with higher nutritional awareness and enhanced dietary practices among pregnant women. Antenatal care services, combined with digital health tools, may serve as effective platforms for reinforcing maternal nutrition education.

Keywords: Dietary practices, Maternal nutrition, Mobile health application, Nutritional awareness, Pregnancy

INTRODUCTION

Nutritional status during pregnancy is a critical determinant of maternal and foetal health. Pregnancy imposes increased nutritional requirements to support physiological adaptations and foetal development. Inadequate maternal nutrition is associated with adverse outcomes such as maternal anaemia, preterm birth, low birth weight and intrauterine growth restriction [1]. Conversely, adequate and balanced nutrition contributes to optimal pregnancy outcomes, maternal well-being and healthy child growth. Despite ongoing public health efforts, maternal malnutrition-including undernutrition, micronutrient deficiencies and overnutrition remains a significant concern, particularly in low- and middle-income countries [1]. In Tamil Nadu, National Family Health Survey (NFHS-5) data indicate that 48% of pregnant women are anaemic and nearly one-fifth are underweight, underscoring the regional burden of pregnancy-specific malnutrition [2]. In India, maternal anaemia and suboptimal dietary practices continue to be prevalent, indicating gaps in nutritional awareness and adherence to recommended antenatal nutritional guidelines.

In recent years, mobile health (mHealth) technology has emerged as a potential approach to support health education and service delivery. mHealth refers to the use of mobile and wireless technologies to facilitate medical and public health practices. With increasing smartphone penetration, mHealth applications provide platforms for disseminating information on Antenatal Care (ANC), nutrition and supplementation. These applications may support improved awareness, self-monitoring and adherence to dietary recommendations during pregnancy [3]. Previous studies have reported associations between the use of mHealth tools and improved knowledge and self-care practices among pregnant women [4-6]. Mobile-based interventions such as voice messaging services (e.g., mMitra) deliver gestational age-specific information and have demonstrated potential in enhancing maternal health awareness in low-resource settings [7].

In India, digital health initiatives such as mMitra and Arogya Setu have demonstrated the feasibility of using mobile platforms for health communication [7,8]. However, evidence regarding the utilisation of mHealth applications and their association with nutritional awareness and dietary practices among pregnant women remains limited, particularly in Tamil Nadu. Most existing studies focus on intervention-based outcomes, whereas observational evidence is required to understand patterns of utilisation and associated factors in real-world settings [4,5].

Therefore, the present study aimed to assess the utilisation of mHealth applications and examine their association with nutritional awareness and dietary practices among pregnant women in a selected community in Chennai, Tamil Nadu. It is hypothesised that selected demographic and obstetrical variables may be associated with nutritional status,

level of awareness and dietary practices among pregnant mothers. Accordingly, the null hypotheses tested in the present study are that there is no significant association between selected demographic variables and nutritional status, level of awareness and dietary practices and that there is no significant association between selected obstetrical variables and these outcomes.

MATERIALS AND METHODS

A community-based cross-sectional study was conducted to assess the nutritional status, level of awareness and dietary practices among pregnant mothers. The study was carried out at Kollumedu Primary Health Centre (PHC), Chennai, Tamil Nadu, from October 2023 to November 2023. Kollumedu PHC is an upgraded centre catering to a population of approximately 2.5 lakh and includes four PHCs (three rural: Ayapakkam, Kathavur, Morai; and one urban: Thiruverkadu). The centre provides comprehensive maternal and child health services, including antenatal outpatient services, 24×7 delivery services, postnatal care, emergency lower segment caesarean section, puerperal sterilisation and other services such as non communicable disease clinic, dental clinic, Siddha services and tuberculosis care. Ethical approval was obtained from the Institutional Ethics Committee of Apollo College of Nursing, Chennai (Ref No: ACON/IEC/2025/08) and written informed consent was obtained from all participants.

Inclusion and Exclusion criteria: Pregnant women in their second and third trimesters attending the antenatal clinic, who owned mobile phones and were willing to participate, were included in the study. Women with high-risk pregnancies or co-morbid medical illnesses like gestational diabetes, pregnancy-induced hypertension and hypothyroidism were excluded, except for those with minor conditions such as nausea, vomiting and fatigue.

Sample size calculation: The sample size for the present study was calculated using the formula for estimation of proportion ($n = Z^2pq/d^2$). Based on preliminary observations and available literature, the prevalence of mHealth application usage among pregnant women was considered as 35.4% (p=0.354) [9], with q=0.646. At a 95% confidence level (Z=1.96), the base sample size was estimated as 138.

The absolute precision (d) was derived using the formula $d = Z\sqrt{(pq/n)}$, which yielded a value of approximately 0.076 (7.6%), indicating an acceptable level of precision for estimating utilisation and examining associations. To account for a potential non-response rate of 15%, the final sample size was adjusted to 158 participants.

Study Procedure

Study instruments and data collection: Data collection was undertaken using pretested and structured instruments developed through a review of existing literature and expert consultation, drawing on nutritional indicators reported in NFHS-5 for Tamil Nadu [2] and on antenatal dietary knowledge and practice items used in comparable Indian antenatal populations [10]. The tool was designed by the researcher and validated by experts in nursing and public health. The instruments were organised into three sections.

Section I: Demographic Questionnaire (9 items) captured age, educational status, nature of work, family type, area of residence, religion, monthly income, facility utilised for Maternal and Child Health (MCH) services and prior information on antenatal diet.

Section II: Obstetrical Data Form (7 items) included gravida, trimester, gestational age, pre-pregnancy BMI, number of antenatal visits, haemoglobin and vomiting during pregnancy.

Section III: Nutritional Assessment (8 items) covered food habits, history of craving for non edible substances (pica), avoidance of certain foods during pregnancy, dietary regimens followed, smartphone ownership, use of mHealth applications, commonly used apps and frequency of use, haemoglobin levels and dietary practices. Pre-pregnancy BMI was additionally recorded to assess baseline nutritional status.

The questionnaire on antenatal dietary awareness comprised 25 multiple-choice questions organised across five domains: calories (5 items), iron and folic acid (5 items), calcium (5 items), protein (5 items) and vitamins and minerals (5 items). Each correct response was awarded one mark, yielding a maximum score of 25. Awareness levels were categorised as adequate (>19/25=75-100%), moderately adequate (12.5 to 18/25=50-74%) and inadequate (<12.5/25=below 50%).

Dietary practices were assessed using a 10-item checklist evaluating meal frequency, intake of fruits, vegetables and protein-rich foods, fluid intake and related habits, scored dichotomously (Yes = 1, No = 0). A cut-off of ≥70% (score>7) was used to distinguish healthy from unhealthy dietary practices, consistent with standard scoring conventions in Knowledge, Attitude, and Practice (KAP) studies.

The instruments were developed specifically for this study, based on a review of the existing literature [2,10] and adapted to the local context. Content validity was established through expert evaluation, with a satisfactory overall Content Validity Index (CVI- 0.89) confirming the appropriateness of all included items. Reliability of the awareness questionnaire was assessed using the split-half method, yielding a Karl Pearson's correlation coefficient of r = 0.80; internal consistency was further confirmed by Cronbach's alpha ($\alpha = 0.82$), indicating good reliability. A pilot study was conducted among 20 pregnant mothers, who were subsequently excluded from the final sample, to assess feasibility and refine the instruments.

Data were collected through face-to-face interviews conducted in Tamil. Anthropometric measurements such as height and weight were recorded using standardised instruments and BMI was calculated as weight (kg)/height (m^2). Haemoglobin values were obtained from recent antenatal laboratory records.

STATISTICAL ANALYSIS

Data coding and analysis were performed using SPSS version 21. Descriptive statistics (frequency, percentage, mean and standard deviation) were used to summarise demographic variables, awareness scores and dietary practices. Inferential statistics, specifically the Chi-square test, were applied to examine associations between selected demographic and obstetrical variables with nutritional status, awareness and dietary practices. The association was examined only for selected demographic variables based on their theoretical relevance and evidence from previous literature indicating their influence on nutritional awareness and dietary practices among pregnant women. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 158 expectant mothers participated in the study. The majority were aged 21-30 years 124 (78.48%) and identified as Hindu 120 (75.94%), with most utilising PHC services 122 (77.21%) [Table/Fig-1]. Most of them 114 (72.15%) reside in rural areas and half of them live in joint families 79 (50%). Of the participants, 57 (36.07%) were graduates, while 96 (60.75%) had previously received information regarding prenatal diet, predominantly from nurses.

Obstetrical characteristics indicated that 104 (65.8%) were primigravidae, 97 (61.3%) were in the second trimester, 74 (46.83%) of the pregnant women were at a gestational age of less than or equal to 30 weeks, 128 (81%) experienced vomiting during the first trimester and 86 (54.43%) had attended less than seven antenatal visits [Table/Fig-2].

Concerning nutritional factors, over half of the pregnant women, 146 (92.4%), identified as non vegetarian; 75(47.5%) reported a history

Demographic variables	n (%)
Age in years	
<20 years	7 (4.43)
21 to 30	124 (78.48)
31 to 40	26 (16.45)
>40	1 (0.63)
Educational status	
No formal education	14 (9)
School education	76 (48)
Undergraduation	57 (36)
Postgraduation	11 (7)
Nature of work	
Mild	53 (33.54)
Moderate	88 (55.69)
Heavy	17 (10.75)
Religion	
Hindu	120 (76)
Christian	25 (16)
Muslim	13 (8)
Area of residence	
Rural	114 (72)
Semi urban	27 (17)
Urban	17 (11)
Type of family	
Nuclear	70 (44)
Joint	79 (50)
Extended	9 (6)
Income per month in Rs	
<15,000	98 (62)
>15,000	60 (38)
Facility visited for MCH Services during pregnancy	
Government Hospitals	31 (20)
PHC/UPHC	122 (77)
Maternity centres	5 (3)
Previous information on antenatal diet	
Yes	96 (61)
No	62 (39)

[Table/Fig-1]: Frequency and percentage distribution of demographic variables of pregnant mothers (N=158).
UPHC: Urban primary health centre

of cravings for non edible substances; fewer than half, 52 (32.9%), refrained from specific foods during pregnancy due to cultural beliefs; 128 (81.01%) did not adhere to any particular dietary regimen; 108 (68.4%) possessed smartphones, yet only 56 (35.4%) indicated regular utilisation of mHealth applications. The most frequently utilised applications were mMitra 22 (13.9%), Pregnancy+ 18 (11.4%) and My Diet Coach 12 (7.6%) [Table/Fig-3a].

The dietary practices were predominantly healthy, with 153 (96.8%) individuals consuming more than three meals daily, 154 (97.4%) partaking in nutritious snacks, 126 (79.7%) ingesting protein-rich foods, 155 (98.1%) incorporating fruits into their diet, 123 (77.8%) maintaining a habit of consuming fresh vegetables, 58 (36.7%) dining outside, 94.3% utilising iodised salt and 114 (72.1%) drinking 1000-2000 mL of fluids daily [Table/Fig-3b]. A total of 72.8% exhibited good dietary habits.

The nutritional status indicated that 77 individuals (48.73%) had a normal BMI, 45 individuals (28.48%) were classified as overweight and 19 individuals (12.02%) were categorised as obese. Haemoglobin levels were ≥11 g/dL in 80 (50.63%) of the subjects [Table/Fig-3c].

Obstetrical variables	n (%)
Gravida	
Primigravida	104 (65.8)
Multigravida	54 (34.17)
Trimester	
Second	97 (61.3)
Third	61 (38.6)
Gestational age in weeks	
<30 Weeks	74 (46.83)
>30 Weeks	84 (53.16)
Number of ANC visits for present pregnancy	
<7	86 (54.43)
>7	72 (45.56)
Vomiting during pregnancy	
First trimester	128 (81)
At present	30 (19)

[Table/Fig-2]: Frequency and percentage distribution of obstetrical variables of the pregnant mother (N=158).

Nutritional variables	n (%)
Food habits	
Vegetarian	10 (6.3)
Eggetarian	2 (1.26)
Non vegetarian	146 (92.4)
History of craving for non edible things?	
Yes	75 (47.5)
No	83 (52.5)
Do you avoid certain foods during pregnancy	
Yes	143 (90.5)
No	15 (9.5)
If yes, reason to avoid certain foods during pregnancy?	
Cultural belief	52 (32.9)
Religious belief	29 (18.34)
Makes fetus big	31 (19.62)
Others*	31 (19.62)
Do you follow any specific dietary regimen?	
Yes	30 (18.98)
No	128 (81.01)
Smartphone ownership	108 (68.4)
Regular mHealth app use	56 (35.4)
Common Apps	
mMitra	22 (13.9)
Pregnancy+	18 (11.4)
My diet coach	12 (7.6)
Others	4 (2.5)
Frequency(weekly)	56 (35.4)

[Table/Fig-3a]: Frequency and percentage distribution of nutritional variables of the pregnant mother (N=158).
*Others: Due to nausea, acid reflux and aversion during pregnancy

Dietary practices	n (%)	n (%)
How many times do you eat per day?	<3	>3
	5 (3.16)	153 (96.8)
	Yes	**No**
Do you have a habit of eating healthy snack?	154 (97.4)	4 (2.5)
Do you eat additional food?	86 (54.4)	72 (45.4)
Do you eat protein rich foods during current pregnancy?	126 (79.7)	32 (20.2)

Do you have the habit of eating fresh vegetable?	123 (77.8)	35 (22.1)
Do you have the habit of eating outside?	58 (36.7)	100 (63.29)
Do you consume fresh fruits, such as orange, lemon and mango?	155 (98.1)	3 (1.89)
Do you take animal source foods like meat, liver, milk?	146 (92.4)	12 (7.59)
Which type of salt you use in your food?	**Iodised salt**	**Not iodised salt**
	149 (94.3)	9 (5.6)
How much fluids do you drink per day?	**1000-2000mL**	**>2000mL**
	114 (72.1)	44 (27.8)
Total	>7	<7
	115 (72.78)	43 (27.21)

[Table/Fig-3b]: Frequency and percentage distribution of dietary practices of the pregnant mothers (N=158)

Variables	n (%)
Pre-pregnancy BMI in kg/m^2 (WHO Asian cut-offs)	
Underweight (<18.5)	17 (10.7)
Normal (18.5-22.9)	77 (48.73)
Overweight (23-27.49)	45 (28.48)
Obese (>27.5)	19 (12.02)
Hb in g/dL (third time of the visit)	
<11	78 (49.36)
≥11	80 (50.63)
Dietary practices	
Healthy practices	115 (72.78)
Unhealthy practices	43 (27.21)

[Table/Fig-3c]: Frequency and percentage distribution of nutritional status among pregnant mothers (N=158).

The average awareness score was 10.48±6.09 out of 25, with the highest knowledge in calcium (84%) and the lowest in iron/folic acid (17%) [Table/Fig-4a]. Half of them 78 (49.3%) of the individuals exhibited adequate awareness, 39 (24.68%) revealed moderate awareness and 41 (25.94%) showed needs improvement [Table/Fig-4b].

Components	Obtainable score	Obtained score		Mean	Mean±SD
		Min	Max		
Calories/Balanced diet	0-5	1	4	1.72	34.4±1.01
Iron/Folic acid supplement	0-5	1	4	0.85	17±1.95
Calcium	0-5	1	5	4.2	84±0.9
Protein	0-5	1	5	1.5	30±1.13
Vitamin and minerals	0-5	1	4	2.21	44.2±1.10
Total	25	5	22	10.48	41.8±6.09

[Table/Fig-4a]: Mean and standard deviation of awareness on antenatal diet among the pregnant mother (N=158)

Variables	n (%)
Adequate awareness	78 (49.36)
Moderate awareness	39 (24.68)
Needs improvement	41 (25.94)

[Table/Fig-4b]: Frequency and percentage distribution of overall level of awareness on antenatal diet among antenatal mother.

The association analysis revealed that monthly income (χ^2=4.98, p=0.02) and area of residence (χ^2=11.90, p=0.001) was significantly related to awareness of antenatal diet [Table/Fig-5a]. For dietary practices, age (<30 years) was significantly associated (χ^2=4.88, p=0.027), with younger mothers reporting healthier practices. Educational status (χ^2=3.95, p=0.046), area of residence (χ^2=15.82, p <0.001) and monthly income (χ^2=5.43, p=0.019) were also significantly associated with healthier practices [Table/Fig-5b].

Obstetrical variables showed that number of ANC visits was strongly associated with both awareness (χ^2=5.01, p=0.02) and dietary practices (χ^2=7.06, p=0.007). Vomiting during pregnancy was significantly associated with dietary practices (χ^2=99.03, p=0.001), indicating that physiological symptoms may hinder adherence to healthy diets. Haemoglobin levels were significantly associated with dietary practices (χ^2=7.72, p=0.005), with mothers having Hb ≥11 g/dL reporting healthier practices. Other variables such as gravida, BMI and trimester did not show significant associations (p>0.05) [Table/Fig-6a,b].

Demographic variables	Awareness*		χ^2 p-value
	Adequate awareness	Moderate awareness and needs improvement	
	n (%)	n (%)	
Age in years			
<30	64 (40.51)	66 (41.77)	0.005 0.94
>30	14 (8.86)	14 (8.86)	
Educational status			
School education	24 (15.18)	30 (18.98)	0.79 0.37
Graduation and above	54 (34.17)	50 (31.64)	
Nature of work			
Mild work	48 (30.38)	41 (25.95)	1.69 0.19
Moderate work	30 (18.99)	39 (24.68)	
Area of residence			
Urban	66 (41.8)	48 (30.38)	11.90* 0.001
Rural	12 (7.6)	32 (20.25)	
Monthly income in Rs			
≤15000	45 (28.48)	32 (20.25)	4.98* 0.02
>15000	33 (20.88)	48 (30.37)	

[Table/Fig-5a]: Association between the selected demographic variables and awareness of diet among pregnant mothers (N=158).

Demographic variables	Dietary practices		χ^2 p-value
	Unhealthy <7	Healthy >7	
	n (%)	n (%)	
Age in years			
<30 years	31 (19.62)	100 (63.29)	4.88*
>30 years	12 (7.59)	15 (9.49)	0.027
Educational status			
School study	30 (18.99)	60 (37.98)	3.95*
Graduation	13 (8.23)	55 (34.81)	0.046
Nature of work			
Mild	17 (10.76)	36 (22.78)	0.18
Moderate	26 (16.46)	79 (50.0)	0.673
Area of residence			
Urban	2 (1.27)	42 (26.58)	15.82*
Rural	41 (25.95)	73 (46.20)	<0.001
Monthly income in Rs			
<15000	33 (20.89)	65 (41.14)	5.43*
>15000	10 (6.33)	50 (31.65)	0.019

[Table/Fig-5b]: Association between selected demographic variables and dietary practices among pregnant mother (N=158).
*Statistically Significant at p<0.05

Obstetrical variables	Awareness		$\chi 2$ p-value
	Adequate awareness	Moderate awareness and needs improvement	
	n (%)	n (%)	
Gravida			
Primi	46 (29.12)	58 (36.71)	3.21 0.07
Multi	32 (20.25)	22 (13.92)	
BMI during pregnancy			
Under weight	8 (5.06)	9 (5.69)	0.04 0.84
Normal and obese	70 (44.30)	71 (44.94)	
Trimester			
Second	52 (32.91)	46 (29.11)	1.40 0.23
Third	26 (16.46)	34 (21.52)	
No of ANC visit			
<7	30 (18.99)	45 (28.48)	5.01* 0.02
>7	48 (30.38)	35 (22.15)	
Vomiting during pregnancy			
I trimester	57 (36.08)	66 (41.77)	2.03 0.15
II and III trimester	21 (13.29)	14 (8.86)	
Haemoglobin			
<11	34 (21.52)	34 (21.52)	0.01 0.88
≥11	44 (27.85)	46 (29.11)	

[Table/Fig-6a]: Association between obstetrical variables and awareness on diet among pregnant mothers (N=158).

Obstetric variables	Dietary practices		$\chi 2$ p-value
	Unhealthy <7	Healthy >7	
	n (%)	n (%)	
Gravida			
Primi	29 (18.35)	75 (47.47)	0.06
Multi	14 (8.86)	40 (25.32)	0.793
Pre-pregnancy BMI			
Underweight/Normal	23 (14.56)	71 (44.94)	0.88
Overweight/obese	20 (12.66)	44 (27.84)	0.347
Trimester			
Second	29 (18.35)	68 (43.04)	0.91
Third	14 (8.86)	47 (29.75)	0.33
No of ANC Visit			
<7	16 (10.13)	70 (44.30)	7.06*
>7	27 (17.09)	45 (28.48)	0.007
Vomiting during pregnancy			
I trimester	13 (8.23)	115 (72.78)	Fishers'-Exact <0.001
II and III trimester	30 (18.99)	0	
Haemoglobin			
<11	29 (18.35)	49 (31.01)	7.72*
≥11	14 (8.86)	66 (41.77)	0.005

[Table/Fig-6b]: Association between the obstetrical variables and dietary practices among pregnant mother (N=158).

The association between mHealth application usage and nutritional outcomes is presented in [Table/Fig-7]. The analysis showed that app users had significantly higher awareness scores and healthier dietary practices compared to non-users ($p<0.05$). Nutritional indicators such as BMI and haemoglobin levels also demonstrated positive associations with mHealth usage, suggesting that women who regularly used apps were more likely to maintain normal BMI and adequate haemoglobin levels. These findings reinforce the role of digital tools in supporting maternal nutrition education and behaviour change.

Outcome	Users (n=56)	Non-users (n=102)	χ^2	p-value
Adequate awareness	40 (71.4%)	38 (37.2%)	14.2	<0.001
Healthy practices	48 (85.7%)	67 (65.7%)	6.8	0.009
Normal BMI	24 (41.07%)	53 (51.9%)	1.19	0.2735
Hb ≥11 g/dL	36 (64.3%)	44 (43.1%)	6.46	0.011

[Table/Fig-7]: Association between the mHealth users and nutritional outcomes among pregnant mothers (N=158).

DISCUSSION

The present study assessed the utilisation of mobile health (mHealth) applications and their association with nutritional awareness and dietary practices among antenatal mothers. The findings indicate that while a majority of participants owned smartphones (68.4%), only about one-third (35.4%) reported regular use of mHealth applications. This gap between access and utilisation has been reported in previous study, where digital tool adoption among pregnant women was influenced by awareness, usability and digital literacy rather than mere availability of smartphones [11].

In the current study, mHealth application usage was significantly associated with higher nutritional awareness. App users demonstrated better awareness scores compared to non-users, consistent with earlier research showing that mobile-based health education is associated with improved awareness of dietary requirements and supplementation practices among pregnant women [9,12]. However, despite this association, just over half of the sample (50.6%) fell into the moderate-awareness or needs-improvement categories overall and component-level scores show this gap was most pronounced for iron and folic acid supplementation, where mean awareness was only 17%, indicating a persistent, topic-specific gap in maternal nutrition education even among app users.

Dietary practices were also found to be significantly better among mHealth users, with higher intake of fruits, vegetables and protein-rich foods. Similar findings have been reported in studies where access to nutrition information through digital platforms was associated with improved dietary diversity and quality [13-15]. The observed association may be attributed to increased exposure to health messages, reminders and self-monitoring features provided by mHealth applications. Nevertheless, as the study design is cross-sectional, causality cannot be inferred.

The analysis of demographic and obstetrical variables highlighted the importance of education, area of residence, income and number of antenatal visits in shaping awareness and dietary practices. Mothers with higher education and better economic status demonstrated healthier behaviours, while repeated antenatal visits were strongly linked to improved knowledge and practices. Physiological factors such as haemoglobin levels and vomiting during pregnancy also influenced dietary practices, reflecting the interplay between health status and nutrition. These findings are consistent with existing evidence that greater utilisation of antenatal care services enhances maternal knowledge and health practices. Girotra S et al., based on NFHS-5 data, reported that adequate antenatal care utilisation was linked with better maternal knowledge and reduced pregnancy-related complications [16]. Similarly, Kesarwani P et al., highlighted that greater utilisation of antenatal care services facilitates improved maternal health practices, while socioeconomic barriers may limit awareness [17]. Clinic-based studies also support these observations; Kaur R et al., demonstrated that women with a higher number of antenatal visits had significantly better knowledge, attitudes and practices related to maternal health [18]. Comparable associations between antenatal care utilisation and maternal knowledge or practice have also been reported in other clinic- and community-based cohorts [19-21].

The present study found that mHealth users had significantly higher awareness regarding antenatal diet compared to non-users (71.4% vs 37.2%, p<0.001). This is supported by a systematic review by Sondaal AE et al., which demonstrated that mHealth interventions are associated with improved maternal health knowledge and health-seeking behaviours [6]. With regard to dietary practices, a higher proportion of mHealth users demonstrated healthy practices compared to non-users (85.7% vs 65.7%, p=0.009). This finding aligns with previous studies indicating that digital health interventions may support behavioural changes through reminders, personalised guidance and continuous engagement [6,22]. A study by Amoakoh-Coleman M et al., also reported that mobile-based interventions were associated with improved adherence to recommended dietary and antenatal practices [23]. The dietary practices strengthened in the present study, such as higher intake of protein-rich foods, fruits and iodised salt, may be attributed to increased exposure to nutritional information among app users.

Overall, the present study contributes to the growing evidence on the role of mHealth in maternal nutrition by providing community-based data from Tamil Nadu. While mHealth applications were found to be significantly associated with improved awareness and dietary practices, their utilisation remains limited. Integrating mHealth strategies with existing antenatal care services, while addressing socioeconomic barriers, may enhance maternal nutrition outcomes, particularly in resource-constrained settings. The study provides community-based evidence on mHealth utilisation and maternal nutrition using validated tools and includes both behavioural and clinical indicators (BMI and haemoglobin).

Limitation(s)

The cross-sectional design limits causal inference. The study was conducted in a single setting with consecutive sampling, which may affect generalisability. Self-reported data may introduce bias and variations in mHealth usage were not explored.

CONCLUSION(S)

The mHealth application use among antenatal mothers was moderate and showed significant association with higher nutritional awareness and better dietary practices. Improved nutritional indicators were also observed among app users. However, gaps in awareness persist, indicating the need to strengthen nutrition education through antenatal care. mHealth tools may support this process, but causal relationships require further study.

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