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Associations of internet use and pregnancy loss with depression and anxiety among women in Bangladesh: evidence from the 2022 BDHS

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Abstract

Background Mental health disorders, such as depression and anxiety, are notable among Bangladeshi married women. Nevertheless, to the best of our knowledge, none study has examined combinedly association between pregnancy loss, internet use, and mental health indicators in Bangladesh. This study aims to explore associations between pregnancy loss, internet use, and mental health symptoms as well as to detect regional disparities among ever married women in Bangladesh.

Methodology This study analyzed 19,987 ever-married women from the Bangladesh Demographic and Health Survey (BDHS) 2022. Depression and anxiety were evaluated using PHQ-9 and GAD-7 scales, respectively. Stepwise survey-weighted multinomial logistic regression was used to analyze the association of mental health indicators with pregnancy loss and internet use. Spatial analysis explored division-wise patterns of mental health outcomes, pregnancy loss, and internet use.

Findings Among 19,987 ever-married women, 5.13% moderate to severe depression and 4.48% experienced moderate to severe anxiety. Pregnancy loss was associated with higher odds of depression and anxiety: women with one loss (anxiety AOR = 1.31, 95% CI: 1.20–1.43); and (depression AOR = 1.29, 95% CI: 1.18–1.41) and those with two or more losses (anxiety AOR 1.82, 95% CI: 1.55–2.14); and depression (AOR = 1.43, 95% CI: 1.24–1.68) compared with women with no pregnancy loss. Internet use in the past 12 months was associated with lower odds of anxiety (AOR = 0.65, 95% CI: 0.59–0.71) and depression (AOR = 0.77,95% CI: 0.69–0.85)). Regional disparities explored Rangpur division is the highest burden of mental health symptoms and Dhaka is the lowest.

Conclusion Pregnancy loss is linked to with a higher risk of depression and anxiety, while internet use is to a lower risk. Regional variations reveal differences in reproductive experiences and internet access. Therefore, enhancing reproductive health programs and internet access are necessary to reduce depression and anxiety in high burden areas.

Keywords Mental health, Pregnancy loss, Internet use, Spatial analysis, Trend analysis

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Introduction

Mental illnesses are a major public health concern worldwide, cutting across all levels of socioeconomic status [1]. Anxiety and depression are two of the most common mental illnesses, with a substantial impact on quality of life, maternal health, and child development [2]. In particular, women who have experienced pregnancy loss a traumatic event involving miscarriage, stillbirth, or neonatal loss are at higher risk of adverse mental health outcomes, including anxiety and depression [1]. The psychological consequences of pregnancy loss affect maternal health, family functioning, and subsequent pregnancies, making urgent research and intervention imperative [3]. Globally, the burden of mental disorders is disproportionately placed on low- and middle-income countries (LMICs), where healthcare systems are often under-resourced and mental illness still carries stigma. Pregnancy loss, miscarriage, and stillbirth are a significant global public health concern. In total, among all clinically diagnosed pregnancies, the estimated 15.3% equate to about 23 million yearly miscarriages [4]. Stillbirth also contributes a significant burden at an estimated almost 1.9 million yearly stillbirths, or close to one stillbirth per 72 total births [5].

The global distribution of pregnancy loss is extremely unequal: Sub-Saharan Africa accounts for around 47% of all stillbirths and South Asia for around 32% [6]. In contrast, the high-income regions, such as Europe, have very low rates of stillbirths typically less than 5 per 1,000 births. Low- and middle-income country surveillance data report that miscarriage or abortion, pregnancy loss, takes place in about 3.2% of pregnancies, with stillbirth rates rising to as high as 35 per 1,000 live births in South Asia, and estimated at 17 per 1,000 in Sub-Saharan Africa [7].

While affluent countries have come a long way in identification and responsiveness to maternal mental health, most LMICs in Asia [8] and Africa lag because of inadequate mental health infrastructure and limited epidemiological data [9]. Bangladesh, a densely populated South Asian country transitioning from the low- to middle-income economy category, is one such example of the challenge. While recent socioeconomic progress and maternal health improvement are underway, mental health remains a weak public health component [10]. Cultural norms, gender inequalities, and limitations of resources contribute to the compounded nature of access and utilization of mental health services, especially in women who undergo pregnancy loss [10]. In Bangladesh, pregnancy loss may also have a larger bearing on family structure and social harmony. Women undergoing pregnancy loss are at higher risk of facing domestic violence, marital conflict, and even divorce [11]. Social stigma of pregnancy loss, added to gender inequality and patriarchal family organization, typically doubles the vulnerability for these women [8]. Social impacts not only intensify adverse mental health consequences but also undermine the social and economic well-being of these women and create a cycle of disadvantage that is often neglected within public health policy [12]. Evidence in industrialized countries shows that there is a clear association between pregnancy loss and subsequent depression and anxiety [13]. Simultaneously, internet use and digitalization have emerged as important social determinants of health in the LMICs. Internet use can play a dual, it can improve to access health information, social support, and mental health resources, but may also expose women to unattainable social expectations, cyberbullying, or misinformation [13]. However, such data are scarce and often not representative of South Asian LMICs like Bangladesh. Physical health outcomes of pregnancy loss are primarily addressed in national surveys and studies, with little attention paid to mental health outcomes or the broader social impacts, such as violence and marital instability [14]. Besides, this is first time Bangladesh Demographic and Health survey (BDHS) collected mental health data using two valid screening tools Generalized Anxiety Disorder (GAD-7), and Patient Health Questionnaire-9 (PHQ-9) [14]. Apart from that, mental health determinants in Bangladesh are multifaceted and are influenced by the socioeconomic status of a person, religious and cultural environment, geographical disparities, media exposure, and access to health information. Few studies have exhaustively examined the risk factors of pregnancy loss [15] and the risk factors of mental health symptoms through national-level data, and no studies have utilized spatial analysis to identify regional disparities in pregnancy loss and internet use associated mental health symptoms [15].

The aim of the study is (1) To examine the association between mental health symptoms and pregnancy loss. (2) To examine the association between mental health symptoms and internet use (3) To examine the spatial variations of mental health symptoms, pregnancy loss, and internet use. (4) To examine the trend line of pregnancy loss(termination) by rural – urban disparities from 1997 to 2022, and the trend line of internet use by rural urban disparities from 2011 to 2022.

The study contributes to fair health outcomes and aligns with international Sustainable Development Goals (SDG) on health and well-being. Lastly, the research emphasizes the need for culturally sensitive, context-specific mental health and social protection policy strategies in maternal health systems of Bangladesh and other similar LMICs.

Methodology

Data sources and study design

This cross-sectional study employed nationally representative data from the 2022 Bangladesh Demographic and Health Survey (BDHS). The survey employed a two-stage stratified sampling strategy to enroll ever-married women aged 15–49 years from all eight administrative divisions of Bangladesh. This study used 19, 987 ever-married women in Bangladesh. The complex survey design, including stratification, clustering, and sampling weights, was entirely corrected in all analyses to provide nationally representative estimates. The Fig. 1 highlights the study methodology. The investigation follows STROBE guidelines.

Outcomes

The primary outcomes were depression and anxiety, measured with the sanctioned Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7) screening questionnaires, respectively. Both outcomes were categorized into four levels none, mild, moderate, and severe based on prevalent cutoff scores. In regression modeling, groups were examined using multinomial logistic regression to assess the symptoms of mental health disorders.

Exposures

The key exposures for consideration in this analysis were internet use and pregnancy loss. Pregnancy loss was assessed as any history of miscarriage, stillbirth, or abortion and as a binary variable (no loss and any loss). Internet use in the past 12 months was a binary variable (user and not a user). These indicators were derived from relevant BDHS questions and re-coded to enhance interpretation.

Covariates

The study selected theory-driven and previously researched covariates that included individual, household, reproductive health, and empowerment factors. Care for reproductive health was ascertained through whether women received adequate antenatal visits (4 or
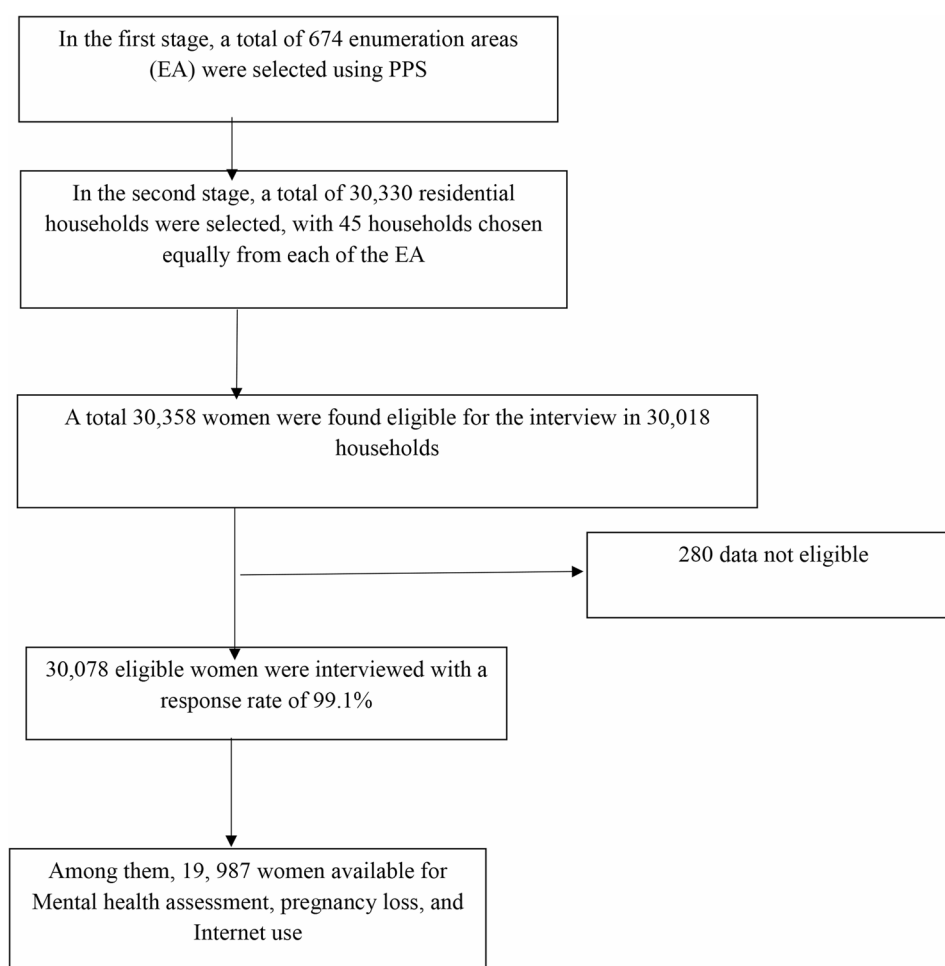
Fig. 1 The Flow of Study Methodology

more), delivered in a health facility. Sociodemographic correlates were age groups (15–49 years), level of education, religion, income in the household, size of household, region, and urban or rural location. Obstetric and family included children ever given birth to, current pregnancy status, number of times married, recent menstruation status, pressure to have a baby, cesarean section, and possession of a health card. Health services access seen as barriers like distance or lack of desire to travel alone, merged into yes/no variable for major problems getting care. Exposure to mass media represented the possession of a cell phone and the frequency with which women read newspapers, viewed TV, or listened to the radio; combined, it meant whether or not they received any media exposure. Women's empowerment was measured by their decision-making on health, money, and visit, use of contraceptives, and a composite empowerment score. Finally, we analyzed whether ever the women justified intimate partner violence under any situation, with a yes/no variable.

Statistical analysis

Descriptive statistics gave a snapshot of sample characteristics as weighted frequencies and proportions. To assess model performance the study applied Likelihood Ratio Test (LRT). Stepwise multinomial logistic regression was employed to test associations, starting with unadjusted models for anxiety outcome variable and pregnancy loss only exposures (Model 1), then applied among 12 stepwise selection-based model 12th number is model shows better based on lower BIC (Bayesian Information Criteria) = 23006.54 but slightly higher (Akaike Information Criteria) AIC = 22832.68 compared to model 11, AIC = 22910.69, Variance Inflation Factor (VIF = 1.8) [16]. Similarly, for anxiety and internet use procedures, among 12 model, the 12th number model reveals better fit compared to rest of models including matrix AIC = 22817.29, BIC = 22983.25 and (VIF = 1.42). Additional outcome variable depression and for one of the main exposure pregnancies losses, among 12 models the 10th number model highlights better model with matrix AIC = 23905.67, BIC = 24016.31, (VIF = 1.06). Similarly for depression and internet user model, among 12 model the 10th number models represent better fit with matrix AIC = 23915.37, BIC = 24018.11, and (VIF = 1.10). Adjusted odds ratio with 95% confidence intervals were reported, and moderate-to-severe anxiety and depression division-level prevalence data were extracted from STATA 17 and prepared in Microsoft Excel (xlsx format) to investigate geographic inequalities in mental disorders. They were read into RStudio version 4.1.1 for geographical mapping. Bangladesh's administrative boundary shapefile was downloaded from the Humanitarian Data Exchange (HDX) platform (https://data.hum

data.org/dataset/cod-ab-bgd) and division-level (level 1) boundaries. Using R packages *sf, tmap, dplyr, and readr*, the shapefile was merged with mental health prevalence data at the division level. Choropleth maps were produced to visually display the spatial distribution of anxiety and depression by the eight divisions. The maps enabled the identification of regional clusters and geographic disparities and were important for informing targeted public health interventions.

All analyses were performed with Stata version 17 (StataCorp, College Station, TX, USA) and R studio 4.5.1, utilizing the *svy* family of commands because of the complex survey design.

The final adjusted models controlled for a comprehensive set of confounding factors, including IPV justification, decision-making autonomy, religion, household wealth, household size, pregnancy pressure, abstinence status, residence status, number of unions, media exposure, and administrative division.

Model diagnostics

Stepwise survey-weighted multinomial logistic regression was employed to examine associations between pregnancy loss, internet use, and mental health outcomes. Model fit was evaluated using Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Variance Inflation Factor (VIF < 2), and Hosmer–Lemeshow goodness-of-fit test, confirming adequate model specification.

Results

Women who had not lost their pregnancies had no depression (72.15%), those who had mild, moderate, and severe depression prevalence were 22.98%, 3.62%, and 1.26%, respectively. Additionally, women with no depression fell in those with one loss to 66.87% and in two or more losses to 64.65% indicating that the more losses, the slight increase in the level of depression. Women who were not depressed had a 29.95% internet use and the prevalence dropped to 25.71%, 21.65% and 21.97% severe, moderate and mild depression, respectively. In the case of anxiety, women who did not experience anxiety were mostly equally likely to experience no loss (78.31%) and single loss (17.47%) and multiple losses (4.22%). The prevalence of internet usage was 30.75% among women who are not anxious and decreased to 22.25%, 22.41% and 26.5% among mild, moderate and severe anxiety groups. On the whole, women who lost pregnancy were more depressed and anxious, and women with depression and anxiety had lower chances internet use [see Supplementary Figure S1-S4].

The majority of women showed the absence of anxiety (73.1%), depression (70.8), and mild symptoms were also prevalent. Some 23% had lost pregnancies, 18.44% one

and 4.88% two or more. There was only 28.51% internet use by women and 40.75% were exposed to family planning information. Most had low parity (65.47%) and no pressure to conceive (97.06%), one and two children (58.78%). Approximately 69.73% had menstruated and 83.17% of them were involved in the decision-making process at home. Majority of the respondents were not justifying IPV (86.95%), in their first union (96.49%), and were not having sex (96.29%). Almost (14.48%) of female and (85.52%) of the female population resided in male headed households. Approximately (45.71%) females were out of secondary education and (39.66%) were none. Majority were of Muslim faith (89.70%), rural dwellers (64.94%) and in 4 + family members were (77.35%), and women who employed (30.90%). In wealth, the rich group comprised (42.51%) with the poor comprising (37.53%) and middle comprising (19.96%). The levels of media exposure were high (81.54%), but (54.05%) of them indicated that they had significant issues trying to access healthcare [see Supplementary Table S1].

Pregnancy loss was strongly associated with having greater likelihoods of anxiety and depression. A single loss women had 31% higher odds of anxiety (OR 1.31, 95% CI 1.20–1.43) and 29% higher odds of depression (OR 1.29, 95% CI 1.18–1.41), while two or more losses women had 82% higher odds of anxiety (OR 1.82, 95% CI 1.55–2.13) and 45% higher odds of depression (OR 1.45, 95% CI 1.25–1.69), all statistically significant ($p < 0.001$). Justification of intimate partner violence increased odds by 37% for anxiety (OR 1.37, 95% CI 1.22–1.54) and 25% for depression (OR 1.25, 95% CI 1.12–1.39). Decision-making autonomy was protective against anxiety (OR 0.83, 95% CI 0.75–0.91). Significant healthcare access barriers increased odds by around 30% for both conditions. Pressure to have a child nearly doubled the odds for anxiety (OR 1.93, 95% CI 1.59–2.34) and depression (OR 1.83, 95% CI 1.49–2.24). Regional differences were elevated; Dhaka women, for example, had reduced odds of anxiety (OR 0.77, 95% CI 0.62–0.95) and depression (OR 0.82, 95% CI 0.68–0.99), whereas women from

Rangpur had elevated odds (anxiety OR 1.38, 95% CI 1.11–1.71; depression OR 1.30, 95% CI 1.06–1.58) [see supplementary Table S2]. Pregnancy loss was highly associated with a higher risk of depression and anxiety. Women who had one pregnancy loss had 29% increased risk of depression (adjusted OR 1.29, 95% CI 1.17–1.41) and 31% increased risk of anxiety (adjusted OR 1.31, 95% CI 1.19–1.43) compared to those who had no loss. Those who experienced two or more losses had even greater probabilities 43% higher for depression (adjusted OR 1.43, 95% CI 1.24–1.68) and 82% higher for anxiety (adjusted OR 1.82, 95% CI 1.55–2.14), all highly significant ($p < 0.001$). Conversely, internet use within the last 12 months was associated with significantly reduced odds for both depression (adjusted OR 0.77, 95% CI 0.71–0.83) and anxiety (adjusted OR 0.66, 95% CI 0.59–0.73), and suggests a protective effect. Such associations persisted even after adjustment for a number of sociodemographic and psychosocial confounders [Table 1].

Pressure to conceive and two or more pregnancy losses emerged as the most influential risk factors, both with significantly higher odds of anxiety with confidence intervals not equaling unity. Regional variation exists with women living in Rangpur at greater risk. Additional risk factors are Muslim religion, having more than one marriage, and considering pregnancy loss as a significant issue. Justifying intimate partner violence and residing in divisions like Chattogram and Sylhet are associated with comparatively higher odds of anxiety. Protective factors increased socioeconomic status (middle and rich wealth), decision-making autonomy, abstinence in the present, rural dwelling, and living in divisions Mymensingh and Dhaka. Internet use addiction also displays a robust protective effect, and the results suggest that online connectedness can buffer anxiety. Results indicate intersections of reproductive stress, social context, and empowerment in risk of anxiety and where focused mental health intervention should be aimed [see Supplementary S5-S6].

The symptom depression model also reflects pressure to become pregnant and pregnancy loss as key risk

Table 1 Associations between pregnancy Loss, internet use and mental health outcomes

Characteristics	Depression (PHQ-9 ≥ 10) Unadjusted OR (95% CI)	Depression (PHQ-9 ≥ 10) Adjusted OR (95% CI)	Anxiety (GAD-7 ≥ 10) Unadjusted OR (95% CI)	Anxiety (GAD-7 ≥ 10) Adjusted OR (95% CI)
Pregnancy loss				
No loss (Ref)	1.00	1.00		
One loss	1.29 (1.17–1.41)***	1.29 (1.17–1.41)***	1.30 (1.20–1.41)***	1.31 (1.19–1.43)***
Two or more losses	1.45 (1.25–1.69)***	1.43 (1.24–1.68)***	1.82 (1.55–2.14)***	1.82 (1.55–2.14)***
Internet use				
No use (Ref)	1.00	1.00		
Used before last 12 months	0.76 (0.69–0.84)**	0.77 (0.71–0.83)***	0.65 (0.60–0.70)**	0.6 (0.59–0.73)*

Adjusted models control for IPV justification, decision autonomy, problems during pregnancy, religion, wealth, household size, pregnancy pressure, abstinence status, residence status, number of unions, media exposure, and household division

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. OR = Odds Ratio, CI = Confidence Interval, Ref = Reference category
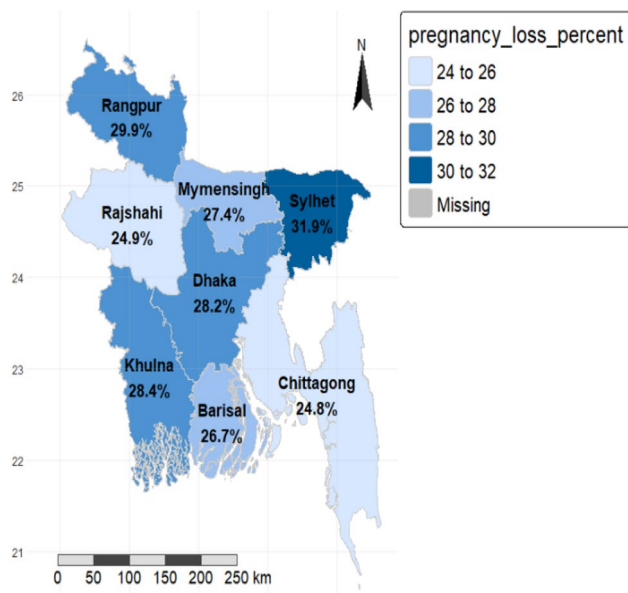
Fig. 2 Spatial Variation of Pregnancy Loss

Fig. 3 Spatial variation of internet use

factors, with both loss of one or more fetuses raising depression risk significantly. Muslim women, those with multiple marriages, or those who justify intimate partner violence have slightly elevated depression risk. Unlike for anxiety, some factors like exposure to media and participation in decision-making have weaker or non-significant associations. Protective factors are derived from past abstaining behaviors, larger household size (4 + persons), higher wealth status, and living in rural areas. Internet usage also demonstrates a trend towards a protective role against depression, though with less statistical confidence than for anxiety. The implications of these results draw attention to the mental health consequences of reproductive challenges within broader socio-cultural and economic frameworks. The results endorse integrated reproductive and mental health care, particularly in vulnerable subgroups facing compounded adversity [see Supplementary Figure S7-S8].

The map indicates dramatic regional differences in rates of pregnancy loss across Bangladesh. Sylhet exhibits the highest rate at nearly 32%, with it being a hot zone. Rangpur, Khulna, and Dhaka also show high rates between 28% and 30%. Barisal and Mymensingh show medium levels, while Chittagong and Rajshahi show the lowest rates below 25%. This geographical pattern suggests corresponding health, socioeconomic, or environmental differences which may be underlying causes of pregnancy loss. Interventions in the high-prevalence sites by public health are therefore warranted to reduce these risks [Figure 2].

The maximum percentage of internet use is in Dhaka at 40.6%, followed by Chattogram (33.7%) and Khulna (29%), indicating higher digital connectivity in the central
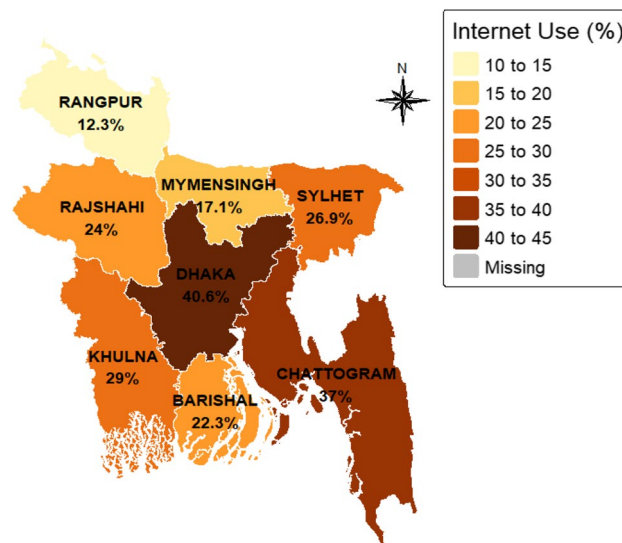
and southeastern regions. Sylhet (26.9%) and Rajshahi (24%) exhibit mediocre usage, and Barishal (22.3%) and Mymensingh (17.1%) have lower utilization. The lowest rate is from Rangpur at 12.3%. These variations reflect extensive spatial inequality in digital access, which can be assumed to be due to differences in urbanization, infrastructure, and socio-economic conditions. The coverage of the data is overall high in all the divisions, calling for targeted efforts for increasing connectivity in low-coverage regions [Figure 3]. Prevalence of anxiety is equally uniform in regional pattern with varying percentage rates of 22.0% to 33.6%. Rangpur again has the highest rate of 33.6%, followed by Chattogram (28.9%) and Barisal (26.8%). Sylhet, Rajshahi, and Khulna have a moderate prevalence of anxiety (26.3%–27.5%), and Mymensingh (24.1%) and Dhaka (22.0%) have the lowest rate. The complete data for all divisions are available. These geographic trends show a consistent pattern of mental health problems, especially in northern Bangladesh, and suggest geographically targeted mental health interventions [Figure 4].

The prevalence of depression in the population is substantially varied by the administrative regions of Bangladesh from 25.3% to 34.8%. Maximum prevalence is in Rangpur with 34.8%, presented by the darkest color, followed by Chattogram (30.5%) and Khulna (30.1%) with higher prevalence. Moderate prevalence rates are for Sylhet (29.2%), Rajshahi (29.1%), and Barisal (27.4%), while lowest rates are in Dhaka (25.4%) and Mymensingh (25.3%), depicted in the lightest color band. There are no missing data, suggesting complete geographical coverage. The results point towards considerable geographic variations in depression burden, with proportional impact across northern and southeastern regions [Figure 5]. Internet use in 2011 was low at 7.5% in urban areas
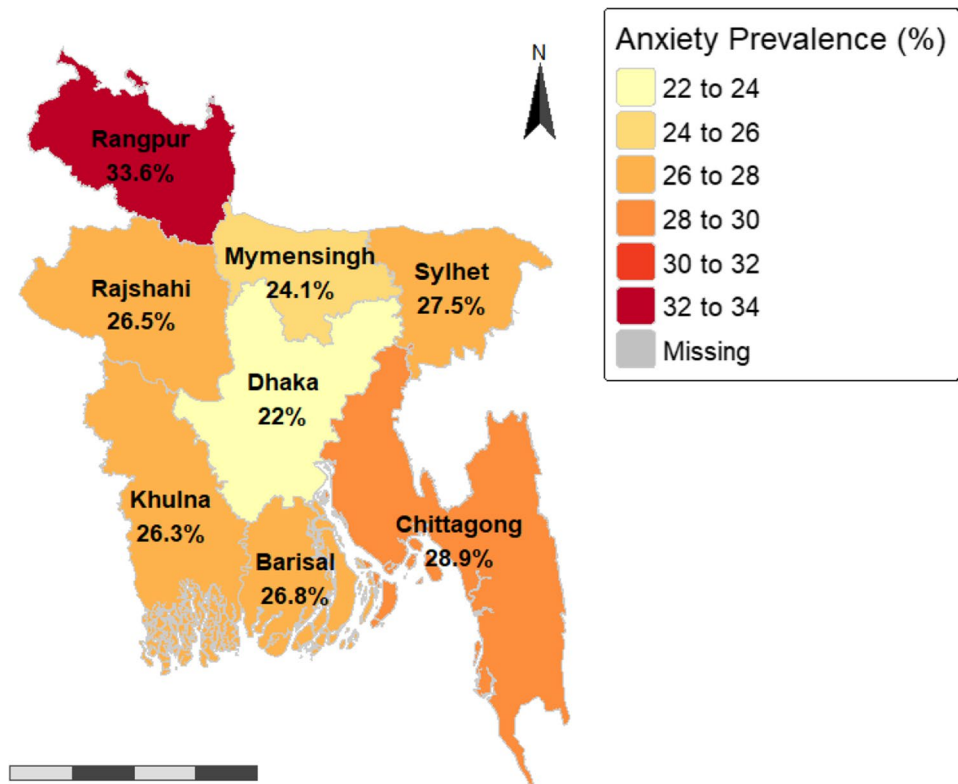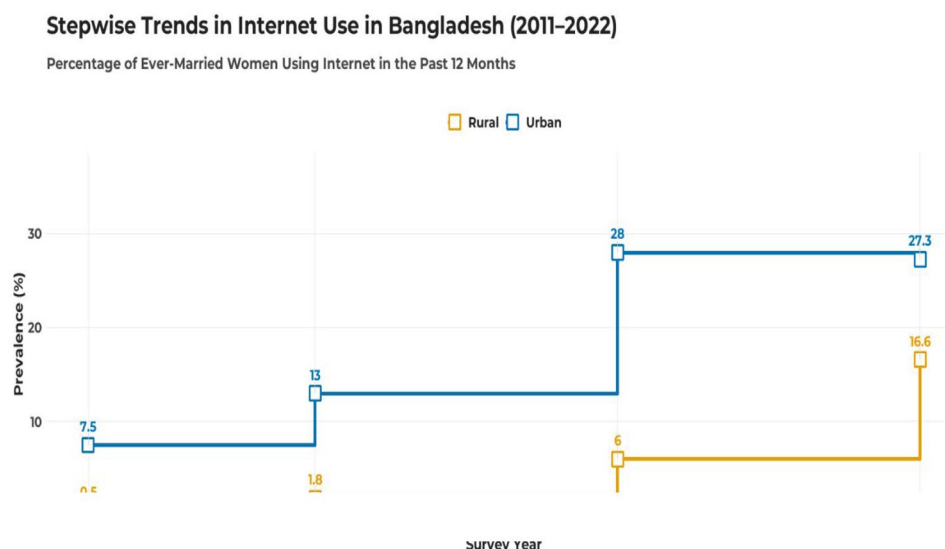
Fig. 4 Spatial variation of anxiety
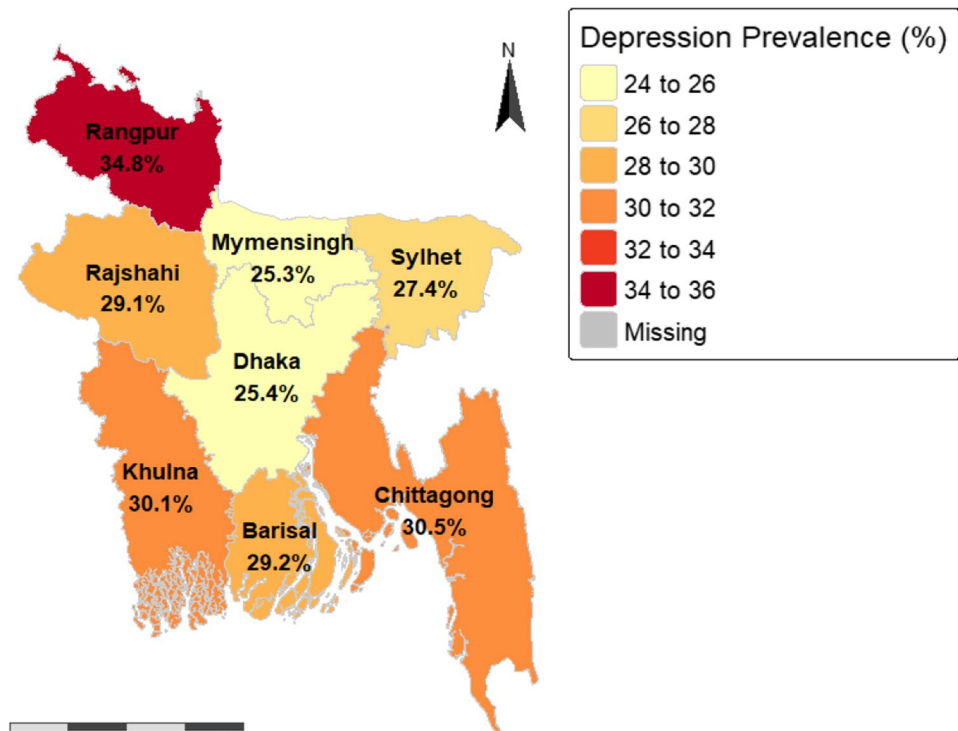
Fig. 5 Spatial variation of depression
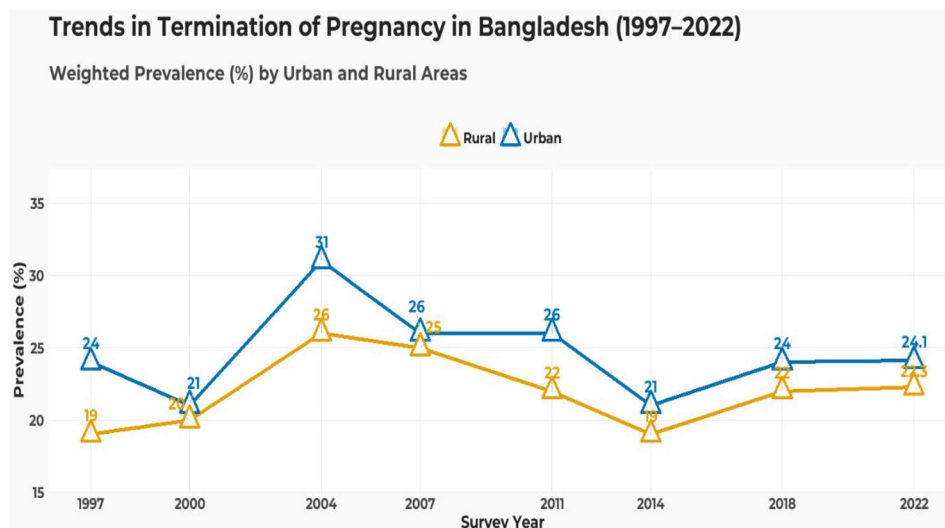
Fig. 6 Trend Analysis of pregnancy loss

Fig. 7 Trend Analysis of internet use

and virtually zero at 0.5% in rural areas. In 2014, urban penetration had roughly doubled to 13%, and rural penetration had increased modestly to 1.8%. Between 2014 and 2018, there was explosive growth: urban penetration increased to 28%, and rural penetration increased threefold to 6%. Between 2018 and 2022, rural use of the internet increased spectacularly to 16.6%, while use in urban areas increased modestly to 27.3%. These trends have been an information revolution with rapid rural adoption following urban pioneering. Infrastructure roll-out, mobile technology availability, and digital literacy campaigns are likely to have contributed. The closing rural-urban divide in internet access has tremendous potential for building women's empowerment, health communication, and economic participation across Bangladesh

[Figure 6]. Urban women report higher rates of terminations than rural women over all 25 years. At 24% in 1997, urban rates fell marginally before more acutely rising to 31% in 2004, while the highest rural rates at 26% occurred in the same year. Both of these rates fell below 2004, rural prevalence decreasing between 19% in 2014 and urban rates increasing to approximately 26%. Both the urban and rural rates increased modestly from 2014 and largely converged by 2022 (24.1% urban and 22.3% rural) [Figure 7].

Discussion

The present article investigates mental health symptom associations with pregnancy loss, use of the internet and mental health, space variation in use of the internet,

pregnancy loss, and mental health, and temporal trends in internet use and termination of pregnancy by urban-rural residence. In line with global meta-analyses of increasing depression and anxiety after perinatal loss (RR ≈ 2.14 for depression, 1.75 for anxiety) [9, 17], our adjusted analyses show strong graded associations: one loss is associated with elevated odds of depression (AOR 1.29; 95% CI 1.17–1.41) and anxiety (AOR 1.31; 95% CI 1.19–1.43), with two or more losses further increasing risk (although with overlap in CI for depression) depression (AOR 1.43; 95% CI 1.24–1.68) and anxiety (AOR 1.82; CI 1.55–2.14) [18]. The study finds novel evidence from an LMIC that prior internet use is significantly associated with reduced chances of anxiety (AOR 0.65; 95% CI 0.59–0.71) and depression (AOR 0.77; 95% CI 0.69–0.85). This protective association is explored to large global data documenting reduced depressive symptoms and increased life satisfaction among older internet users [17]. It is one of the first country-level research studies in Bangladesh to explore digital access to mental well-being, and it calls for longitudinal studies to define causality and processes [19]. This studies spatial analyses reveal striking geographic differences between administrative areas: Rangpur has much greater odds of both anxiety (AOR 1.38; 95% CI 1.11–1.71) and depression (AOR 1.30; CI 1.06-1.06.06.06.06.06,58). Dhaka has much lower odds of anxiety (AOR 0.77; 95% CI 0.62–0.95) and depression (AOR 0.82; CI 0.68–0.99). These gradients indicate pregnancy loss and internet exposure trends. For instance, regions with high levels of pregnancy loss (e.g., Rangpur at ~ 32%) are also those of elevated mental health risk, while those with higher internet usage (e.g., Dhaka at ~ 40.6%) experience lower mental health burden [20, 21]. Geospatial mental health disparities in Bangladesh's rural environment have been similarly noted but only infrequently linked to digital exposure or reproductive.

outcomes [20]. Pregnancy loss(termination) was consistently much greater in urban (reaching ~ 31% in 2004) than rural, though the rural–urban gap was closing by 2022 (~ 24.1% vs. 22.3%).

The Internet use increased exponentially from 2014 to 2022, with rural women's adoption trebling (~ 6% to ~ 16.6%), whereas urban usage plateaued (28%) [22]. These trends highlight structural change in health provision and diffusion of the digital. Convergence across rural termination rates over time may reflect improved rural access or changing reproductive values [7]. At the same time, faster rural take-up of internet use offers promise in leveraging digital connectivity to benefit mental wellbeing and reproductive health interventions [6]. Encouraging digital inclusion particularly in poor-resource divisions can be a scalable mental health strategy [23]. Divisions like Rangpur have to be integrated with reproductive health, psychosocial care, and digital

outreach programs [24, 25]. The investigation findings are comprehensively in line with systematic reviews of heightened depression/anxiety after pregnancy loss (e.g., meta-analysis RR ≈ 2.14). Internet use's protective relationship is consistent with global evidence for older people but adds this to younger LMIC women, making a point of the growing importance of digital determinants in mental health [26–28]. But unlike some cohort studies of high-income groups, we did not find evidence of moderate adverse effects of exposure to media other than internet [29]. Furthermore, our cross-sectional design limits causal inference to some degree, whereas prospective cohort studies (e.g., in Norway) [30]found elevated miscarriage risk for women with pre-existing psychiatric illness but not exposure to the internet [24, 31, 32].

Strengths
National, large dataset, comparable survey weights, control for a range of confounders, equivalent associations in models, and combined spatial and temporal dimensions.

Limitations
This study has several limitations. The cross-sectional design restricts causal interpretation of the observed associations. Self-reported measures of pregnancy loss and mental health symptoms may introduce recall or reporting bias. Internet use was assessed retrospectively without detailed information on frequency, purpose, or quality of engagement. Moreover, spatial analyses were conducted at the division level, which may mask important intra-divisional variations and local contextual factors.

Conclusion
This study reveals pregnancy loss significantly increases the risk of depression and anxiety, whereas internet use is associated with improved mental well-being among Bangladeshi women. Beyond general digital access, online engagement may enhance perceived social support, health information-seeking, and emotional coping mechanisms that help buffer psychological distress. Addressing digital inequities alongside reproductive health support could promote more equitable mental health outcomes across regions. Nonetheless, longitudinal research is needed to clarify the causal pathways linking digital inclusion and mental health resilience[33, 34].

Ethical considerations
The BDHS 2022 survey protocol received the ethical approval of Bangladesh Medical Research Council and ICF International. Informed consent was obtained from all participants before data collection. The secondary analysis used de-identified publicly available data and therefore did not require any additional institutional

ethical approval. However, details of ethical approval for DHS are available at: https://dhsprogram.com/Methodology/Protecting-the-Privacy-of-DHS-Survey-Respondents.cfm.

Supplementary Information

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Declarations

Competing interests
The authors declare no competing interests.

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