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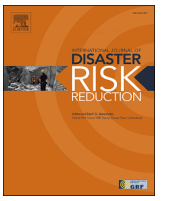

# Gender differences in COVID-19 knowledge, risk perception, and public stigma among the general community: Findings from a nationwide cross-sectional study in India

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ABSTRACT

*Introduction:* Individual and community characteristics predictive of knowledge, perception, and attitude on COVID-19, specifically on gender, have not been adequately explored.
*Objective:* To examine the gender differences in COVID-19 knowledge, self-risk perception and public stigma among the general community and to understand other socio-demographic factors which were predictive of them.
*Method:* A nationally representative cross-sectional multi-centric survey was conducted among adult individuals(≥18 yrs) from the community member (N = 1978) from six states and one union territory of India between August 2020 to February 2021. The participants were selected using systematic random sampling. The data were collected telephonically using pilot-tested structured questionnaires and were analyzed using STATA. Gender-segregated multivariable analysis was conducted to identify statistically significant predictors ($p < 0.05$) of COVID-19-related knowledge, risk perception, and public stigma in the community.
*Results:* Study identified significant differences between males and females in their self-risk perception (22.0% & 18.2% respectively) and stigmatizing attitude (55.3% & 47.1% respectively). Highly educated males and females had higher odds of having COVID-19 knowledge (aOR: 16.83: $p < 0.05$) than illiterates. Highly educated women had higher odds of having self-risk perception (aOR: 2.6; $p < 0.05$) but lower public stigma [aOR: 0.57; $p < 0.05$]. Male rural residents had lower odds of having self-risk perception and knowledge [aOR: 0.55; $p < 0.05$ & aOR: 0.72; $p < 0.05$] and female rural residents had higher odds of having public stigma [aOR: 1.36; $p < 0.05$].
*Conclusion:* Our study findings suggest the importance of considering thegender differentials and their background, education status and residential status in designing effective interventions to improve knowledge and reduce risk perception and stigma in the community about COVID-19.

## 1. Introduction

The public health impact of COVID-19 pandemic in India remains enormous [1]. The morbidity and mortality caused due to COVID-19 have been huge, and it has had a detrimental impact on the health system [1]. While effective non-pharmaceutical interventions (social distancing, respiratory and cough hygiene, testing acceptance) proved to be of paramount importance in addressing the pandemic, they also necessitated an understanding of the social and psychological dimensions of COVID-19. Measuring communities' knowledge and awareness levels about COVID-19 became crucial to ensure compliance towards COVID protective behavior. In addition, understanding the social dimension of COVID-19, which was characterized by stigma and discrimination towards suspected and infected patients, family members, and healthcare providers during the initial wave, was of importance [2–4] [2–4] [2–4]. In this context, studies assessing COVID-19-related knowledge [5–13] [5–13] [5–13], risk perception [14,15], and stigma [2,3] at the community level in India have remained scarce and hold limitations. The major limitations of existing studies pertain to the inadequacy of sample representativeness and internet-based self-questionnaire methods of data collection. The latter could have led to the over-representation of the younger, educated and urban population, given their easier access to technology and social media in India.

India being a diverse country with diverse geographies, cultures, socio-economic strata and languages; there is a need for adequate sampling strategy and representation which is reflective of the country's diversity. From a methodological perspective, there is a gap in the earlier studies, in which well-structured, pilot-tested and validated tools for measuring COVID-19-related knowledge, perception and stigma in India were not used.

In addition from a research evidence perspective, there is a need to understand and distinguish COVID-19-related knowledge, attitudes, and perceptions in terms of key socio-demographic characteristics of the communities of interest. Especially studies which have assessed the significance of "gender" in understanding COVID-19-related knowledge, attitudes, and perception are absent. Therefore, considering these two gaps, we aim to understand the differences in the knowledge, self-risk perception and public stigma in the Indian communities, based on gender and other socio-demographic factors using structured pilot tested and validated tools [16]. For our study, we define public stigma as the negative attitudes and prejudice held by members of the general community toward those infected by the COVID-19 virus. We define self-risk perception as an individual perception of the possibility of getting a COVID-19 virus infection.

## 2. Methodology

The present study is a part of the larger multi-centric study carried out across India to understand the factors related to COVID-19 stigma among the general community and the COVID-19-recovered individuals. However, for this paper, we have considered only data related to the general community for analysis. We define the general community for our study as individuals from any community who self-reported not being diagnosed with COVID-19 at the time of data collection.

### 2.1. Study design, setting and period

This cross-sectional survey was implemented between August 2020 to February 2021 in six states (Madhya Pradesh, Odisha, Uttar Pradesh, Assam, Tamil Nadu, Maharashtra) and one union territory (Delhi) representing all six zones of India (East, West, North, South, Central and North-East India). In each zone, one district/Union Territory (UT) with a high COVID-19 caseload (red districts) and one district with zero caseloads (green districts) were selected. District-wise COVID-19 caseloads were generated from the Department of Health and Family Welfare, Ministry of Health and Family Welfare, Government of India dated: 10/04/2020, D, O. No. Z. 280 1 5/19/2020-EM R and as of 30th April 2020. NE – North East. The selected districts are given in annexure-I.

### 2.2. Study participants

The study participants were adults (18 years and above) who resided in the selected districts/union territories and self-reported not being diagnosed with COVID-19 at the time of data collection.

### 2.3. Sample size

With an assumed 10% prevalence of stigmatizing attitude in the general population toward those who are infected by COVID-19, and considering a 20% relative precision, 5% level of significance and with the design effect of 2, the minimum number of required participants were 1800. The calculated sample size was distributed equally among all the 18 selected districts (i.e. one district in green and two red districts) in a high-burden state representing the six regional zones of India.

### 2.4. Selection of study participants and data collection

A heterogeneous and comprehensive list of general community residents was collected using i) the COVID-19 contact tracing registry of the health department in the district and ii) the beneficiary list of community-based organizations in the districts. From these sources, participants were selected using systematic random sampling and were contacted telephonically.

For maintaining uniformity across the study sites, training was conducted, and the interviewer manual was provided to the researchers. Participant Information Sheet (PIS) and Informed Consent (IC) were read out to the respondents in the local language over the phone by trained researchers and also shared over WhatsApp messenger wherever possible. Data were collected telephonically in all the sites, after obtaining verbal informed consent from the participants, as the use of traditional mode of data collection (face-to-face interview) was not possible due to the national lockdown and containment measures implemented by the local government. All the interviews lasted for 20–30 min. All the calls were recorded on a mobile phone. Data collected at each site was checked by the respective supervisors at the study sites, and regular online assistance was provided by the central team. Ten per cent post-data entry check was conducted by the central team.

### 2.5. Tools of data collection and scoring

The survey questionnaire included sections on socio-demographic details, knowledge of COVID-19 (cause, transmission mode, symptoms and preventive measures), and self-risk perceptions of contracting COVID-19 infection. The research team also designed and validated the COVID-19 stigma tool to capture general community perceptions, judgmental attitudes and reactions towards those infected by COVID-19 through pilot testing in all the states. The validated tool comprised six items that were assessed on a three-point scale. The tool development process has been described in detail elsewhere [16]. Structured questions and statements to quantify COVID-19 knowledge, self-risk perception, and stigma have been provided in annexure-II.

**Knowledge score:** A score was developed to assess the respondent's comprehensive knowledge about the cause, transmission, symptoms, and asymptomatic nature of COVID-19 and its prevention using five questions. A maximum of 10 scores was assigned to each question, thus total score ranged from 0 to 50. The total scores were categorized into poor knowledge ($<$1st tertile distribution score), average knowledge (between 1st and 2nd tertile distribution score) and good knowledge (more than 2nd tertile distribution score). For our analysis, we considered more than 2nd tertile distribution score as having good knowledge.

**Public Stigma score:** The tool comprised six statements rated on a three-point scale ranging from 0 = disagree to 2 = agree, with higher scores indicating higher stigma attitudes. The total score ranged from 0 to 12. The tertile distribution stigma score of six was considered indicative of high public stigma attitudes, and the tertile scores of up to five were considered indicative of low public stigma attitudes.

**Self-risk perception score:** On a scale of one to five (1-Very unlikely, 2-Unlikely, 3-Neutral, 4-Likely, 5-.Very likely), the respondents were asked how likely they think they might become infected with COVID-19. We considered a score of 1–3 as indicative of low self-risk perception and four to five as high self-risk perception.

### 2.6. Data entry and management

The data entry and management software was developed using the Census and Survey Processing System (CSPro). Data recorded on hard copies of the interview schedule was entered into the software. The complete data from all the participating sites were combined and compiled. The data were stored in excel and STATA format.

### 2.7. Ethical consideration and approval

The Central Ethics Committee for Human Research, ICMR-NCDIR, Bengaluru, and the Institute Ethics Committees of the collaborating institutes located across the selected states reviewed and approved all the documents pertaining to the study. Ethics Committee Registration No. ECR/135/Inst/TN/2013/RR-19.

### 2.8. Statistical analysis

All data were entered in excel and analyzed using STATA statistical software: Release 15. College Station, TX: StataCorp LLC, 2017. Descriptive statistics with frequency and proportions were used to characterize the socio-demographics of the participants. Knowledge, self-risk perception and public stigma were calculated as proportions with 95% confidence intervals. Association of knowledge, self-risk perception and public stigma between male and female participants was assessed using the Chi-Square test with a p-value significance of $< 0.05$. A separate multivariable logistic regression analysis was used to identify the characteristics of community members which were associated with knowledge, self-risk perception and public stigma. Multivariable analysis was performed for male and female samples separately using the sort command option of STATA. The dependent variable was constructed as a categorical variable which was coded as "1" if knowledge, self-risk perception and public stigma were categorized as high and "0" if were categorized as low. The independent variables included age, education status, residential status, marital status and occupational status. P-value $< 0.05$ was considered for significance in multivariable analysis.

## 3. Results

Out of the 10,502 people contacted over the phone, 2,281 individuals consented to participate in the study. The overall response rate was 22%. In terms of states, Tamil Nadu had the lowest response rate (11.5%) and Odisha had the highest (43%) response rate. Low response rates were due to either faulty telephone numbers or poor network issues due to which the participants could not be reached out.

Out of 2281 consented individuals, all were interviewed. Among them 1978 individuals were from the general community and 303 individuals were COVID-19 recovered individuals.

Of the total 1978 general community participants, 50.6% were male, and 49.3% were female. Majority of participants (39.5%) were aged between 18 to 30 years, married (71.8%) and were working in the unorganized sector (33.2%). More than two-fifths (46.0%) of the participants had studied up to higher secondary, and more than half (51.6%) of the respondents lived in rural areas (see Table-1).

Findings (Table 2) highlight that high knowledge and self-risk perception were comparatively low in the community (32.2% & 20.1%, respectively), while high public stigma was comparatively greater (51.3%) .

Findings (Table 3) show a significant difference between males and females in their self-risk perception of COVID-19 infection (22% & 18.2%, respectively). Similarly, males and females showed significant differences (55.3% & 47.1%, respectively) in stigmatizing attitudes toward COVID-19-infected individuals. There were no significant difference between males and females regarding COVID-19-related knowledge.

Results of the multivariable logistic regression analysis of gender-wise factors associated with high COVID-19 knowledge are shown in Table-4. Male participants with higher age ($>61$ yrs) and from rural areas had lower odds of having COVID-19-related knowledge when compared to young age males (18–30 yrs) and urban residents, respectively [aOR: 0.44; $p < 0.05$ &aOR: 0.72; $p < 0.05$ respectively]. Male participants who were students had higher odds of having COVID-19-related knowledge when compared to unemployed males (aOR: 3.04; $p < 0.05$), and college-educated males had higher odds of having COVID-19-related knowledge when compared to illiterates (aOR: 4.04; $p < 0.05$). Female participants who were in organized sector occupations had higher

**Table 1**
Demographic profiles of community participants.

| Demographic profiles | Male | | Female | | Total (No.-1978) | Percentage |
|---|---|---|---|---|---|---|
| Age(in yrs) | N | Percentage | N | Percentage | | |
| 18–30 | 373 | 37.2 | 410 | 42.0 | 783 | 39.5 |
| 31–45 | 373 | 37.2 | 390 | 39.9 | 763 | 38.5 |
| 46–60 | 207 | 20.6 | 156 | 15.9 | 363 | 18.3 |
| >61 | 49 | 4.8 | 20 | 2.0 | 69 | 3.4 |
| **Marital Status** | | | | | | |
| Unmarried | 283 | 28.2 | 274 | 28.0 | 557 | 28.1 |
| Married | 719 | 71.7 | 702 | 71.9 | 1421 | 71.8 |
| **Occupation** | | | | | | |
| Unemployed | 42 | 4.1 | 483 | 49.4 | 525 | 26.5 |
| Organized | 387 | 38.6 | 261 | 26.7 | 648 | 32.7 |
| Unorganized | 508 | 50.7 | 149 | 15.2 | 657 | 33.2 |
| Students | 65 | 6.4 | 83 | 8.5 | 148 | 7.4 |
| **Education** | | | | | | |
| Illiterate | 39 | 3.8 | 96 | 9.8 | 135 | 6.8 |
| Primary | 52 | 5.1 | 74 | 7.5 | 126 | 6.3 |
| Higher Secondary | 479 | 47.8 | 432 | 44.2 | 911 | 46.0 |
| College | 432 | 43.1 | 374 | 38.3 | 806 | 40.7 |
| **Place of residence** | | | | | | |
| Urban | 487 | 48.6 | 470 | 48.1 | 957 | 48.3 |
| Rural | 515 | 51.4 | 506 | 51.8 | 1021 | 51.6 |

**Table 2**
COVID-19-related knowledge, self-risk perceptions and public stigma in the community.

| Knowledge | Frequency | Percentage | 95% CI |
|---|---|---|---|
| Low knowledge | 1341 | 67.8 | 65.6–69.8 |
| High knowledge | 637 | 32.2 | 30.1–34.3 |
| **Self-risk perception** | | | |
| Low self-risk perception | 1577 | 79.8 | 77.8–81.4 |
| High self-risk perception | 399 | 20.1 | 18.4–22.0 |
| **Public Stigma** | | | |
| Low public stigma | 962 | 48.6 | 46.4–50.8 |
| High public stigma | 1014 | 51.3 | 49.0–53.4 |

**Table 3**
COVID-19-related knowledge, self-risk perceptions and public stigma in the community by gender.

| Knowledge | Male | | 95% CI | Female | | 95% CI | Total | | P-value |
|---|---|---|---|---|---|---|---|---|---|
| | N | % | | N | % | | N | % | |
| | | | | | | | | | 0.063 |
| Low knowledge | 660 | 65.8 | 62.8–68.8 | 681 | 69.7 | 66.7–72.6 | 1341 | 67.8 | |
| High knowledge | 342 | 34.1 | 31.1–37.1 | 295 | 30.2 | 27.3–33.2 | 637 | 32.2 | |
| **Self-risk perceptions** | | | | | | | | | **0.036** |
| Low self-risk perceptions | 781 | 77.9 | 75.2–80.4 | 796 | 81.7 | 78.9–83.9 | 1577 | 79.8 | |
| High self-risk perceptions | 221 | 22.0 | 19.5–24.7 | 178 | 18.2 | 15.8–20.8 | 399 | 20.1 | |
| **Stigma** | | | | | | | | | **<0.001** |
| Low public stigma | 447 | 44.6 | 41.5–47.7 | 515 | 52.8 | 49.5–55.9 | 962 | 48.6 | |
| High public stigma | 555 | 55.3 | 52.2–58.4 | 459 | 47.1 | 43.8–50.2 | 1014 | 51.3 | |

**Table 4**
Multivariable analysis of gender-segregated predictors of COVID-19-related high knowledge in the community.

| Demographic variables | Male No. (342) | % | aOR | P-value | 95% CI | Female No. (295) | % | aOR[a] | P-value | 95% CI |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age (in yrs)** | | | | | | | | | | |
| 31–45 | 123 | 35.9 | 0.79 | 0.228 | 0.55–1.15 | 118 | 40.0 | 1.31 | 0.130 | 0.92–1.89 |
| 46–60 | 62 | 18.1 | 0.73 | 0.176 | 0.47–1.14 | 43 | 14.5 | 1.42 | 0.147 | 0.88–2.30 |
| >61 | 11 | 3.2 | 0.44 | 0.037 | 0.20–0.95 | 5 | 1.6 | 1.22 | 0.707 | 0.41–3.62 |
| 18–30 | 146 | 42.6 | Reference | | | 129 | 43.7 | Reference | | |
| **Marital Status** | | | | | | | | | | |
| Married | 234 | 68.4 | 1.34 | 0.119 | 0.92–1.96 | 197 | 66.7 | 1.02 | 0.904 | 0.69–1.51 |
| Unmarried | 108 | 31.5 | Reference | | | 98 | 33.2 | Reference | | |
| **Occupation** | | | | | | | | | | |
| Organized | 172 | 50.2 | 1.96 | 0.085 | 0.91–4.25 | 118 | 40.0 | 1.81 | 0.001 | 1.27–2.59 |
| Unorganized | 125 | 36.5 | 1.29 | 0.515 | 0.59–2.79 | 28 | 9.4 | 0.88 | 0.624 | 0.54–1.44 |
| Students | 35 | 10.2 | 3.04 | 0.016 | 1.23–7.53 | 34 | 11.5 | 1.55 | 0.145 | 0.85–2.83 |
| Unemployed | 10 | 2.9 | Reference | | | 115 | 38.9 | Reference | | |
| **Education** | | | | | | | | | | |
| Primary | 9 | 2.6 | 1.17 | 0.781 | 0.37–3.68 | 9 | 3.0 | 3.00 | 0.078 | 0.88–10.22 |
| Higher Secondary | 114 | 33.3 | 1.60 | 0.303 | 0.65–3.98 | 110 | 37.2 | 7.57 | <0.001 | 2.68–21.35 |
| College | 213 | 62.2 | 4.04 | 0.003 | 1.61–10.12 | 172 | 58.3 | 16.83 | <0.001 | 5.86–48.32 |
| Illiterate | 6 | 1.7 | Reference | | | 4 | 1.3 | Reference | | |
| **Place of residence** | | | | | | | | | | |
| Rural | 144 | 42.1 | 0.72 | 0.02 | 0.54–0.95 | 133 | 45.0 | 1.00 | 0.956 | 0.74–1.36 |
| Urban | 198 | 57.8 | Reference | | | 162 | 54.9 | Reference | | |

Dependent variable in the model is "High Knowledge about COVID-19". Coded as 1 if yes and coded as 0 if No.
[a] Adjusted Odds Ratio.

odds of having COVID-19-related knowledge when compared to unemployed females (aOR: 1.81; $p < 0.05$). High school and college-educated females had higher odds of having COVID-19-related knowledge when compared to illiterates (aOR: 7.57; $p < 0.05$, aOR: 16.83: $p < 0.05$) .

Results of the multivariable logistic regression analysis of gender-wise factors associated with COVID-19-related high self-risk perception are shown in Table 5. Male participants who were married had higher odds of having COVID-19-related self-risk perception when compared to unmarried males (aOR: 1.6; $p < 0.05$). The males who were living in rural residents had lower odds of having COVID-19-related high self-risk perception when compared to urban residents [aOR: 0.55; $p < 0.05$). Female participants who were working in the organized sector had higher odds of having COVID-19-related high self-risk perception when compared to unemployed

**Table 5**
Multivariable analysis of gender-segregated predictors of COVID-19-related high self-risk perception in the community.

| Demographic variables | Male No. (221) | % | aOR | P-value | 95% CI | Female No. (178) | % | aOR | P-value | 95% CI |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age (in yrs)** | | | | | | | | | | |
| 31–45 | 85 | 38.4 | 0.90 | 0.624 | 0.59–1.36 | 86 | 48.3 | 1.71 | 0.012 | 1.12–2.61 |
| 46–60 | 50 | 22.6 | 1.03 | 0.896 | 0.63–1.66 | 21 | 11.7 | 0.91 | 0.780 | 0.50–1.65 |
| >61 | 8 | 3.6 | 0.55 | 0.17 9 | 0.23–1.30 | 2 | 1.1 | 0.76 | 0.724 | 0.16–3.45 |
| 18–30 | 78 | 35.2 | Reference | | | 69 | 38.7 | Reference | | |
| **Marital Status** | | | | | | | | | | |
| Married | 168 | 76.0 | 1.60 | 0.033 | 1.03–2.47 | 115 | 64.6 | 0.72 | 0.140 | 0.46–1.11 |
| Unmarried | 53 | 23.9 | Reference | | | 63 | 35.3 | Reference | | |
| **Occupation** | | | | | | | | | | |
| Organized | 123 | 55.6 | 2.49 | 0.069 | 0.93–6.66 | 82 | 46.0 | 2.21 | <0.001 | 1.47–3.32 |
| Unorganized | 83 | 37.5 | 1.56 | 0.378 | 0.58–4.20 | 16 | 8.9 | 0.75 | 0.367 | 0.41–1.38 |
| Students | 10 | 4.5 | 1.27 | 0.688 | 0.38–4.20 | 16 | 8.9 | 1.15 | 0.688 | 0.56–2.38 |
| Unemployed | 5 | 2.2 | Reference | | | 64 | 35.9 | Reference | | |
| **Education** | | | | | | | | | | |
| Primary | 5 | 2.2 | 0.66 | 0.547 | 0.17–2.51 | 10 | 5.6 | 1.65 | 0.340 | 0.58–4.65 |
| Higher Secondary | 76 | 34.3 | 1.23 | 0.673 | 0.46–3.31 | 64 | 35.9 | 1.79 | 0.171 | 0.77–4.17 |
| College | 135 | 61.0 | 2.44 | 0.078 | 0.90–6.62 | 97 | 54.4 | 2.63 | 0.028 | 1.10–6.27 |
| Illiterate | 5 | 2.2 | Reference | | | 7 | 3.9 | Reference | | |
| **Place of residence** | | | | | | | | | | |
| Rural | 80 | 36.1 | 0.55 | <0.001 | 0.39–0.76 | 71 | 39.8 | 0.70 | 0.055 | 0.49–1.00 |
| Urban | 141 | 63.8 | Reference | | | 107 | 60.1 | Reference | | |

Dependent variable in the model is "High self-risk perception about COVID-19". Coded as 1 if yes and coded as 0 if No.
*Adjusted Odds Ratio.

females (aOR: 2.21; $p < 0.05$), and college-educated females had higher odds of having COVID-19-related high self-risk perception when compared to illiterates (aOR: 2.6; $p < 0.05$).

Results of the multivariable logistic regression analysis of gender factors associated with COVID-19-related public stigma are shown in Table 6. Male participants in the middle age (31–45 yrs) or higher age group (>61 yrs) had lower odds of having COVID-19-related high public stigma when compared to young age group males (18–30 yrs) [aOR: 0.54; $p < 0.05$ &aOR: 0.46; $p < 0.05$ respectively]. Female participants in the middle age group (31–45 yrs) had lower odds of having COVID-19-related high public stigma when compared to young age group females (18–30 yrs) [aOR: 0.73; $p < 0.05$]. Higher secondary and college-educated females had lower odds of having COVID-19-related high stigma when compared to illiterates [aOR: 0.53; $p < 0.05$ &aOR: 0.57; $p < 0.05$, re-

**Table 6**
Multivariableanalysis of gender-segregated predictors of COVID-19-related public stigma in the community.

| Demographic variables | Male No. (555) | % | aOR | P-value | 95% CI | Female No. (459) | % | aOR | P-value | 95% CI |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age (in Yrs)** | | | | | | | | | | |
| 31–45 | 185 | 33.3 | 0.54 | 0.001 | 0.38–0.77 | 167 | 36.0 | 0.73 | 0.050 | 0.53–0.99 |
| 46–60 | 117 | 21.0 | 0.67 | 0.060 | 0.45–1.01 | 73 | 15.9 | 0.84 | 0.424 | 0.55–1.27 |
| >61 | 23 | 4.1 | 0.46 | 0.021 | 0.24–0.89 | 10 | 2.1 | 0.94 | 0.896 | 0.37–2.36 |
| 18–30 | 230 | 41.4 | Reference | | | 209 | 45.0 | Reference | | |
| **Marital Status** | | | | | | | | | | |
| Married | 391 | 70.4 | 0.94 | 0.766 | 0.66–1.34 | 315 | 68.0 | 0.74 | 0.098 | 0.53–1.05 |
| Unmarried | 164 | 29.5 | Reference | | | 144 | 31.3 | Reference | | |
| **Occupation** | | | | | | | | | | |
| Organized | 186 | 33.5 | 0.90 | 0.774 | 0.46–1.76 | 115 | 25.0 | 0.92 | 0.647 | 0.66–1.29 |
| Unorganized | 309 | 55.6 | 1.27 | 0.473 | 0.65–2.44 | 72 | 15.6 | 0.95 | 0.823 | 0.65–1.40 |
| Students | 36 | 6.4 | 0.84 | 0.687 | 0.37–1.91 | 44 | 9.5 | 0.96 | 0.903 | 0.55–1.69 |
| Unemployed | 24 | 4.3 | Reference | | | 228 | 49.6 | Reference | | |
| **Education** | | | | | | | | | | |
| Primary | 36 | 6.4 | 1.83 | 0.176 | 0.76–4.42 | 40 | 8.7 | 0.87 | 0.676 | 0.47–1.62 |
| Higher Secondary | 298 | 53.6 | 1.34 | 0.392 | 0.68–2.63 | 191 | 41.6 | 0.53 | 0.010 | 0.33–0.86 |
| College | 199 | 35.8 | 0.74 | 0.403 | 0.37–1.49 | 172 | 37.4 | 0.57 | 0.038 | 0.34–0.97 |
| Illiterate | 22 | 3.9 | Reference | | | 56 | 12.2 | Reference | | |
| **Place of residence** | | | | | | | | | | |
| Rural | 294 | 52.9 | 0.95 | 0.710 | 0.72–1.24 | 259 | 56.4 | 1.36 | 0.024 | 1.04–1.79 |
| Urban | 261 | 47.0 | Reference | | | 200 | 43.5 | Reference | | |

Dependent variable in the model is "High self-risk perception about COVID-19". Coded as 1 if yes and coded as 0 if No.
*Adjusted Odds Ratio.

spectively]. Female rural residents had higher odds of having COVID-19-related high public stigma when compared to urban residents [aOR: 1.36; $p < 0.05$].

## 4. Discussion

This study reports the gender-segregated findings of COVID-19-related knowledge, self-risk perception and public stigma prevalent in the communities in India. The study findings are important since they provide a pan-Indian perspective and thus hold practical implications.

### *4.1. Gender and socio-demographic differences in COVID-19 knowledge*

Our study found that majority (67.8%) of community members reported low or poor COVID-19 knowledge, unlike the previous studies in India, which have reported a higher (59–75%) proportion of community members having correct COVID-19 knowledge [5,6]. Other studies conducted during the first wave of COVID-19 in India, used online survey methods involving educated and urban participants and thus may have limited participation of rural women, and illiterates who were included and represented in the present study. Hence, the difference in COVID-19 knowledge level found in our study can be attributed to the current study's wider and diverse sample representation.

Findings show that female participants' COVID-19 knowledge (69.77%) was lower than males' (65.87%), however, the difference was not statistically significant. This confirms prior studies from South Asian countries, where males had higher COVID-19 knowledge than females [10,17,18], which could be due to women's lower literacy, and lesser access to information, internet access, and cell phone ownership [19–21].

### *4.2. Gender and socio-demographic predictors of COVID-19 knowledge*

The study identified several gender-segregated factors that influence COVID-19 knowledge. Younger (18–30 yrs), college-educated, urban men and college-educated, working in organized-sector women had higher COVID-19 knowledge. College education was sixteen times more predictive of high COVID-19 knowledge among females and four times more predictive among males, underscoring the relevance of education in acquiring COVID-19 knowledge. This is similar to prior findings [5,6,10,17,18], and underscores the relevance of the level of public education as an important structural factor in a diverse and unequal country like India.

Male students and women working in the organized sector had better COVID-19 knowledge, indicating the importance of Information, Education, and Communication (IEC) activities required and undertaken at organizational levels in India. Rural males had lower COVID-19 knowledge than urban males, supporting this hypothesis. The lack of IEC activities in communities may have contributed to the propagation of myths and misleading information regarding COVID-19 during the initial wave of the pandemic, resulting in a rural-urban [22] and organized and unorganized sector knowledge divide. Our study indicated that younger males (18–30 yrs) have higher COVID-19 knowledge, unlike the previous study findings [5,18]. Our study gender-segregated data may explain these varied findings. Also, the younger age group and males having better COVID-19 knowledge could be attributed to the advantage they have in terms of cell phones and internet access. Since in India the younger age group (18–29 yrs) and males use more internet and smartphone as compared to the older age group and females [23–26] [23–26] [23–26], a male younger age group could be surfing more internet and watched more news related to COVID-19.

### *4.3. Gender and socio-demographic differences and predictors of COVID-19 self-risk perception*

Only one-fifth of the community members in our study had high self-risk perceptions, similar to earlier findings in India indicating low-risk perception [14,15]. However, in contrast to earlier studies [27–30] [27–30] [27–30], more female participants (81.72%) perceived themselves to be at lower risk of COVID-19 infection than males (77.94%). Rural men and women had lower self-risk perceptions too which could be attributed to the pandemic's limited spread in rural India during the first wave, which had a low community impact, unlike the second wave's rapid spread and adverse public health implications [31,32].

Married men in urban areas showed higher self-risk perception which could be attributed to their higher family responsibilities which require greater exposure to COVID-19-related risk outside the home for essential work. Moreover, since the COVID-19 infection was higher in the urban areas during the first wave [31], married urban males could have shown greater risk perception. The same patterns were reflected among females who were college-educated and employed in organized sectors. On the other hand, the higher self-risk perception could have been triggered by the higher level of awareness about the disease, as our study findings also showed that males had better COVID-19 knowledge but tended to have higher self-risk perceptions. Moreover, our multivariable analysis also showed that college-educated people have higher self-risk perceptions. A similar study finding was observed among the Nigerian and Canadian populations, where higher COVID-19 knowledge was related to greater risk perception [33,34].

Half of our study population (51.32%) expressed public stigma about COVID-19, underscoring the panic and fear over the once-in-a-century pandemic. The uncertainty surrounding transmission paths of the disease may have heightened stigma against the disease and the infected individuals. Studies in other counties have shown that stigmatizing attitude was reported to be in the range of 26% to 64% [35–38] [35–38] [35–38], which was at par with our study results. Our study showed that males in India had a higher public stigma rate than females, as previously observed [39]. Men may have a more stigmatizing attitude due to their higher self-risk perception, as previous studies have shown [36,37].

Our study indicated that younger age groups (18–30 yrs) had higher odds of having stigmatizing attitudes among both genders, contrary to prior studies that found older age groups have more stigmatizing attitudes [38,39]. Younger age groups may have more

stigmatizing attitudes since they were more engaged online. The social media spread of COVID-19 myths during the initial outbreak might have prevented them from discerning truth from false information [40–43] [40–43] [40–43].

Our gender-segregated multivariable analysis indicated that rural women had higher odds of having higher public stigma attitudes, whereas higher-educated women were less likely. We found no significant results based on male participants' education and place of residence. Rural attitudes about infectious diseases may explain this. Comparable findings in the context of stigmatizing diseases like TB indicated that rural inhabitants had low self-esteem and expressed stigma when a close family member was diagnosed with an infectious condition [44]. Low literacy and lack of knowledge of COVID-19 may also explain rural women's stigmatizing views and discrimination [45,46]. Thus, the place of living and the educational status of women were found to be driving the stigmatizing attitude in the community rather than being a woman itself. Interestingly such predictiveness was not found among the male gender in the present study.

In this paper, we considered gender as a structural determinant and how it drives the knowledge, risk perception and stigma of COVID-19. The method and insights arrived at from this study could be potential for understanding the gender dimensions prevalent during a pandemic situation and may not be particularly limited by the epidemic projectile over time.

These findings hold some practical implications for developing community-level interventions to address the COVID-19 stigma in India. Rural backwardness and lack of formal education (illiteracy) could be the two factors that need to be accounted for while developing interventions for mitigating stigma at the community level. Such data segregation might be helpful to reach the appropriate target population rather than implementing one fit for all interventions. Considering that pandemic events are highly probable in the 21st century as predicted by global health agencies [47,48], our analysis and interpretation could be valid baseline evidence to develop gender-responsive pandemic preparedness and information, education campaigns for pandemic situations in general in India.

### *4.4. Strength of the study*

Ours is the first multicentric study which is nationally representative in reporting the gender-segregated findings on COVID-19 knowledge, perception and stigma attitudes. The study followed a rigorous methodology involving standard statistical procedures and analysis methods which improve the reliability of the results. The measurement tools used for the data collection were developed and pilot tested, thus improving the validity of the study. The study also followed standard ethical guidelines and procedures and ensured participants' autonomy in reporting their COVID-19 experiences, knowledge and perceptions and thus could be considered valid and reliable. Given these strengths, the study findings can have significant implications for preparedness and interventions for future pandemics.

## 5. Limitations

The study findings are limited to the first COVID-19 wave in India and should be regarded as a baseline for knowledge, public stigma, and self-risk perception. Further studies would be required to track the changes in trend. We acquired the data via phone using self-report; thus, socially desirable responses are possible. The low response rate of telephonic interviews in the study majorly due to faulty phone numbers or network coverage issues may have resulted in a biased sample. However, this was the best available option to collect information from the participants during the pandemic when face-to-face interviews were not possible. Moreover, even though the COVID-19 knowledge and self-risk perception-related questionnaires have been developed with the help of various experts (psychologists, public health practitioners, epidemiologists, sociologists, demographers, statisticians and social workers) and have been pilot tested at the field level; they need to be further validated.

## 6. Conclusion

Overall, our research indicated that the general public had a low level of COVID-19 knowledge and self-risk perception, but had a strong public stigmatization toward individuals who are affected by the disease. In a gender-differentiated analysis, we discovered that men had more COVID-19 knowledge, a higher self-risk perception, and more stigmatizing attitudes than women. However, after controlling for various background demographic variables of both men and women, we identified some key factors that influenced both genders' knowledge, risk perception, and stigma. For both men and women, educational status and place of residence were the most significant characteristics that influenced the low level of knowledge, high self-risk perception, and high stigmatizing attitude.These findings suggest the importance of considering gender differentials and their background, education status and residential status in designing effective interventions to improve knowledge and reduce risk perception and stigma in the community about COVID-19.

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**Annexure-I**

| State | District | Zone |
|---|---|---|
| Highest COVID-19 Cases (Red districts) | | |
| Madhya Pradesh | Ujjain | Central |

(*continued on next page*)

Annexure-I (*continued*)

| State | District | Zone |
|---|---|---|
| | Bhopal | |
| Odisha | Khordha | East |
| | Cuttack | |
| Delhi | New Delhi | North |
| Uttar Pradesh | Gorakhpur | |
| Assam | Kamrup (Metro) | North-East |
| | Kamrup | |
| Tamil Nadu | Chennai | South |
| | Madurai | |
| Maharashtra | Mumbai | West |
| | Pune | |
| **Zero COVID-19 cases (Green districts)** | | |
| Madhya Pradesh | Sehore | Central |
| Odisha | Ganjam | East |
| Gorakhpur | Basti | North |
| Assam | KarbiAnglong | North-East |
| Tamil Nadu | Krishnagiri | South |
| Maharashtra | Nandurbar | West |

**Source:** 1. D, O. No. Z. 280 1 5/ 19/2020-EM R, Dated: 10/04/2020, Department of Health and Family Welfare, Ministry of Health and Family Welfare, Government of India
2. As of 30th April 2020. NE – North East

**Annexure-II**
Questions on COVID-19 knowledge

| Sl No. | Questions | Response | |
|---|---|---|---|
| 1. | COVID-19 is caused by | Germs<br>Virus<br>By Bat<br>Eating Seafood or any animal food/meat products<br>Others | (multiples responses) |
| 2. | COVID-19 is transmitted through | Air<br>Touching another person<br>Unknowingly touching a surface/object which has the virus and then touching your eyes and nose<br>Consumption of the meat/chicken/seafood<br>Visiting butcher shops and fish markets<br>Caused by contaminated water<br>Others | (multiples responses) |
| 3. | Symptoms of COVID-19 | Fever<br>Cough<br>Difficulty in breathing<br>Nasal congestion<br>Running nose<br>Sore Throat<br>Loss of smell and taste<br>Fatigue<br>Diarrhea<br>Constipation,<br>Rash<br>Asymptomatic (No symptoms)<br>Any pain (head, body muscle, chest, back)<br>Others | (multiples responses) |
| 4. | Is it possible that COVID-19 positive individuals can be completely asymptomatic for some time? | True<br>False | True/false |
| 5. | COVID-19 can be prevented through | wearing face mask<br>Washing hands frequently (With soap/hand sanitizer)<br>Practicing physical distancing<br>Avoiding contact with people who have symptoms of cough<br>Avoiding contact with people who have a travel history to a foreign country<br>Avoiding crowded areas | (multiples responses) |

(*continued on next page*)

Annexure-II (*continued*)

| Sl No. | Questions | Response |
|---|---|---|
| | | Not visiting butcher shops and fish markets<br>Avoiding visits to a hospital or clinic<br>Avoiding public transportation<br>Being at home<br>others |

Question on COVID-19 self-risk perceptions

| Sl. No. | Question | Response | |
|---|---|---|---|
| 1. | How likely do you think you might become infected with COVID-19? | Very Unlikely<br>Unlikely<br>Neutral<br>Likely<br>Very likely | 5 point scale |

Statements on Public stigma

| Sl. No. | Statements | Response | |
|---|---|---|---|
| 1. | People infected with COVID-19 are always careless and spread the disease | Agree<br>Disagree<br>Cant' say | 3 point scale |
| 2. | People with COVID-19 disease got what they deserve | Agree<br>Disagree<br>Cant' say | |
| 3. | If a person was infected with COVID-19, it is better to avoid his/her family members | Agree<br>Disagree<br>Cant' say | |
| 4. | People infected with COVID-19 should continue to be isolated even after their recovery | Agree<br>Disagree<br>Cant' say | |
| 5. | Most people are uncomfortable around COVID-19-infected people even after their results are negative and after they are discharged from the hospital | Agree<br>Disagree<br>Cant' say | |
| 6. | People with COVID-19 are treated as outcaste | Agree<br>Disagree<br>Cant' say | |

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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