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RESEARCH ARTICLE

Trends over time in the knowledge, attitude and practices of pregnant women related to COVID-19: A cross-sectional survey from seven low- and middle-income countries

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Abstract

Objective: To understand trends in the knowledge, attitudes and practices (KAP) of pregnant women related to COVID-19 in seven low- and middle-income countries.

Design: Multi-country population-based prospective observational study.

Setting: Study sites in Bangladesh, the Demographic Republic of Congo (DRC), Guatemala, India (two sites), Kenya, Pakistan and Zambia.

Population: Pregnant women in the Global Network's Maternal and Neonatal Health Registry (MNHR).
Methods: Pregnant women enrolled in the MNHR were interviewed to assess their KAP related to COVID-19 from September 2020 through July 2022 across all study sites.
Main outcome measures: Trends of COVID-19 KAP were assessed using the Cochran–Armitage test for trend.
Results: A total of 52 297 women participated in this study. There were wide inter-country differences in COVID-19-related knowledge. The level of knowledge of women in the DRC was much lower than that of women in the other sites. The ability to name COVID-19 symptoms increased over time in the African sites, whereas no such change was observed in Bangladesh, Belagavi and Guatemala. All sites observed decreasing trends over time in women avoiding antenatal care visits.
Conclusions: The knowledge and attitudes of pregnant women related to COVID-19 varied substantially among the Global Network sites over a period of 2 years; however, there was very little change in knowledge related to COVID-19 over time across these sites. The major change observed was that fewer women reported avoiding medical care because of COVID-19 across all sites over time.

KEYWORDS
COVID-19, KAP, LMICs, pregnant women, trends

1 | INTRODUCTION

COVID-19 first appeared in late 2019 and was declared a global pandemic by the World Health Organization (WHO) in March 2020.[1] Since the onset, the viral cause of COVID-19, severe acute respiratory syndrome coronavirus 2 (SARS-COV-2),[2] has been continually mutating. The repeated emergence of new variants of SARS-COV-2, each differing in transmission and severity, continues to raise global health concerns.[2] The different variants of COVID-19 together have resulted in more than 6 million deaths worldwide.[2–4]

The SARS-CoV-2 virus spreads via respiratory droplets; the disease presentation can range from asymptomatic to severe illness, leading to hospitalisation and death. Older age and pre-existing medical conditions increase the risk of developing severe disease and mortality.[5] Pregnant women appear more prone to contracting COVID-19, and those with severe disease may have an increase in adverse outcomes. Published reports suggest that the clinical presentation of COVID-19 in pregnant women can be similar to that in the general population, but the potential of increased risk of adverse pregnancy outcomes, such as preterm birth and low birthweight, are of concern.[6]

In the beginning of the epidemic, when vaccines were not available, appropriate personal behaviours were critical in safe-guarding individuals from contracting COVID-19. For the effective control of disease spread, the WHO emphasized preventive measures such as hand-washing, social distancing, mask wearing and the reduction of interpersonal contacts.[7] Lockdowns were enforced within countries and travel bans were imposed.[8]

Attitudes towards the way people reacted to COVID-19 appeared to change gradually. The strict adherence to mask wearing, social distancing and avoiding social gatherings and crowded areas decreased over time.[9,10] The introduction of anti-COVID-19 vaccines, which decreased the severe morbidity and mortality associated with COVID-19 infection, is likely to have accelerated the change in appropriate protective behaviours.[11] Nevertheless, precautionary behavioural measures (in addition to vaccination against COVID-19) remain the mainstay for containing the pandemic.[12,13] The WHO has emphasized the importance of continuously improving the awareness related to COVID-19 to control its spread.[14] By understanding the knowledge, attitude and practices (KAP) of pregnant women related to COVID-19, issues related to improving their safety can be identified and addressed.

Various studies assessing KAP related to COVID-19 have been conducted around the world; however, very limited data are available among pregnant women in general, and particularly in low- and middle-income countries (LMICs). A recently published KAP study of pregnant women conducted by Naqvi et al. revealed that pregnant women in LMICs often have limited knowledge related to COVID-19, and used varying practices to prevent COVID-19.[15] However, no data are available to assess the COVID-19-related KAP trends in LMICs over time. The present study aims to understand the trends of KAP in pregnant women related to COVID-19 in seven LMICs.

2 | METHODS

The *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) Global Network's multi-country COVID-19 KAP study was initiated to examine the

KAP of pregnant women related to COVID-19.[15] The study was conducted as part of the Global Network's Maternal Newborn Health Registry (MNHR) at eight sites in seven countries from September 2020 through July 2022.[16,17] The participating sites were located in Bangladesh (District Tangail), the Democratic Republic of the Congo (DRC) (North and South Ubangi Province), Guatemala (Chimaltenango), India (Belagavi and Nagpur), western Kenya, Pakistan (Thatta in Sindh Province) and Zambia (Kafue and Chongwe). The starting date of the KAP survey varied by site, and ranged from 17 September 2020, in Pakistan, to 9 February 2021, in Zambia. The questionnaires were generally completed with help from research staff in the health clinics at the woman's first prenatal visit.

The level of knowledge related to COVID-19 was assessed by questions related to nine symptoms, four modes of transmission, six methods to prevent spread and the two groups at highest risk. Each of the questions was asked in an open-ended fashion. Symptoms of interest related to COVID-19 included fever, cough, difficulty breathing, sore throat, runny or stuffy nose, tiredness, aches and pains, diarrhoea and the loss of taste or smell. Transmission modes of interest included respiratory droplets from a sick person, respiratory droplets from an asymptomatic person, touching contaminated objects and shaking hands. Preventative measures of interest included hand-washing or using a hand sanitizer, keeping a distance from others, avoiding shaking hands, avoiding touching face, wearing a mask and staying home. High-risk groups of interest included the elderly and those with other comorbidities.

2.1 | Statistical analyses

Data analysis was performed with SAS Enterprise Guide 7.1 (SAS Institute Inc., Cary, NC, USA). For each of the knowledge components, scores were computed using valid responses and then dichotomized according to whether the participant met a minimum threshold of valid responses. These were defined as being able to identify at least three symptoms, at least two transmission modes, at least three prevention measures and at least one group at greatest risk. The components of attitudes included the fear of getting COVID-19 from their provider while visiting for antenatal care and their concerns regarding the capacity of hospitals to provide care. Practices included the avoidance of receiving prenatal care and keeping a distance from others to prevent women from COVID-19 exposure.

Data collection occurred from September 2020 through July 2022. For the time trend analysis, we divided the time into four periods (September 2020–February 2021, March 2021–August 2021, September 2021–February 2022 and March 2022–July 2022). Maternal demographic characteristics and distributions of KAP related to COVID-19 stratified by time periods are presented in frequencies and percentages. The time trends were assessed by the unadjusted and adjusted Cochran–Armitage test for trend by site for the given characteristics over the four time periods; $p < 0.05$ for trend was considered a statistically significant association between the KAP characteristics for COVID-19 with the time periods. The country/regional differences in KAP characteristics related to COVID-19 were compared by the time periods for each country and were plotted as bar charts.

2.2 | Ethical approvals

This study was approved by the institutional review board at each US university, the Research Triangle Institute International and by the relevant ethics review committees of the participating sites. All women provided informed consent for participation in the study.

3 | RESULTS

During the time of the KAP survey, data collection continued across the eight sites. A total of 74 169 women were enrolled in the MNHR and 52 297 women answered the COVID-19 questionnaire (Figure 1). Table 1 describes the numbers and proportions of maternal socio-demographic and obstetric characteristics by time period. Most women were 20–35 years of age (76.9%). About 71% of women had primary or secondary education, and this increased over time. Of the women enrolled in the study, 38.5% were enrolled in the first trimester, 45.1% were enrolled in the second trimester and 16.4% were enrolled in the third trimester. Nearly 74% of the women enrolled were either nulliparous or had a parity of one or two.

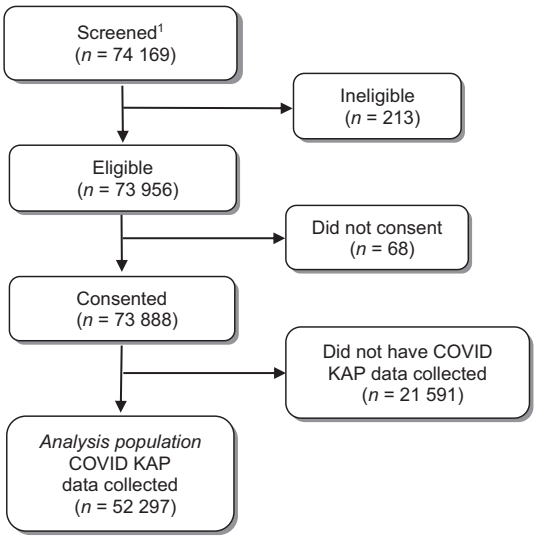

FIGURE 1 Enrolment diagram. [1]Data entered into the data management system as of 8 September 2022 are included in this report. Screened during the time period during which the COVID-19 knowledge, attitudes and practices (KAP) data were collected. The sites began collecting COVID-19 KAP as follows: Pakistan, 17 September 2020; DRC, 16 October 2020; Guatemala, 12 November 2020; Nagpur, India, 26 November 2020; Kenya, 15 December 2020; Belagavi, India, 15 December 2020; Bangladesh, 15 December 2020; and Zambia, 9 February 2021.

TABLE 1 Maternal sociodemographic characteristics by study time period.

Characteristic	Overall, *n* (%)	Time period, *n* (%)			
		Sep 2020–Feb 2021	Mar 2021–Aug 2021	Sep 2021–Feb 2022	Mar 2022–Jul 2022
Women, *n*	52 297	8597	14 395	16 516	12 789
Maternal age (years)	52 289	8596	14 394	16 512	12 787
<20	8792 (16.8)	1342 (15.6)	2375 (16.5)	2930 (17.7)	2145 (16.8)
20–35	40 225 (76.9)	6737 (78.4)	11 182 (77.7)	12 514 (75.8)	9792 (76.6)
≥36	3272 (6.3)	517 (6.0)	837 (5.8)	1068 (6.5)	850 (6.6)
Maternal level of education	52 271	8596	14 393	16 505	12 777
No formal schooling, illiterate	11 374 (21.8)	2327 (27.1)	3069 (21.3)	3562 (21.6)	2416 (18.9)
Primary/secondary	37 300 (71.4)	5731 (66.7)	10 276 (71.4)	11 919 (72.2)	9374 (73.4)
University+	3597 (6.9)	538 (6.3)	1048 (7.3)	1024 (6.2)	987 (7.7)
Gestational age upon enrolment (weeks)	51 448	8430	14 057	16 290	12 671
0–13	19 783 (38.5)	2933 (34.8)	5760 (41.0)	5792 (35.6)	5298 (41.8)
14–28	23 210 (45.1)	3949 (46.8)	5922 (42.1)	7616 (46.8)	5723 (45.2)
≥29	8455 (16.4)	1548 (18.4)	2375 (16.9)	2882 (17.7)	1650 (13.0)
Parity	52 282	8597	14 395	16 505	12 785
0	16 655 (31.9)	2579 (30.0)	4676 (32.5)	5102 (30.9)	4298 (33.6)
1–2	21 945 (42.0)	3567 (41.5)	6219 (43.2)	6775 (41.0)	5384 (42.1)
≥3	13 682 (26.2)	2451 (28.5)	3500 (24.3)	4628 (28.0)	3103 (24.3)

TABLE 2 Evaluation of maternal knowledge, attitutdes and practices from September 2022 through July 2022.

Characteristic	Overall *n* (%)	Time period, *n* (%)				*p*-value[a]	
		Sep 2020–Feb 2021	Mar 2021–Aug 2021	Sep 2021–Feb 2022	Mar 2022–Jul 2022	Unadjusted	Adjusted[b]
Women, *n*	52 297	8597	14 395	16 516	12 789		
Knowledge							
3+ symptoms	28 450 (54.4)	4014 (46.7)	8705 (60.5)	8994 (54.5)	6737 (52.7)	0.047*	0.87
2+ transmission modes	17 080 (32.7)	2563 (29.8)	5190 (36.1)	5344 (32.4)	3983 (31.1)	0.08	<0.0001**
3+ preventive measures	25 999 (49.7)	3494 (40.6)	7948 (55.2)	8780 (53.2)	5777 (45.2)	0.11	0.14
1+ high-risk groups	41 385 (79.1)	6475 (75.3)	11 678 (81.1)	12 595 (76.3)	10 637 (83.2)	<0.0001**	<0.0001**
Attitudes							
Fear of COVID-19 exposure	13 204 (25.2)	1648 (19.2)	3714 (25.8)	4455 (27.0)	3387 (26.5)	<0.0001**	<0.0001**
Believe that hospital lacks capacity to provide care	7923 (15.2)	1796 (20.9)	2011 (14.0)	1887 (11.4)	2229 (17.4)	<0.0001**	<0.0001**
Practices							
Avoided prenatal care	7911 (15.1)	2804 (32.6)	3019 (21.0)	1188 (7.2)	900 (7.0)	<0.0001**	<0.0001**
Maintained distance to avoid COVID-19	22 553 (43.1)	3225 (37.5)	6705 (46.6)	7514 (45.5)	5109 (39.9)	0.60	0.005*

[a]Cochran–Armitage test for trend for a given characteristic over the four time periods: *$p < 0.05$; **$p < 0.001$.

[b]Adjusted by site.

Table 2 presents the proportion of women over time in all sites able to respond correctly to the minimum number of questions defined as having acceptable KAP. The last two columns present the unadjusted and the adjusted *p*-values for the test of trend. About 54% of women named three or more COVID-19 symptoms, 32.7% knew two or more transmission modes, 49.7% knew three or more preventive measures and 79.1% named at least one high-risk condition.

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Knowledge about the transmission modes was significantly higher in participants surveyed between March 2021 and August 2021, compared with the first 6 months of the survey, and thereafter it remained more or less consistent over time. However, knowledge about preventive measures was higher during the second and third time periods, ranging from March 2021 to February 2022, compared with the first and last time periods ($p < 0.0001$ for each).

With regards to attitudes, women were asked about obstacles to receiving COVID-19-related care. Over the time periods studied, about 25% of the women reported fears of getting COVID-19 from their provider, and 15% raised concerns regarding the capacity of hospitals to provide care. As with knowledge, there were small changes over time in these issues, including an increasing trend of fear of COVID-19 exposure and a decreasing trend of concerns regarding the capacity of hospitals to provide care.

Women were also asked whether they had avoided or planned to avoid prenatal care at clinics because of their fear of COVID-19. Over the entire time period, 15% of women said they planned to avoid antenatal care visits at the clinic, but from the first to the last time period, the proportion that said they would avoid care decreased from 32.6% to 7.0%. Over all time periods, 43.1% of women said that they would keep their distance from others to avoid COVID-19, and although there were small fluctuations, the actual proportion did not change much over time.

We also assessed women's KAP related to COVID-19 by study site and time period. Figure 2 shows the percentages of women in each site over time who could name at least three symptoms, two or more modes of transmission, three or more preventive measures and at least one high-risk group. The first observation on scanning the four panels is how different and much lower the knowledge levels of the women in the DRC were compared with the women at the other sites. Figure 2(A) shows that the ability to name three or more symptoms increased over time in each of the African sites (DRC, Kenya and Zambia) ($p \leq 0.005$ for each), in comparison with the Nagpur and Pakistani sites, where an initial increase in the ability to name three or more symptoms was followed by a significant decrease in ability. The sites in Bangladesh, Belagavi and Guatemala had no significant changes over time ($p \geq 0.97$ for each). Figure 2(B) shows that six of the eight sites had small but significant decreasing trends in the ability to name two or more modes of transmission ($p \leq 0.042$), whereas the Zambian site had an increasing trend ($p \leq 0.0001$). The Nagpur site had no change in this characteristic over time ($p = 0.85$).

Figure 2(C) shows that an increasing trend in the ability to name three or more prevention measures was observed in all African sites and in the Bangladeshi site ($p \leq 0.003$ for each), in comparison with the Nagpur and Pakistani sites, which had significant decreasing trends ($p < 0.0001$). Neither the Guatemalan site nor the Belagavi site had a significant change over time ($p \geq 0.08$). Figure 2(D) similarly shows that the African and Pakistani sites showed an increasing time trend for knowing at least one high-risk group ($p < 0.0001$ for each), compared with the Indian and Bangladeshi sites, which had significant decreasing trends ($p \leq 0.010$); the Guatemalan site had no significant trend with time ($p = 0.07$).

Figure 3 describes trends for possible obstacles to receiving COVID-19-related care by site. Figure 3(A) shows that the

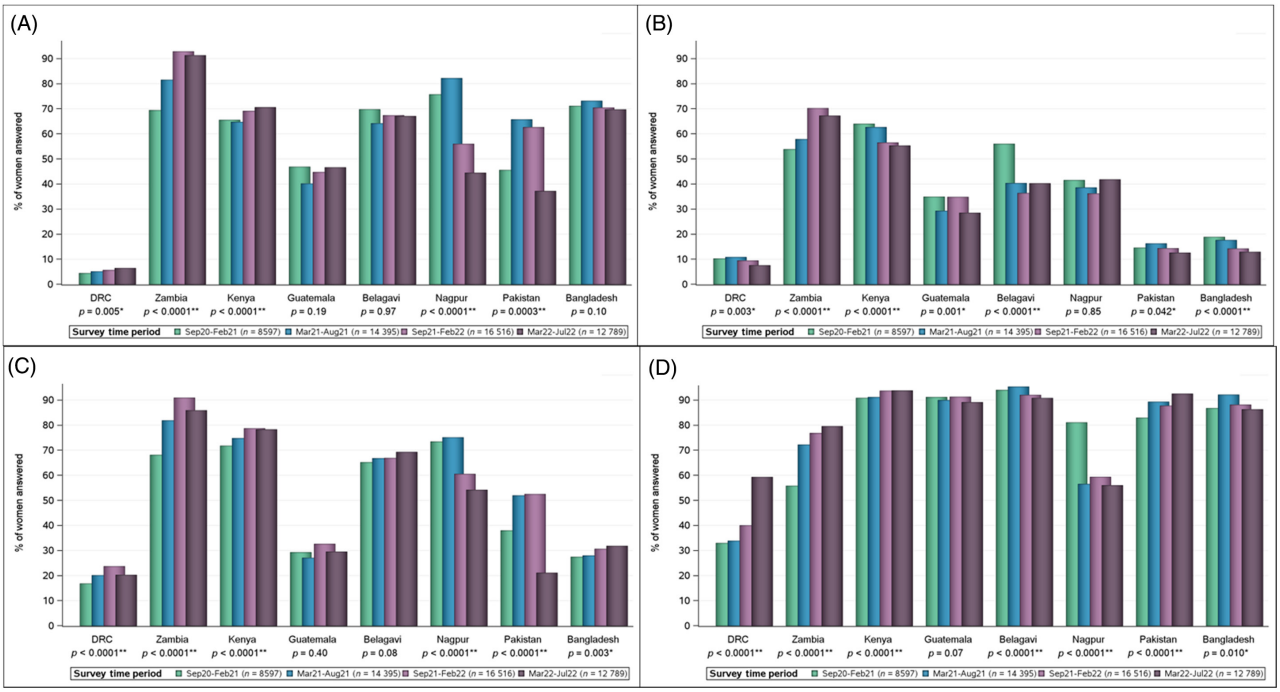

FIGURE 2 Womens' knowledge about COVID-19 by site and time period. (A) Knowledge of 3+ symptoms by site and time period. (B) Knowledge of 2+ transmission modes by site and time period. (C) Knowledge of 3+ prevention measures by site and time period. (D) Knowledge of 1+ high risk group by site and time period.

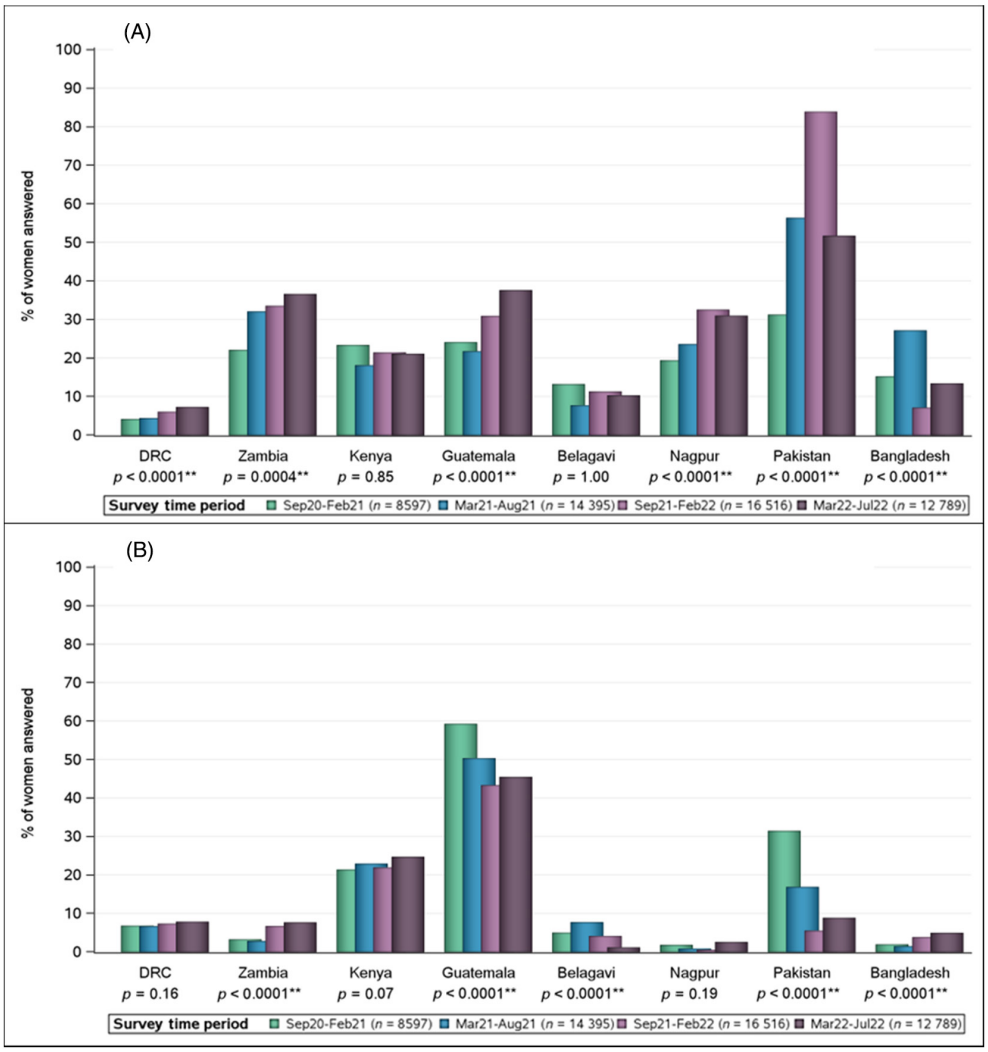

FIGURE 3 Women's attitudes to COVID-19 by site and time period. (A) Fear of COVID-19 exposure from provider by site and time period. (B) Believe hospital lacks capacity to provide care by site and time period.

DRC, Zambia, Guatemala, Nagpur, and Pakistani sites had significant increasing trends for women's fear of COVID-19 exposure ($p \leq 0.0004$), in comparison with the Bangladeshi site, with a decreasing trend ($p < 0.0001$). The Kenyan and Belagavi sites had no significant trends in these answers over time ($p = 0.85$ and $p = 1.00$, respectively). Figure 3(B) similarly shows an increasing trend for women's concerns regarding the capacity of hospitals to provide care was found in the Zambian and Bangladeshi sites ($p < 0.0001$ for each), in comparison with the decreasing trends with time in the Guatemalan, Belagavi and Pakistani sites ($p < 0.0001$). For this issue, the DRC, Kenyan and Nagpur sites had no significant association with time ($p \geq 0.07$).

Figure 4 presents the trends over time for women's avoidance in receiving antenatal care and keeping a distance from others because of COVID-19. Figure 4(A) shows all participating sites observed decreasing trends with time in women avoiding clinic visits for antenatal care ($p < 0.0001$ for each). Figure 4(B) similarly shows that there was an increasing trend with time observed for keeping a distance from others to avoid COVID-19 exposure in Zambia, Kenya, Belagavi and Bangladesh ($p \leq 0.019$ each). In comparison, the Guatemala, Nagpur and Pakistani sites had decreasing trends ($p < 0.0001$ for each); the DRC site did not show any significant trend over time ($p = 0.20$).

4 | DISCUSSION

4.1 | Main findings

The current study, conducted in Global Network sites of seven LMICs on three continents, revealed wide inter- and intra-regional variations in COVID-19-related KAP over time in pregnant women. There was wide inter-country variation in knowledge, with the level of knowledge of women in the DRC being much lower than in women at the other sites; however, the ability to name symptoms increased over time in African countries, whereas no such change was observed in Guatemala, Belagavi, and Bangladesh. Similar trends with wide inter-site variation were observed with regards to attitude. With regards to preventive practices, all participating

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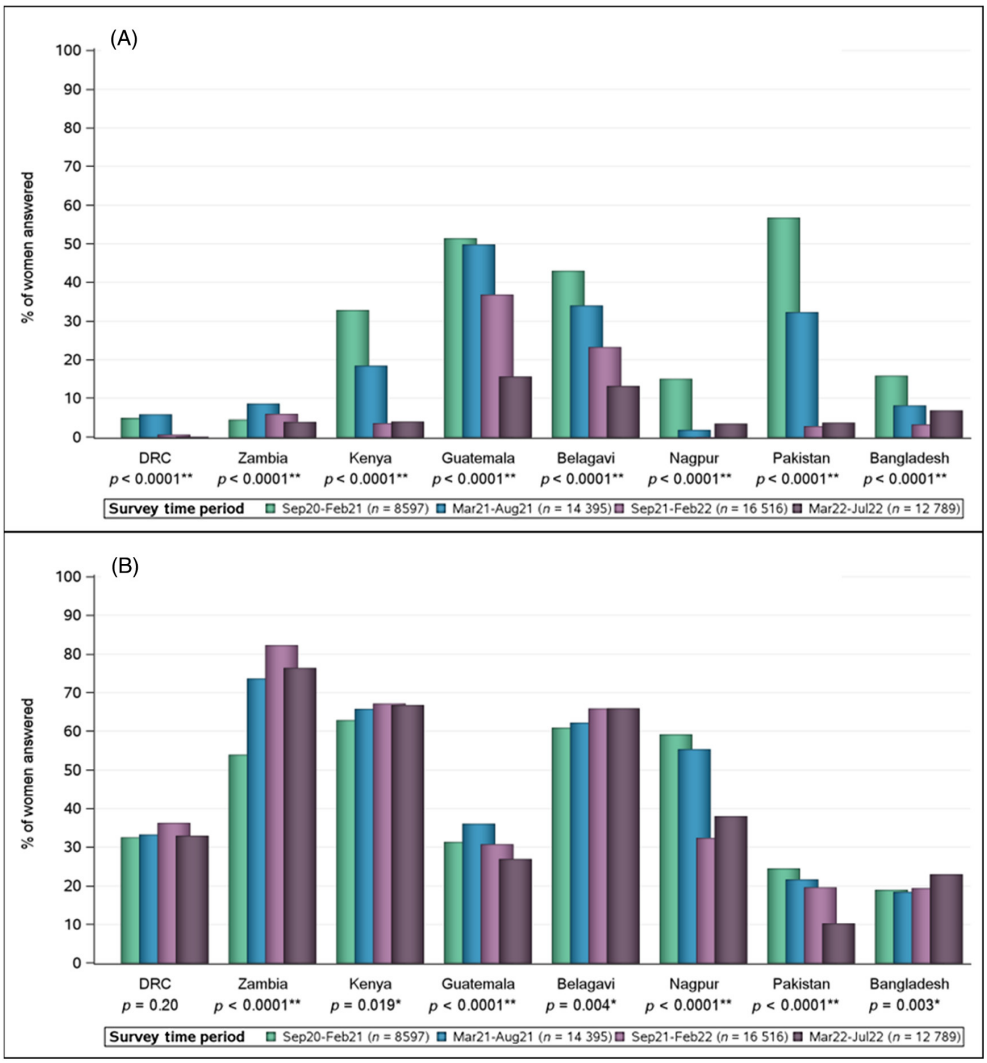

FIGURE 4 Women's practices regarding COVID-19 by site and time period. (A) Avoided prenatal care by site and time period. (B) Maintained distance to avoid COVID-19 by site and time period.

sites observed decreasing trends with time in women avoiding clinic visits for antenatal care; however, there was wide variation among countries about keeping a distance from others to avoid COVID-19 exposure.

4.2 | Strengths and limitations

The article has some strengths and limitations. To the best of our knowledge, this is the first study comparing trends of COVID-19 KAP over time among pregnant women in LMICs of Asia, Africa and Central America. Moreover, it is a multinational population-based study with a large sample size. Data were collected prospectively from pregnant women over a period of 2 years using a standardized survey instrument. The limitations include the varied timing of survey execution in study sites and the use of a non-validated tool with arbitrary cut-offs. We acknowledge that we had no time to validate the study tools and cut-offs because of the rapidly evolving pandemic. However, study tools were evaluated and approved by the investigators of all study sites.

4.3 | Interpretations

The world has been through several waves of COVID-19 since the onset of the pandemic in 2020. Therefore, it is important to examine trends in KAP over time in pregnant women, to better understand and develop effective strategies to improve outcomes related to COVID-19 infection. Although this is important for the general population, it may be particularly important for pregnant women as they are one of the most vulnerable groups and have unique issues. Various studies have evaluated KAP related to COVID-19 among pregnant women,[15,18–22] but none have assessed the trends over time in pregnant women's KAP across sites. However, a few single- and multi-site studies have examined the changes over time in KAP related to COVID-19 in the general population.[23–26]

In this large multi-site study, we had an opportunity to examine trends in COVID-19 KAP among pregnant women of seven LMICs over a period of 2 years.

The overall knowledge of pregnant women in our study related to COVID-19 symptoms, mode of transmission, preventative measures and identifying high-risk groups was widely variable across the sites and time periods. Women in the DRC had a lower level of knowledge than women in the other sites. The wide inter-country variability in our study regarding knowledge related to COVID-19 is consistent with the diverse findings from studies conducted in South Africa,[27] Ghana,[20] Iran,[21] Bangladesh,[19] and Pakistan.[28] Across the time periods, the fluctuations in some of these rates by test of trend were significant. However, inspection of the actual values does not reveal important changes in these values over time. We suspect that the large sample size contributes to the significant *p*-values.

We found a decreasing fear of getting COVID-19 from their providers and belief that hospitals lack capacity to provide care. These results are consistent with reports about pregnant women from South Africa.[27] The decreasing proportion of the women with fear of getting COVID-19 from their providers across our sites is also consistent with a multinational study of 22 countries where 36.8% of the population had a fear of getting COVID-19 from their doctors.[29]

During the early days of study, about one third of pregnant women in general and nearly half of the Guatemalan, Indian and Pakistani women planned to avoid prenatal care. However, this fear decreased significantly over time to only 7% planning to avoid prenatal care. The initial findings are consistent with an Indian study,[22] where 32% of women planned to avoid antenatal care visits. Potential reasons for these changes may include increased vaccination coverage over time, with an improved sense of protection, and relaxed movement and lockdown restrictions.

5 | CONCLUSION

The knowledge and attitudes of pregnant women related to COVID-19 varied substantially among the Global Network sites over a period of 2 years; however, there was very little change in knowledge related to COVID-19 over time across these sites. The major change we observed across all sites is that over time, fewer women claimed to avoid medical care because of COVID-19 risk. These may have implications for policymakers and public health experts across sites.

AUTHOR CONTRIBUTIONS

RLG, SS, SJ, SMB, EMM, PLH, CCB and NFK conceived of the study, with input from SSG, EC, RJD, AP, WAP, MB, WAC, SB and MKT. EF and CMB performed statistical analyses. RH, LF, AL, AT, AK, FE, PD and MM oversaw the implementation. SJ and RLG wrote the first draft of the article, with input from SS and EMM. All authors reviewed and approved the final version for publication.

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CONFLICT OF INTEREST STATEMENT

None.

ETHICS STATEMENT

This study was approved by the institutional review board at each US university, the Research Triangle Institute International and by the relevant ethics review committees of the participating sites.

DATA AVAILABILITY STATEMENT

Data for this study will be available through the NICHD Data and Specimen Hub https://dash.nichd.nih.gov/.

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REFERENCES

1. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. Acta Bio Medica: Atenei Parmensis. 2020;91(1):157.
2. SeyedAlinaghi S, Mirzapour P, Dadras O, Pashaei Z, Karimi A, MohsseniPour M, et al. Characterization of SARS-CoV-2 different variants and related morbidity and mortality: a systematic review. Eur J Med Res. 2021;26(1):1–20.
3. Velavan TP, Meyer CG. The COVID-19 epidemic. Trop Med Int Health. 2020;25(3):278–80.
4. WHO. WHO Coronavirus (COVID-19) Dashboard with vaccination data 2022. Available from: https://covid19.who.int/
5. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. New England Journal of Medicine. 2020;382:1199–207.
6. Allotey J, Stallings E, Bonet M, Yap M, Chatterjee S, Kew T, et al. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: living systematic review and meta-analysis. BMJ. 2020;370:m3320.
7. World Health Organization. Rational use of personal protective equipment (PPE) for coronavirus disease (COVID-19): interim guidance, 19 march 2020. Geneva, Switzerland: World Health Organization; 2020.
8. Prem K, Liu Y, Russell TW, Kucharski AJ, Eggo RM, Davies N, et al. The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study. Lancet Public Health. 2020;5(5):e261–70.
9. Rastogi T, Awasthi S, Khare R, Prasad M, Sami G, Verma VK. Perceptions and practices of COVID-19 protective measures among

the general public of North India. Clinical Epidemiology and Global Health. 2022;13:100927.
10. Wafula ST, Mugume IB, Sensasi B, Okware S, Chimbaru A, Nanyunja M, et al. Intention to vaccinate against COVID-19 and adherence to non-pharmaceutical interventions against COVID-19 prior to the second wave of the pandemic in Uganda: a cross-sectional study. BMJ Open. 2022;12(6):e057322.
11. Kirby T. New variant of SARS-CoV-2 in UK causes surge of COVID-19. Lancet Respir Med. 2021;9(2):e20–1.
12. Kuhlmann C, Mayer CK, Claassen M, Maponga T, Burgers WA, Keeton R, et al. Breakthrough infections with SARS-CoV-2 omicron despite mRNA vaccine booster dose. Lancet. 2022;399(10325):625–6.
13. Deng J-F, Olowokure B, Kaydos-Daniels S, Chang H-J, Barwick R, Lee M-L, et al. Severe acute respiratory syndrome (SARS): knowledge, attitudes, practices and sources of information among physicians answering a SARS fever hotline service. Public Health. 2006;120(1):15–9.
14. Nachega JB, Sam-Agudu NA, Budhram S, Taha TE, Vannevel V, Somapillay P, et al. Effect of SARS-CoV-2 infection in pregnancy on maternal and neonatal outcomes in Africa: an AFREhealth call for evidence through multicountry research collaboration. Am J Trop Med Hyg. 2021;104(2):461.
15. Naqvi F, Naqvi S, Billah SM, Saleem S, Fogleman E, Peres-da-Silva N, et al. Knowledge, attitude and practices of pregnant women related to COVID-19 infection: a cross-sectional survey in seven countries from the global network for Women's and Children's health. BJOG. 2022;129:1289–97.
16. Koso-Thomas M, McClure EM. Global network for Women's and Children's Health Research Investigators. The global network for Women's and Children's Health Research: a model of capacity-building research. Semin Fetal Neonatal Med. 2015;20:293–9.
17. McClure EM, Garces AL, Hibberd PL, Moore JL, Goudar SS, Saleem S, et al. The global network maternal newborn health registry: a multi-country, community-based registry of pregnancy outcomes. Reproductive Health. 2020;17(2):1–11.
18. Anikwe CC, Ogah CO, Anikwe IH, Okorochukwu BC, Ikeoha CC. Coronavirus disease 2019: knowledge, attitude, and practice of pregnant women in a tertiary hospital in Abakaliki, Southeast Nigeria. Int J Gynaecol Obstet. 2020;151(2):197–202.
19. Ferdous MZ, Islam MS, Sikder MT, Mosaddek ASM, Zegarra-Valdivia JA, Gozal D. Knowledge, attitude, and practice regarding COVID-19 outbreak in Bangladesh: an online-based cross-sectional study. PloS One. 2020;15(10):e0239254.
20. Kumbeni MT, Apanga PA, Yeboah EO, Lettor IBK. Knowledge and preventive practices towards COVID-19 among pregnant women seeking antenatal services in northern Ghana. PLoS One. 2021;16(6):e0253446.
21. Maharlouei N, Asadi N, Bazrafshan K, Roozmeh S, Rezaianzadeh A, Zahed-Roozegar MH, et al. Knowledge and attitude regarding COVID-19 among pregnant women in southwestern Iran in the early period of its outbreak: a cross-sectional study. Am J Trop Med Hyg. 2020;103(6):2368–75.
22. Goyal M, Singh P, Singh K, Shekhar S, Agrawal N, Misra S. The effect of the COVID-19 pandemic on maternal health due to delay in seeking health care: experience from a tertiary center. Int J Gynaecol Obstet. 2021;152(2):231–5.
23. Lau LL, Hung N, Go DJ, Choi M, Dodd W, Wei X. Dramatic increases in knowledge, attitudes and practices of COVID-19 observed among low-income households in The Philippines: a repeated cross-sectional study in 2020. J Glob Health. 2022;12:05015.
24. Thisted L. COVID-19 knowledge, attitudes and practices (KAP) survey April (round 1) and may (round 2) 2020 Northwest Syria analysis. Epidemic. REACH Initiative. 2020. Available from: https://reliefweb.int/report/syrian-arab-republic/covid-19-knowledge-attitudes-and-practices-kap-survey-northeast-syria-0 Accessed 12 Feb 2023
25. Braley J. COVID-19 knowledge, attitudes and practices (KAP) survey: Northeast Syria analysis – April (round 2) and may (round 3) 2020 assessment. REACH Initiative. 2020. Available from: https://reliefweb.int/report/syrian-arab-republic/covid-19-knowledge-attitudes-and-practices-kap-survey-northeast-syria-1 Accessed 12 Feb 2023
26. John Hopkins Center for Communication Programs. KAP COVID Trend Analysis for 23 Countries. 2021. Available from: https://ccp.jhu.edu/kap-covid/kap-covid-trend-analysis-for-23-countries/ Accessed 12 Feb 2023
27. Hoque AM, Alam AM, Hoque M, Hoque ME, Hal GV. Knowledge, attitudes, and practices towards COVID-19 of pregnant women at a primary health Care Facility in South Africa. European Journal of Medical and Health Sciences. 2021;3(1):50–5.
28. Naz S, Dur ESS, Saleem S, Malik A, Raza A. Knowledge, attitudes, and practices (KAP) towards COVID-19 pandemic among pregnant women in a tertiary hospital in Karachi, Pakistan. PLoS One. 2022;17(11):e0274252.
29. Masoud AT, Zaazouee MS, Elsayed SM, Ragab KM, Kamal EM, Alnasser YT, et al. KAP-COVID(GLOBAL): a multinational survey of the levels and determinants of public knowledge, attitudes and practices towards COVID-19. BMJ Open. 2021;11(2):e043971.

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