BMC Digital Health

RESEARCH

Open Access

An analysis of predictors and wealth-based inequality in internet use among women in India: aiming for better digital health outcomes

Rakesh Chandra[1*], Jeetendra Kumar Patel[2], Sonal Srivastava[3], Aditya Singh[4] and Saradiya Mukherjee[3]

Abstract

Background Digital health, aiming to boost healthcare accessibility, is an emerging concept in the domain of healthcare administration and delivery in developing countries. In India, according to the National Family Health Survey (NFHS-5), more than half (55%) of the men have reported ever using the internet, while only one-third (33%) of the women have done so. This gendered digital divide is further complicated and worsened by the fact that individuals in the lowest wealth quintile exhibit significantly lower internet usage rates, with only 9% of women and 26% of men. Such intersectionality of the gendered digital divide might prove a barrier to realizing the full potential of digital health in India. Eliminating digital inequalities in all forms and ensuring universal digitalization is essential for desired digital health outcomes.

Methods This study aims to explore India's readiness for digital health in terms of access to basic digital infrastructure, i.e., the internet. We analyze access to the Internet among Indian women of reproductive age using pan-India survey data from the fifth round of the National Family Health Survey (2019–21). We investigate predictors of Internet use in a regression model and apply the Erreygers Concentration Index (ECI) to examine inequalities in Internet access. Using decomposition analyses, we analyze factors contributing to digital inequality in terms of internet use.

Results Our inequality analysis based on the ECI [ECI- 0.4444 ($p < 0.001$)] suggests that a significant inequality exists in internet access. Furthermore, the decomposition analyses in the study find women's educational level to be the most prominent (28.19%) contributing factor to internet inequality, followed by wealth (25.67%), place of residence (23.16%), and caste (1.10%).

Recommendation We suggest a comprehensive readiness and need assessment, revamping of digital infrastructure, and moving with caution in implementing digital health innovation in the country as it may further exacerbate the existing healthcare access inequities.

Keywords Decomposition analysis, Digital health, Erreygers concentration index, India, Inequality analysis, Internet use

*Correspondence:
Rakesh Chandra
chandra.rakeysh@gmail.com; rakesh.chandra@tiss.edu
Full list of author information is available at the end of the article

Background

'Digital health', aiming to boost healthcare accessibility, is an emerging concept in the domain of healthcare administration and delivery in developing countries [1]. It refers to leveraging Information and Communication Technologies (ICTs) in medicine and health professions to address illnesses, manage health risks, and foster wellness [2]. ICT is an umbrella term encompassing diverse technological tools, devices, applications, and services used for creating, consuming, transmitting, communicating, storing, managing, and adding value to the information electronically [3]. ICT's potential role in unlocking the untapped value of digital health solutions in improving healthcare access, particularly in low-resource settings, is now well-recognized globally [1, 3]. Few studies suggest that internet usage has improved access to digital healthcare and has various benefits, including increased health knowledge, self-care abilities [4], and awareness [3]. In recent years, the proliferation of the internet has revolutionized various aspects of daily life, including communication, education, commerce, and healthcare. However, despite the increasing availability of internet services globally, significant inequalities persist in terms of access, adoption, and usage, particularly among marginalized and underserved populations [5, 6]. These inequalities of digital services, also referred to as the digital divide—-can be defined as systematic differences (based on socioeconomic, cultural, and other characteristics) between groups and regions in the opportunity, ability, and decisive to engage with digital systems for betterment [6]. The digital divide continues to prevail within and across nations, leading to uneven uptakes and adoption of digital goods and services [7]. It is widely acknowledged that the introduction of digital health can reduce the prevailing disparities in healthcare access [8]. However, inequalities in internet usage can further exacerbate or reproduce the inequalities [9] and might act as a never-ending barrier to harnessing the desired outcome, i.e., health equity and health for all [10, 11]. Thus, digital health inequality is now considered an emerging form of public health challenge [10–12]. Consequently, bridging the digital divide, which was initially dismissed as a luxury, has now gained widespread recognition [6].

In order to eliminate this divide, various structural factors such as low income/wealth index, residence in areas with poor digital infrastructure, and inadequate digital skills [12, 13], age, income, education, and family structure [14] have been identified as major demographic and social determinants of internet access and utilization. Gender differences in internet use are also evident in the form of the gendered digital divide [15, 16]. Notably, gender consistently emerges as a significant predictor of technology use patterns [16], comfort with technology [17], and engagement in various activities [18]. Globally, women are found to be 26% less likely to own smartphones, with even greater disparities observed in regions such as South Asia and Africa [19]. Women are often considered household saviors in terms of health due to their traditional roles as caregivers and nurturers [20]. Therefore, women's access to the internet and digital health services can be a significant next step in digital health goals. Although consistent efforts are being made to narrow the digital divide across countries, gender disparities in technology and internet use remain particularly pronounced in developing nations like India.

In India, the digital divide remains a pertinent issue. According to the National Family Health Survey (NFHS-5), more than half (55%) of the men have reported ever using the internet, while only one-third (33%) of the women have done so. This gendered digital divide is further complicated and worsened by the fact that individuals in the lowest wealth quintile exhibit significantly lower internet usage rates, with only 9% of women and 26% of men having access to the internet [21]. Such intersectionality of the gendered digital divide might prove a barrier to realizing the full potential of digital health in India. Eliminating digital inequalities in all forms and ensuring universal digitalization is essential for desired digital health outcomes.

Most of the available studies related to internet access and use in India are in the education domain, and from the perspective of health, they focus on the internet's effects on medical students [22–24], medical professionals [25, 26], and schools and college-going students including research scholars and faculty [27–29]. No national-level study attempts to understand the potential impact of inequality in internet access on the success of digital health in India. It is to be highlighted here that women play a key role in India's household health. Therefore, patterns of internet use among women will be crucial in the future digital health ecosystem. Although the digital divide and gendered digital inequality attract much attention, the intersectionality of such inequality and sub-group vulnerabilities of Indian women as potential consumers of digital health have not been studied in terms of unequal internet access and use. Through a series of analyses at the national level, this study aims to fill this gap in the literature and provide valuable insights for policymakers, healthcare providers, and stakeholders working towards promoting digital inclusion and digital health. To unravel digital inequality among Indian women, firstly, we present a descriptive analysis measuring the association between

various independent and outcome variables, i.e., use of the internet among women. Furthermore, we use a multinomial logistic regression model to identify the predictors of internet use among women. Secondly, using the Erreygers Concentration Index, we highlight inequality in internet use among women. Finally, a decomposition analysis is performed to discover the contributing factors (women's characteristics) in the identified inequality.

Methods

Data source and sample selection

This study utilizes data collected during the fifth round of the National Family Health Survey (NFHS-5), conducted from 2019 to 2021. The NFHS is a comprehensive and nationally representative survey that collects data on various demographic, socioeconomic, health, and family planning-related variables. Its purpose is to aid policymakers and program managers in establishing benchmarks and monitoring progress over time in India's health sector [21]. From a total of 724,115 interviewed women, our sample encompasses 108,785 women selected within the state module, where the 'internet use' inquiry was administered.

Variables

The study's dependent variable is 'internet use' extracted from the NFHS-5 question, which was asked to respondents during the survey: "Have you ever used the internet?". Responses were 'yes' or 'no,' coded as 1 and 0, respectively. Based on a few important pieces of literature [6, 12, 14–16], various socioeconomic and demographic factors are taken as independent variables in this study. Women's age group, place of residence, the highest level of education, current marital status, religion, caste categories, women's working status, and household wealth index were selected as the independent variables. Table 1 shows the description and coding of each independent variable used in the study.

Statistical analysis

The study employed a sequence of statistical analyses as outlined below:

1) *Two-way table with measures of association*

To examine the relationship between the dependent and independent variables, which are both categorical, Pearson's chi-square test was employed. This statistical test assessed the association between background and outcome variables. Its purpose was to summarize the data and determine the statistical significance of the background variables in relation to the outcome variable. Additionally, this test assisted in identifying variables that were not statistically relevant and, therefore, could be eliminated from subsequent statistical analyses.

2) *Logistic Regression for the binary outcome variable*

A multinomial logistic regression model was applied since the outcome variable is dichotomous, viz., the use of internet responses as 'Yes' or 'No' to describe the effects of each predictor on the outcome variable. The Binary Logistic model can be described as the following equation;

Table 1 Description of independent variables

Variable	Description	Coding
Age Group	Respondents aged from 15 to 49 years were grouped into four categories.	1 = 15–19 years (Teenage), 2 = 20–29 years (Twenties), 3 = 30–39 years (Thirties), 4 = 40–49 years (Forties)
Place of Residence	The type of place of residence where the respondent lives.	1 = Urban, 2 = Rural
Education	The highest level of education obtained by the respondent.	0 = No education, 1 = Primary, 2 = Secondary, 3 = Higher
Marital status	The current marital status of the respondent.	0 = Never in union (including married without *Gauna*), 1 = Married, 2 = Widowed, 3 = Divorced, 4 = Separated
Religion	The religious affiliation of the respondent.	1 = Hindu, 2 = Muslim, 3 = Christian 4 = Sikh, 5 = Other
Social group/ Caste	The social class/ caste category of the respondent.	1 = Scheduled Caste (SC), 2 = Scheduled Tribe (ST), 3 = Other Backward Caste (OBC), 4 = General/Other
Working Status	Whether the respondent has/had been working in the last 12 months	0 = No, 1 = Yes
Wealth Index	The wealth index of the respondent's household	1 = Poorest, 2 = Poorer, 3 = Middle, 4 = Richer 5 = Richest

$$Logit\ (\mathrm{Y}) = \ln\left(\frac{\pi}{1-\pi}\right) = \alpha + (\beta 1\ \mathrm{X1} + \beta 2\ \mathrm{X2} + \ldots\ldots + \beta \mathrm{n}\ \mathrm{Xn}\ ) + \varepsilon \quad (1)$$

Where **Y** is the outcome variable of interest (Use of the Internet is 'Yes'), **π** is the probability of occurrence of the outcome variable. In this case, $\frac{\pi}{1-\pi}$ represents the odds ratio. Logit is the natural log (ln) of odds of Y (internet use). **α** is the Y-intercept, $\boldsymbol{\beta}_{\mathbf{n}}$ is the nth predictor's regression coefficient, $\mathbf{X}_{\mathbf{n}}$ is the n^{th} independent variable, and **ε** is the standard error of the equation. The value of coefficient β determines the direction of the relationship between X and the logit of Y. The model has all significant variables ($p < 0.05$), and the odds ratio for each independent variable is included. The results are presented as an odds ratio with *p*-values and a 95% confidence interval.

3) *Measuring and Decomposing Inequalities in Internet Use among Women*

Since the 1990s, concentration indices have been widely used to measure socioeconomic inequalities in health [30]. The concentration index has been applied in a different context in this paper to measure wealth-based inequality in internet use among women considering access to digital health. The calculation of CI requires a rank measure of wealth status, for which the wealth factor scores have been used in this study. NFHS-5 derived the wealth factor scores and wealth index by calculating a composite value for various household assets. We used the Erreygers Concentration Index (ECI) [31] and its decomposition to measure the contribution of independent variables in inequality. The standard concentration index (CI) can be computed as follows:

$$\mathrm{CI} = \frac{2}{\bar{\mathrm{y}}}\ \mathrm{cov}\ \left(\mathrm{y_i}, \mathrm{r_i}\right) \quad (2)$$

Where y is the variable of interest of the i individual, $\bar{y}$ is the mean of y_i, and r_i is the fractional rank of i^{th} person [32]. Since the internet use variable in our study is binary, a normalization process is required to measure inequality. This study uses the ECI, which is represented as:

$$\mathrm{ECI}\ (\mathrm{y}) = \frac{4\bar{\mathrm{y}}}{\mathrm{y}^{\max} - \mathrm{y}^{\min}}\mathrm{CI} \quad (3)$$

Where $\bar{y}$ is the mean of the internet variable, CI is the standard concentration index, y^{max} is the maximum value of the internet variable, in this case, '1' and y^{min} is the minimum value of the internet variable, in this case, '0' [33]. The CI value ranges from −1 to +1, but when y is a binary variable, as in our case, ECI ranges from $\bar{y} - 1$ to 1- $\bar{y}$ [32]. The CI is zero when there is no socioeconomic inequality in internet use, meaning that internet use is equally distributed across the population. It takes on positive value when internet use is more concentrated amongst the richer population and negative value when it is more concentrated amongst the poorer population [34, 35].

Decomposition of ECI–

In this study, after computing the ECI and concentration curve, a decomposition analysis was conducted to examine the impact of various predictor factors on wealth-based internet use inequality among women in India. Following the approach proposed by O'Donnell et al. (2007) [35], we utilized a generalized linear model (GLM) with a binomial family and logit link due to the binary nature of the outcome variables. Employing GLM with a binomial distribution and identity link function preserved the non-linear relationship and distribution structure of the variables under consideration. The identity link was computed using the Stata command: "glm y x, family (binomial) link (identity)" [36]. Elasticities, concentration indices, and factor contributions were analyzed to assess the influence of explanatory variables on internet use inequality among women in India. The absolute contribution of a variable is a product of the elasticity of internet use for every background variable and the CI for each variable. So, to estimate the contribution, we first need to estimate the coefficient of the predictor variables using a regression model. A Generalised Linear Model (GLM) is used as it is found to be the best choice for decomposing inequality in the case of a binary outcome variable [36, 37]. Stata 16 statistical software was used for all the statistical analysis, including ECI and its decomposition [34, 38].

Results

Prevalence and predictors of internet use among women in India

Table 2 presents the prevalence and predictors of internet use among women in India. Out of 108,785 women participants, only one-third (33%) of women reported utilizing the internet. Internet usage was notably higher among women who were younger, urban dwellers, highly educated, and from affluent backgrounds. This trend of internet use exhibited a noticeable decline with increasing age, which can be attributed to the relatively recent adoption of internet and smartphone technology in

India. More specifically, women in their twenties [20–29] constituted the largest cohort of internet users, accounting for 44.87% of the total, closely followed by teenagers at 41.34%.

Interestingly, never-married women, likely representing a younger demographic, exhibited the highest proportion of internet usage, with at least 50% of them reporting internet access. In contrast, the lowest ratio of internet access was found among widowed women, with only 15% of this group reporting internet use, followed by separated women at 25.98%. Further analysis revealed that the prevalence of Internet usage was significantly higher among urban women, with approximately 52.48% of them having Internet access. In contrast, only around 27% of women in rural areas reported internet usage. Educational attainment was pivotal in women's internet access; a mere 5.4% of illiterate women reported using the internet, while around 80% of women with education beyond secondary level had internet access. When considering religious and caste groups, Sikhs (48.73%) and General caste (46.62%) women had the highest proportions of internet usage. Wealth also played a critical role, with 65.6% of women from the richest households reporting internet use, compared to only 12.05% of women from the poorest households. The prevalence of internet usage among women gradually increased as overall household wealth increased. While non-working women had a slightly higher proportion (36.05%) of internet usage than working women (27.45%), the difference between the two groups was marginal.

Table 2 indicates that there is a significant association between internet use and background characteristics of women. In an attempt to develop a better understanding of these associations, we extend this analysis further using a regression model. Through binary regression analysis, we identified age, education, and wealth as the most significant predictors of internet use among women in India. Women in their twenties and teenagers were found to be the most likely users of the internet, while older women were less inclined to utilize it. The likelihood of using the internet increased substantially (5 to 25 times) for women with higher and secondary education compared to those with no formal education.

Similarly, women from wealthier households were 2 to 6 times more likely to use the internet than those from the poorest households. Other socio-demographic characteristics such as religion, caste, marital status, and employment status also exhibited significant associations with women's internet use. All these significantly associating predictors have been utilized to decompose the inequality of internet use among women in the next step of the analysis.

Inequalities in internet use among women in India

The concentration curve (CC) plot for inequality in internet use among women (see Fig. 1) indicated that internet use was more prevalent among wealthier women, with the concentration index (ECI) calculated as 0.4444 ($p < 0.0001$) (values are presented in Table 3), signifying that richer women were significantly more likely to use the internet than their economically disadvantaged counterparts. The concentration curve of internet use lies below the line of equality, indicating that internet use is more prevalent among wealthier women. The concentration index directly relates to the CC plot and represents twice the area between the CC and the 45-degree equality line [35].

Factors contributing to the inequalities in internet use among women in India

In order to gain a deeper understanding of the factors contributing to internet use inequality among women in India, a decomposition analysis was conducted, as presented in Table 3. This table provides insights into the elasticity (the product of the coefficient means of each background variable and total % contribution to the inequalities in internet usage), the concentration index of explanatory variables, and the absolute and percentage contributions of these factors. The analysis revealed that education level contributed to approximately 28.19% of the overall inequality in internet use, followed by the wealth index (25.67%) and place of residence (23.16%). Collectively, these variables accounted for 77.04% of economic inequality in women's internet use. Significant factors influencing internet use inequality included residing in rural areas (23.16%), having secondary education (12.84%) or higher education (16%), and belonging to the wealthiest households (20.06%). The data also indicated that an individual's caste significantly contributed to internet use inequality, with the other/general caste category contributing over 2% to the overall inequality. Without inequality in these factors, the inequality in internet use will decrease.

A small portion of the overall inequality, approximately 22.96%, remains unexplained and is attributed to the residuals. The unexplained component refers to the inequality in internet use that cannot be accounted for by the systematic variation across the background variables utilized in this analysis, thus rendering it non-decomposable. This suggests the presence of other factors influencing the unexplained portion of inequality. To some extent, the residuals contribute to the pro-rich inequality observed in internet use. This is evident from the positive value of the residuals. Conversely, a negative residual would have explained pro-poor inequality.

Table 2 Prevalence and predictors of internet use among women in India, 2019-21

Independent Variables	Internet use			
	Sample 108,785 (100%)	YES 36,209 (33.28%)	Chi-square value	AOR (95% CI)
Age-group			6412.01***	
15–19 years	18,237	7539 (41.34)		Ref.
20–29 years	35,694	16,016 (44.87)		1.145 (1.084–1.211) ***
30–39 years	30,083	8797 (29.24)		0.806 (0.755–0.861) ***
40–49 years	24,771	3857 (15.57)		0.384 (0.356–0.413) ***
Place of residence			5974.99 ***	
Urban	27,064	14,202 (52.48)		Ref.
Rural	81,721	22,007 (26.93)		0.601 (0.578–0.624) ***
Education			28,615.96***	
No education	25,133	1267 (5.04)		Ref.
Primary	12,805	1461 (11.41)		1.837 (1.691–1.995) ***
Secondary	55,398	20,848 (37.63)		5.515 (5.173–5.880) ***
Higher	15,449	12,633 (81.77)		27.89 (25.83–30.11) ***
Marital status			5560.63***	
Never in union	27,178	13,946 (51.31)		Ref.
Married	76,910	21,352 (27.76)		0.681 (0.647–0.717) ***
Widowed	3345	504 (15.07)		0.656 (0.578–0.745) ***
Divorced	459	175 (38.13)		1.065 (0.835–1.359)
Separated	893	232 (25.98)		0.787 (0.649–0.954) **
Religion			985.04***	
Hindu	81,496	25,860 (31.73)		Ref.
Muslim	13,816	4276 (30.95)		0.937 (0.888–0.989) **
Christian	7937	3520 (44.35)		1.977 (1.846–2.117) ***
Sikh	2553	1244 (48.73)		2.382 (2.156–2.632) ***
Other	2983	1309 (43.88)		2.169 (1.342–1.490) ***
Social group/ Caste			2048.67***	
Scheduled Caste	20,814	5719 (27.48)		Ref.
Scheduled Tribe	20,511	6132 (29.90)		1.165 (1.098–1.237) ***
OBC	41,953	13,335 (31.79)		1.006 (0.961–1.053)
None of them (Other)	19,841	9249 (46.62)		1.414 (1.342–1.490)
Working status (in last 12 months)			791.07***	
Not working	73,809	26,609 (36.05)		Ref.
Working	34,976	9600 (27.45)		1.072 (1.033–1.113) ***
Wealth index			15,424.21***	
Poorest	22,289	2686 (12.05)		Ref.
Poorer	23,799	5212 (21.90)		1.695 (1.600–1.795) ***
Middle	22,877	7098 (31.03)		2.360 (2.229–2.498) ***
Richer	21,625	9277 (42.90)		3.353 (3.164–3.554) ***
Richest	18,195	11,936 (65.60)		6.441 (6.042–6.866) ***

AOR Adjusted Odds Ratio, *Ref* Reference Category, *CI Confidence Interval*

****p* < 0.001, ** *p* < 0.01, * *p* < 0.05

Data Source: National Family and Health Survey- 5, 2019–21, India

Discussion

The current study highlights the level of internet access among Indian women and the inequalities, aiming to assess the preliminary readiness to adopt digital health among women in India. Firstly, the prevalence and predictors of internet use among women in India were examined. Further, using the Erreygers Concentration Index, the wealth-based inequality of internet use

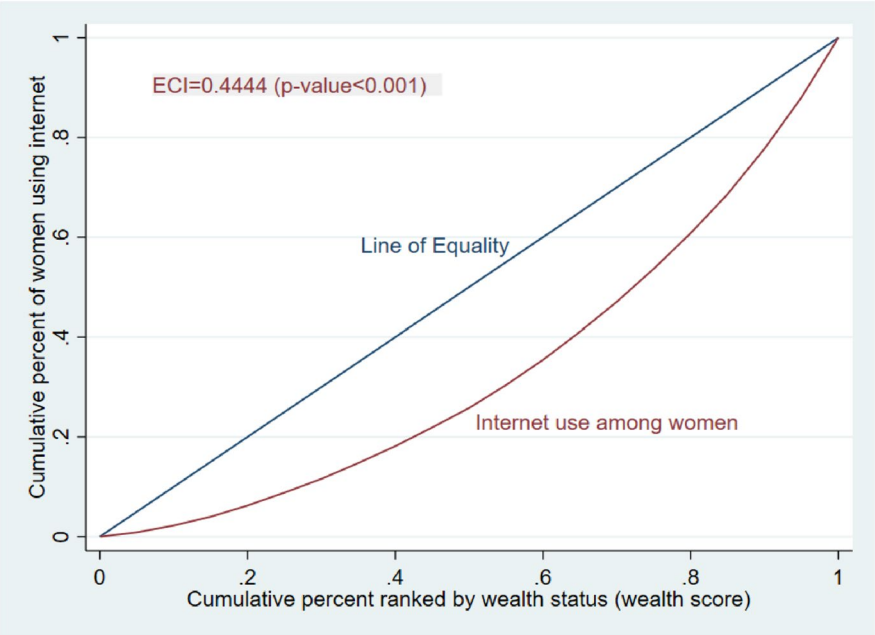

Fig. 1 Concentration curve showing the wealth-based inequality in internet use among women in India, 2019–21. Data Source: National Family and Health Survey-5 (2019–21), India

was measured, which yielded that internet use among women in India is concentrated among rich households. This warranted a decomposition analysis to discover the contributing factors of the assessed inequality in internet use. It was found that place of residence, education, wealth status, and caste category are major contributing factors to internet use in India, along with a multitude of other variables such as age, marital status, religious background, and working status. It was found that only one-third of Indian women have "ever used the internet," and further analysis indicated notable inequalities among women in internet access, particularly in rural areas and lower-income groups. As observed, the Erreygers concentration index (ECI) calculated as 0.4444 ($p < 0.0001$) (values are presented in Table 3) showed that significant inequality in internet access exists; richer women were significantly more likely to have access to the internet than their economically disadvantaged counterparts.

Among key contributors to the internet inequality among women, wealth status emerges as a significant predictor, accounting for 25.67% of the observed inequality. It was also noted from the regression model that the odds of internet use increase with increasing wealth. Economic disparities in internet use are pronounced as reported by previous studies, as individuals belonging to the highest wealth quintile are more likely to report internet usage, with 69% of women and 78% of men. Conversely, those in the lowest wealth quintile exhibit notably lower internet use rates, with only 9% of women and 26% of men reporting internet usage [21]. Bridging this wealth-based digital divide among women is essential for any effective digital health policy intervention, including the Ayushman Bharat Digital Mission (ABDM), which aims to create an inclusive digital healthcare ecosystem [39]. Therefore, policies should prioritize the provisioning of affordable internet services to promote digital inclusion, particularly among economically disadvantaged women across the country.

The study identifies several key contributors to internet use inequality among Indian women. Education level emerges as the most prominent factor, contributing approximately 28.19% to the overall inequality, and it was noted that increasing education level increased the odds of women using the internet. The role of education in internet access has been extensively emphasized previously [12, 40], and a high education level among women is a prominent factor in equitable internet use. In addition to this simple positive relationship between educational attainment and internet access, Antonio and Tuffley (2014) also highlighted the role of access to the internet in overcoming educational barriers faced by women [40]. According to the findings of our study, poor educational level hinders internet usage. Additionally, it can be imagined that mere access to the internet cannot help overcome education barriers in the Indian context, considering the absence of basic reading and writing skills in 35% of women in India [41]. Thus, poor education impedes women's access to the internet and prevents

Table 3 Decomposition of the inequalities in the internet use among women in India

Background Variable	Elasticity	Concentration Index	Absolute Contribution	% Contribution	Total
Age					
15–19	Ref				
20–29	0.0254	0.0123	0.0003	0.0700	
30–39	−0.0356	0.0148	−0.0005	−0.1186	
40–49	−0.1261	0.0288	−0.0036	−0.8166	−0.87
Place of Residence					
Urban	Ref				
Rural	−0.2255	−0.4564	0.1029	23.1607	23.16
Education					
No education	Ref				
Primary	0.0345	−0.0880	−0.0030	−0.6827	
Secondary	0.4686	0.1219	0.0571	12.8497	
Higher	0.2699	0.2638	0.0712	16.0215	28.19
Marital Status					
Never in union	Ref				
Married	−0.1589	−0.0098	0.0016	0.3488	
Widowed	−0.0077	−0.0102	0.0001	0.0178	
Divorced	0.0001	0.0005	0.0000	0.0000	
Separated	−0.0011	−0.0042	0.0000	0.0011	0.37
Religion					
Hindu	Ref				
Muslim	−0.0040	0.0248	−0.0001	−0.0224	
Christian	0.0295	−0.0399	−0.0012	−0.2651	
Sikh	0.0119	0.0546	0.0006	0.1460	
Other	0.0123	−0.0150	−0.0002	−0.0416	−0.18
Social group/ Caste					
Scheduled Caste	Ref				
Scheduled Tribe	0.0164	−0.2735	−0.0045	−1.0062	
OBC	0.0009	0.0947	0.0001	0.0182	
Other/General	0.0390	0.2376	0.0093	2.0855	1.10
Working Status					
Not working	Ref				
Working	0.0131	−0.1329	−0.0017	−0.3919	−0.39
Wealth Index					
Poorest	Ref				
Poorer	0.0646	−0.2550	−0.0165	−3.7051	
Middle	0.1022	0.0213	0.0022	0.4895	
Richer	0.1378	0.2845	0.0392	8.8200	
Richest	0.1814	0.4916	0.0892	20.0634	25.67
Total					***77.04***
Residuals					***22.96***
Index	Erreygers Normalized Concentration Index				
No. of obs.	108,785				
Index value	**0.4444**				
Std. error	0.0030				
p-value	<0.001				

Data Source: National Family and Health Survey- 5, 2019–21, India

them from reaping the benefits offered by online services, including healthcare. Gann (2019) finds that, in the United States, individuals with less than a high school education are significantly more likely to be offline, with approximately 35% of adults not using the internet [10]. This finding underscores the significance of addressing educational barriers that impede digital inclusion among women, especially those who lack essential reading and writing skills. We observe education to be vital in fostering digital literacy and enabling women to harness the benefits of online services, including digital health solutions.

Place of residence significantly contributes 23.16% to the overall inequality, highlighting the urban-rural digital divide in internet usage. Rural women were about 40% less likely to have used the internet as compared to urban women. This disparity seems to emanate from the supply side and is more systemic in nature. This highlights the need to address infrastructure and connectivity challenges faced by women in rural regions. Enhancing internet infrastructure, establishing digital access points, and providing training programs are essential to empower rural women with digital skills and facilitate their access to digital health services. Caste-based disparities also impact internet access among women in India, with the other/general caste contributing over 1% to the observed inequality. This underscores the influence of social and cultural factors in shaping digital inclusion. While there is no immediate solution to such social factors contributing to uneven digital access landscapes, caste, sensitive policies, and initiatives should work towards creating an inclusive digital environment that addresses these social inequalities and ensures equal opportunities for women across various castes and social backgrounds.

This study's findings have significant implications for health policymakers and other stakeholders aiming to enhance women's access to digital health services in India. In India, the National Health Policy (2017) recognized the integral role of digital technology in healthcare delivery and envisioned the setup of a National Health Authority (NHA) to regulate, develop, and deploy digital health to ensure the continuum of care [42]. Moreover, the National Digital Mission (NDM) was launched as a pilot in six union territories (Andaman & Nicobar, Chandigarh, Dadra & Nagar Haveli, and Daman & Diu, Ladakh, Lakshadweep, and Puducherry) on the 15th August 2020 [43]. It has been scaled up to the national level in 2021 with the name of 'Ayushman Bharat Digital Mission' (ABDM) [39, 44], aiming to "improve equitable access to quality healthcare by encouraging the use of technologies such as telemedicine and enabling national portability of health services" [45]. While the country seems to be geared up to cash the benefits of the much-touted "digital revolution," a realistic assessment of digital readiness at the population level is the need of the hour. As shown in our analysis, it is concerning that only one-third of the women had ever accessed the internet, and that too with significant intersectional inequality. Effective strategies should focus on finding ways to overcome the educational barriers to internet access. Leveraging the internet to improve women's educational status, particularly in rural and marginalized communities, could be explored. The cost of internet services must be reduced further. While many societies are debating whether the internet should be considered a basic need, India must start envisioning the internet as a digital highway to reach the last mile population. Additionally, only large-scale public and private investments aiming to establish seamless digital connectivity across the country could address rural-urban disparities in internet infrastructure and digital skills. In this context, India does have a model from Kerala, one of its states, where the state government has invested in developing an optical fiber network of 35,000 km running across the state and providing free internet access to the underprivileged population who cannot afford it. Furthermore, only an inclusive and enabling digital environment that addresses social inequalities can help universalize internet access and is essential to realizing the potential of digital health for all. While the initiative to introduce digital health in India must not be pushed back altogether for any reason, it is suggested that the country must do the essential groundwork before embarking on such an extraordinary journey of transforming the healthcare delivery system.

Strengths and limitation

Our study utilizes a nationally representative sample distributed well across the country, enabling us to generalize the findings nationally. By utilizing the most recent and extensive data available in India, our study provides valuable insights into internet use among women. To the best of our knowledge, this is the first comprehensive investigation that identifies predictors of internet use in the country. We also explored the inequalities in internet use and factors contributing to these disparities among women. Despite identifying several significant determinants for promoting internet access, our model left approximately 23% of the inequality unexplained. This suggests the presence of unidentified factors that contribute to internet use inequality, highlighting the need for further research to explore diverse determinants of internet use in India. While this study attempts to explore India's readiness

for digital health, it does so only in terms of internet access and use due to the limitation of the available data. The idea of digital readiness is broad and has multiple dimensions like analytic readiness, data readiness, technology readiness, and population readiness. Thus, the presented study is limited in scope and only addresses population readiness.

Conclusion

This study attempts to assess India's readiness for digital health in terms of internet access among women as the nation is set to embark on a digital health journey. The study analyzed levels of access to the internet and inequalities among Indian women of reproductive age using pan-India survey data. The study finds a very dismal level of internet access among women, which is also marked by significant intersectional inequalities. The analyses in the study found women's educational level to be the most prominent contributing factor in the prevailing internet inequality, followed by wealth, place of residence, and caste. The study discusses the need to address both demand-side barriers and systemic issues along with digital health policy initiatives. The authors suggest a comprehensive need assessment, addressing internet access inequities and revamping digital infrastructure for a desired outcome from digital health innovations. Policy actors are suggested to tread cautiously in implementing digital health innovation in the country as the existing ground situations may exacerbate the prevailing healthcare access inequities further.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s44247-024-00090-z.

Supplementary Material 1.

Acknowledgments
Na.

Authors' contributions
RC conceptualized the research idea, finalized the methodology, supervised the analysis and written the final manuscript. JP and SS curated and analyzed the data, and written the first draft of the manuscript. AS and SM validated the analysis and results and helped in revisions and finalization of the manuscript.

Funding
None.

Availability of data and materials
All data files are available on the DHS website and can be accessed at the following link:https://dhsprogram.com/data/available-datasets.cfm.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Tata Institute of Social Sciences, Mumbai, India. [2]Department of General and Applied Geography, Doctor Hari Singh Gour University, Sagar, India. [3]Independent Researcher, Mumbai, India. [4]Department of Geography, Banaras Hindu University, Varanasi, India.

Received: 20 November 2023 Accepted: 10 April 2024
Published online: 10 July 2024

References

1. Digital health. https://www.who.int/health-topics/digital-health#tab=tab_1. Accessed 4 Oct 2023.
2. Ronquillo Y, Meyers A, Korvek SJ. Digital Health. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024. https://www.ncbi.nlm.nih.gov/books/NBK470260/.
3. Mackey A, Petrucka P. Technology as the key to women's empowerment: a scoping review. BMC Women's Health. 2021;21:78. https://doi.org/10.1186/s12905-021-01225-4.
4. Wagner TH, Bundorf MK, Singer SJ, Baker LC. Free Internet Access, the Digital Divide, and Health Information. Medical Care. 2005;43:4. https://doi.org/10.1097/01.mlr.0000156857.14152.6e.
5. Bala S, Singhal P. Gender digital divide in India: a case of inter-regional analysis of Uttar Pradesh. J Inf Commun Ethics Soc. 2018;16:2. https://doi.org/10.1108/jices-07-2017-0046.
6. Helsper E. The Digital Disconnect: The Social Causes and Consequences of Digital Inequalities. 55 City Road, London: SAGE Publications Ltd; 2021. https://doi.org/10.4135/9781526492982.
7. Mathrani A, Sarvesh T, Mathrani S: Digital Gender Divide in Online Education during Covid-19 Lockdown in India. In: Proceedings of the 2020 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE): 16-18 December 2020; Gold Coast, Australia. 2020. p. 1-6. https://doi.org/10.1109/CSDE50874.2020.9411378.
8. Gudi N, Lakiang T, Pattanshetty S, Sarbadhikari SN, John O. Challenges and prospects in india's digital health journey. Indian J Public Health. 2021;65(2):209–12. Available from: http://www.ijph.in/text.asp?2021/65/2/209/318362
9. Zhang M. Internet use that reproduces educational inequalities: evidence from big data. Comput Educ. 2015;86:212–23. https://doi.org/10.1016/j.compedu.2015.08.007.
10. Gann B. Digital inclusion and Health in Wales. J Consum Health Internet. 2019;23(2):146–60. https://doi.org/10.1080/15398285.2019.1608499.
11. Gann B. Transforming lives: Combating digital health inequality. IFLA J. 45(3):187–98. https://doi.org/10.1177/0340035219845013.
12. Pan Z, Yan W, Jing G, Zheng J. Exploring structured inequality in Internet use behavior. Asian J Commun. 2011;21(2):116–32.
13. Stephens M, Mankee-Williams A. The sickening truth of the digital divide: digital health reforms and digital inequality. J Soc Incl. 2021;12(2):57–66. Available from: https://josi.org.au/article/10.36251/josi.227/
14. Bucy EP. Social access to the internet. Harv Int J Press. 2000;5(1):50–61. https://doi.org/10.1162/108118000568967.
15. Li N, Kirkup G. Gender and cultural differences in Internet use: a study of China and the UK. Comput Educ. 2007;48(2):301–17.
16. Thakkar S, Miller P, Palackal A, Shrum WM. Internet and Mobile use: exploring the gendered digital divide in Kerala. Loyola J Soc Sci. 2022;36(2):35–56.
17. Joiner R, Stewart C, Beaney C. Gender Digital Divide. In: The Wiley handbook of psychology, technology, and society [Internet]. Chichester, UK: John Wiley & Sons, Ltd; 2015. p. 74–88. Available from: https://researchportal.bath.ac.uk/en/publications/gender-digital-divide-does-it-exist-and-what-are-the-explanations.
18. Mejova Y, Gandhi HR, Rafaliya TJ, Sitapara MR, Kashyap R, Weber I. Measuring Subnational Digital Gender Inequality in India through Gender Gaps in Facebook Use. In: Proceedings of the 1st ACM SIGCAS Conference on

Computing and Sustainable Societies: 2018. New York, USA; 2018. p. 1-5. Available from: https://idr.nitk.ac.in/jspui/handle/123456789/8978.
19. Organisation for Economic Co-operation and Development (OECD): Bridging the digital gender divide: include, upskill, innovate. Paris, France; 2018. https://www.oecd.org/digital/bridging-the-digital-gender-divide.pdf.
20. Hibbard JH, Pope CR. Women's Roles, Interest in Health and Health Behavior. Women Health [Internet]. 1987 Nov 4 [cited 2024 Feb 4];12(2):67–84. Available from: https://doi.org/10.1300/J013v12n02_05.
21. International Institute for Population Sciences (IIPS) & ICF. National Family Health Survey (NFHS-5), 2019-21: India: Volume II. Mumbai, India: IIPS; 2021. Available from: https://www.rchiips.org/nfhs.
22. Narde A, Gupta M, Kanade HT, Mardikar PA. Internet use among students of a medical college in Central India. J Datta Meghe Inst Med Sci Univ. 2013;8(3):202–5.
23. Sharma D, Kumaresan K, Ashok B. Internet use among medical students in an institution in South India. Indian J Public Health Res Dev. 2013;4(2):110–4.
24. Anand N, Thomas C, Jain PA, Bhat A, Thomas C, Prathyusha PV, et al. Internet use behaviors, internet addiction and psychological distress among medical college students: a multi Centre study from South India. Asian J Psychiatry. 2018;37:71–7.
25. Grover S, Sahoo S, Bhalla A, Avasthi A. Problematic internet use and its correlates among resident doctors of a tertiary care hospital of North India: A cross-sectional study. Asian J Psychiatry. 2019;39:42–7. https://doi.org/10.1016/j.ajp.2018.11.018.
26. Trivedi M, Joshi A. Computer and Internet use by health care professionals in a rural medical college in India. Library Philosophy and Practice (e-journal). 2008. Available from: https://digitalcommons.unl.edu/libphilprac/204/.
27. Fusilier M, Durlabhji S. An exploration of student internet use in India: the technology acceptance model and the theory of planned behaviour. Campus-Wide Inf Syst. 2005;22(4):233–46.
28. Madhusudhan M. Internet use by research scholars in University of Delhi, India. Libr Hi Tech News. 2007;24(8):36–42. Available from: https://api.elsevier.com/content/abstract/scopus_id/35448940079
29. Naik L, Kumar K. Internet use among faculty and students of college libraries in Bangalore, India: A study. Library Philosophy and Practice (e-journal). 2019. Available from: https://digitalcommons.unl.edu/libphilprac/2235/.
30. Kjellsson G, Gerdtham UG. On correcting the concentration index for binary variables. J Health Econ. 2013;32(3):659–70. https://doi.org/10.1016/j.jhealeco.2012.10.012.
31. Erreygers G. Correcting the concentration index. J Health Econ. 2009;28(2):504–15.
32. Taleb El Hassen MV, Cabases JM, Zine Eddine El Idrissi MD, Mills S. Changes in Inequality in Use of Maternal Health Care Services: Evidence from Skilled Birth Attendance in Mauritania for the Period 2007–2015. Int J Environ Res Public Health. 2022;19(6):3566. Available from: https://www.mdpi.com/1660-4601/19/6/3566
33. Mutyambizi C, Booysen F, Stokes A, Pavlova M, Groot W. Lifestyle and socioeconomic inequalities in diabetes prevalence in South Africa: A decomposition analysis. Devleesschauwer B, PLoS ONE. 2019 14(1):e0211208 https://doi.org/10.1371/journal.pone.0211208
34. O'Donnell O, O'Neill S, Van Ourti T, Walsh B. Conindex: Estimation of concentration indices. Stata J. 2016;16:(1):112–38. https://doi.org/10.1177/1536867X1601600112.
35. O'Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. Analyzing Health Equity Using Household Survey Data: A Guide to Techniques and Their Implementation. © Washington, DC: World Bank; 2008. https://hdl.handle.net/10986/6896. License: CC BY 3.0 IGO.
36. Yiengprugsawan V, Lim LL, Carmichael GA, Dear KB, Sleigh AC. Decomposing socioeconomic inequality for binary health outcomes: An improved estimation that does not vary by choice of reference group. BMC Res Notes. 2010;3:57. https://doi.org/10.1186/1756-0500-3-57.
37. Shibre G, Mekonnen W, Mariam DH. Decomposition analysis of women's empowerment-based inequalities in the use of maternal health care services in Ethiopia: evidence from demographic and Health surveys. PLOS ONE. 2023;18(4):e0285024. https://doi.org/10.1371/journal.pone.0285024.
38. StataCorp. Stata statistical software: release 16. College Station, TX: StataCorp LLC; 2019.
39. National Health Authority. Official website Ayushman Bharat Digital Mission [Internet]. 2022 [cited 2022 Jul 3]. Available from: https://ndhm.gov.in/%0Ahttps://abdm.gov.in /
40. Antonio A, Tuffley D. The Gender Digital Divide in Developing Countries. Future Internet. 2014;6:(4):673–87. https://doi.org/10.3390/fi6040673.
41. Office of the Registrar General & Census Commissioner: Census of India. New Delhi; 2011. Available from: https://censusindia.gov.in/census.website/.
42. Vartan CK, Montuschi E. National Health Policy. British Medical J Govern India. 1943;2:279.
43. Update on Ayushman Bharat Digital Mission (Press release by Ministry of Health and Family Welfare on 05 APR 2022 3:49 PM by PIB Delhi). https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1813660. Accessed 27 June 2022 .
44. PM to launch Ayushman Bharat Digital Mission on 27th September (Press release by Prime Minister's Office on 26 SEP 2021 2:28 PM by PIB Delhi). https://pib.gov.in/PressReleseDetail.aspx?PMO=3&PRID=1758248. Accessed on 2022 June 27.
45. Cabinet approves implementation of Ayushman Bharat Digital Mission with a budget of Rs.1,600 crore for five years (Press release by Cabinet Committee on Economic Affairs (CCEA) on 26 FEB 2022 1:55 PM by PIB Delhi). https://pib.gov.in/PressReleasePage.aspx?PRID=1801322. Accessed 27 June 2022.

Publisher's Note