Exposure of mobile phones and mass media in maternal health services use in developing nations: evidence from Urban Health Survey 2013 of Bangladesh

Raaj Kishore Biswas, Nusma Rahman, Humayera Islam, Teresa Senserrick and Jahar Bhowmik

ABSTRACT
Communications through mobile phones and mass media have shown to be useful for health promotion activities in developing nations. This study explored the potential association of mothers’ mobile phone ownership and mass media exposure on maternal health care services in a developing nation setting: urban Bangladesh. The Urban Health Survey 2013 was examined for antenatal care, delivery assistance, and postnatal care of both mothers and children through multiple regression models, adjusting for sociodemographic factors. Among 8987 ever-married female respondents, 64.1% owned mobile phones and 88% were exposed to mass media (TV, radio or newspaper) at least once a week. Mobile phone ownership was associated with a 48% greater likelihood of access to antenatal care, 34% greater delivery assistance and 31% greater postnatal care of the mother, but no differences were found for postnatal care of children. Similarly, frequent media exposure was associated with increased access to antenatal care (38%) and delivery assistance (46%), but not associated with postnatal care of mothers or children. The results suggested that mobile phones and mass media could be valid avenues for promoting access to maternal health services, and thus, support for mobile phone access and investment in awareness campaigns targeting relevant communities are worthwhile.

KEYWORDS
Cell phone; newspaper; television; antenatal care; delivery care; postnatal care

Introduction
Mobile phones and mass media have been used to create awareness of many public health issues, including maternal health care. Health promotion can be an effective tool for promoting healthy lifestyles and prevent unhealthy behavior (Hornik 2002; Clayman et al. 2010; Morris and Jenkins 2018). In a developing country such as Bangladesh, where public health care has progressed remarkably in the last decade despite a low-functioning economy, phones and media have been argued as assets for improving health care accessibility of mothers and new born children (Donner 2008; DeRenzi et al. 2011; Chowdhury et al. 2013; Ahmed et al. 2013; El Arifeen et al. 2013). This study assesses the application of health promotion in urban Bangladesh and how it might influence mothers’ access to prenatal, delivery and postnatal care, as well as children’s post-birth care. The potential roles of mobile...
phone use and mass media exposure are analyzed using the Urban Health Survey (UHS) 2013 to understand their associations with maternal care during the reproductive years and neonatal service access, while adjusting for the urban sociodemographic context. That is, our interest was exploring whether there might be a correlation between these health promotion mediums and mothers’ maternal health-related behaviors.

Reviewing the studies on mobile phones in developing countries, Donner (2008) reasonably argued that mobile phones have moved beyond their role as a typical telecommunication device, and now contribute to the complex dimensions of social, cultural, and economic development (Van Kleef et al. 2010; Allabouche et al. 2016; Blauw and Franses 2016; Flax et al. 2017; Brunette and Curioso 2017). However, most studies examining the benefits of owning mobile devices have focused on developed countries (Varshney 2014; Stoyanov et al. 2015; Silva et al. 2015). In these settings, ownership allows users to gain both access and quicker access to health care; specifically, a higher rate of appointments, quicker diagnosis, functionality and treatments, and improved engagement with health facilitators (Bayes 2001; Krishna, Boren, and Balas 2009; Kahn, Yang, and Kahn 2010; Beratarrechea et al. 2014).

In recent years, various pilot projects were launched to evaluate the effectiveness of mobile phones in health care in developing countries, including Bangladesh (DeRenzi et al. 2011). For example, Islam et al. (2015) found that a Short Message Service (SMS) based intervention as an addition to standard care for type 2 diabetes was effective in improving glycemic control among adults in urban areas of Bangladesh. Another interesting application of mobile phones was to successfully detect and treat malaria patients in remote locations of Bangladesh (Prue et al. 2013). However, most research on applications of mobile phones and health service utilization in Bangladesh has focused on rural areas; for example, vaccination coverage among children (Uddin et al. 2016), breast health promotion (Ginsburg et al. 2014), basic health care (m-health) (Ashraf et al. 2010; Uddin et al. 2017), and health, population, and nutrition service delivery (Afroz 2012). Therefore, the link between mobile phone ownership and access to maternal health services in urban Bangladesh remains unknown.

Unlike mobile phones, the use of mass media in health care that is, the routine exposure of health messages to large proportion of population, is much researched and widely applied in developing countries. Although some media campaigns have not been successful (Hornik et al. 2002; Naugle and Hornik 2014), most of the literature conveys positive effects. For example, in a review of mass media campaigns (e.g. radio, television, newspapers) for various health risk factors, Wakefield, Loken, and Hornik (2010) concluded that media exposure brings substantial positive changes regarding health-related behavior. The dissemination of knowledge and promotion of health are common recommendations in most public health studies ranging from awareness of vaccinations and sexually transmitted diseases, and cessation of smoking to promotion of physical activities for cardiovascular health (Allsop 2006; Fuster, Kelly, and Vedanthan 2011; Leavy et al. 2011; Wakefield et al. 2011; Farrelly et al. 2012). In a developing nation such as Bangladesh, where a significant proportion of the population still live under the poverty line, health campaigns disseminated through media have potential to play a vital role in promoting health care and building awareness. Furthermore, women are more likely to own mobile phones and use them on regular bases in urban areas of Bangladesh (based on a 2013 survey), which provided further motivation for the focus of the present research (Heath 2014; Uddin et al. 2016).

Systematic public health awareness campaigns are regularly mobilized in Bangladesh by non-government organizations through foreign aid (e.g. United States Agency for International Development-USAID and Department of International Development-DFID) and/or Government patronage, with positive outcomes (Sanghvi et al. 2016). One of the success stories of mass communication of public health campaigns in Bangladesh is an oral rehydration therapy initiative by BRAC, a non-government organization that accentuates both peer-to-peer contact and use of mass media (Chowdhury and Cash 1996). For this initiative, health workers conducted home visits to provide hands-on instruction, and were compensated based on whether the mother learned to prepare the oral
rehydration solution (Cash and Chowdhury 2013). Following an arsenic awareness campaign in Bangladesh, Madajewicz et al. (2007) claimed that mass media communicated information on associated health behavior was as effective in improving behavior as a door-to-door campaign. Entertaining short films about healthy living on TV and radio have also had significant reach and associated positive impacts on general health behavioral changes in Bangladesh (Do and Kincaid 2006; Rahman and Rahman 2007; Kim et al. 2018). These show the positive effect of using of mass media campaigns to change health behaviour countries such as Bangladesh.

Maternal and newborn health services include the health care of mothers during pregnancy, childbirth, and postpartum, and of newborns postnatally (WHO, UNICEF 2012). Regular visits by skilled health personnel during pregnancy refers to antenatal care (Dairo and Owoyokun 2010; WHO 2016); delivery by skilled birth attendants (SBA) during childbirth is delivery care (WHO 2010; Titaley et al. 2010); and post-pregnancy cares of both mothers and children by professional health workers refers to postnatal care (Gogia and Sachdev 2010; WHO 2014). Multiple projects are active in Bangladesh to improve maternal and newborn care mostly focusing on rural areas (Amin, Shah, and Becker 2010; Quayyum et al. 2013). They have performed well in regard to the targets of the Millennium Development Goals 2015, particularly in reducing maternal and child mortality, and are on track to achieve the Sustainable Development Goals (Lozano et al. 2011; Chowdhury et al. 2011; El Arifeen et al. 2014; Kumar, Kumar, and Vivekaadhish 2016). Moreover, previous research has demonstrated the role of mass media in reducing the fertility rate (Rabbi 2012), reducing maternal mortality (El Arifeen et al. 2014), and increasing access to family health services by women in rural areas (Guilkey and Hutchinson 2011). However, the association between mass media exposure and access to maternal health services in urban areas has not yet been explored.

This study assessed the association between ownership of mobile phones together with frequent exposure to mass media and access to maternal health care services in urban Bangladesh. The focus was on relevant outcome measures available in a nationally representative survey: antenatal care, delivery assistance, postnatal care of the mother, and postnatal care of the child. As radio and TV channels in Bangladesh regularly broadcast message on maternal and child health care (Hutchinson et al. 2006; Strobach and Zaumseil 2007; Kabir and Khan 2013), it was assumed that frequent media exposure in general reflected higher exposure to relevant maternal care messaging specifically. Following the positive findings of past literature, we hypothesized that phone ownership and higher media exposure would be associated with higher access of maternal services in urban Bangladesh. Given that the current Bangladesh Government is focusing on digitalization and encouraging applications of technologies in the healthcare system (MEASURE Evaluation 2019), a positive outcome of this study was expected to provide support for future eHealth interventions in maternal health services in Bangladesh via phone and mass media applications.

Materials and methods

Data overview

The Bangladesh Urban Health Survey (UHS) 2013 is the most recent in a series of nationally representative surveys of urban residents conducted by the National Institute of Population Research and Training (NIPORT), University of North Carolina at Chapel Hill, USA, and the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) for which detailed methods have been previously reported (NIPORT, icddr,b, & UNC-Chapel Hill 2013). Data were collected from three strata: (a) slum areas of city corporations (major divisional cities), (b) non-slum areas of city corporations, and (c) other district municipalities or large towns with over 45,000 residents.

A three-stage stratified sampling method was used to randomly select mohallas (the smallest administrative areas of Bangladesh), two non-slum clusters and one slum cluster from each mohalla, and households within each cluster. For female participants, ever married women aged between 14 and 49 years, were sampled and therefore were the focus of the present study.
**Outcome variable**

Four survey measures of maternal health services were included as outcome variables in the statistical analysis: antenatal care, delivery service, postnatal care of mothers, and postnatal care of children. All of these variables were binary in nature, either respondents received the care through quality assistance or not. A total sample of $N = 8987$ females had complete responses for antenatal, delivery, and postnatal care of children, reducing to $n = 4423$ when including mothers’ postnatal care responses.

**Independent variables**

The two primary independent variables were ownership of a personal mobile phone and exposure to media (Figures 1 and 2). Among the sampled women, 5758 (64.1%) of the respondents owned mobile phones. A respondent was referred to as frequently exposed to media if she watched TV or listened to the radio or read a newspaper at least once a week. Respondents reporting less frequent exposures were considered as not exposed to media. Twelve percent ($N = 1080$) of the respondents in the sample were not exposed to any form of mass media.

Several sociodemographic variables were applied to adjust the statistical models: duration of stay in current urban residence (less than 2 years, 2–4 years, 5+ years), education (none, primary, secondary, higher), age of respondent (continuous), wealth quintile (a five-scale based index on household assets quantified by the principal component approach), seven divisions (the highest administrative area of Bangladesh), sample domain [city corporation (non-slum area), city corporation (slum area), other urban areas], working status (yes, no), and distance to the nearest health facility from home (less than one kilometer, one–two kilometers, two–five kilometers, over five kilometers). Author-defined variable categories were duration of stay in the current urban residence and distance to a health facility, based on a technical report by Jamil et al. (2014).

![Figure 1. Distribution of maternal health services with ownership of mobile phones.](image-url)
Bivariate analysis (Agresti and Kateri 2011) was conducted to overview the frequency distributions of the sociodemographic factors on the maternal health service outcome variables. Chi-square ($\chi^2$) tests were used to determine the strength of bivariate dependencies. Following these, multinomial logistic regression models (Upton 2016) were fitted with the binary outcomes to the sociodemographic factors. This provided the effect sizes and directions of the independent covariates, as odds ratios, against the outcomes. These then were adjusted for cluster-wise differences and survey weights (as detailed in the UHS 2013). The analysis was conducted in R (version 3.4.1). The R package survey was applied to adjust the clusters and survey weights in generalized linear regression models.

While generally a $p$-value of 0.05 is considered the threshold of significant association, we followed the recommendation of Benjamin et al. (2018) to use a threshold of 0.005 for new discoveries. Therefore, we interpreted the covariates as significant only when the $p$-values were less or equal to 0.005 and were consistent with the associated confidence intervals.

**Results**

Table 1 shows the bivariate associations between the sociodemographic factors and the four health service outcomes for mothers and newborns. Most of the associations were found to be significant ($p$-value < 0.005). Exceptions were associations of distance between respondent’s home and nearest health facility with delivery assistance and postnatal care of both mothers and children. Another non-significant association was observed between length of stay in the current residence and postnatal care of mothers. Some of the cells in the bivariate distribution table (Table 1) had small counts (e.g. division vs postnatal care of mothers); however, all of the expected cell counts were above five, which satisfied the chi-square assumption of minimum cell frequency (Table 1). Therefore, all
| Covariates                        | Scales | Antenatal care | Delivery assistance | Postnatal care (mother) | Postnatal care (child) |
|----------------------------------|--------|----------------|---------------------|-------------------------|------------------------|
|                                  |        | No (%)         | Yes (%)             | No (%)                  | Yes (%)                |
| **Duration of stay in current residence** |        |                |                     |                         |                        |
| <2 years                         |        | 172 (28.7)     | 428 (71.3)          | 100 (16.7)              | 500 (83.3)             |
| 2–5 years                        |        | 243 (20.8)     | 926 (79.2)          | 153 (13.1)              | 1016 (86.9)            |
| >5 years                         |        | 1454 (20.6)    | 5615 (79.4)         | 889 (12.6)              | 6180 (87.4)            |
| *P*-value                        |        | <0.001         |                     | <0.001                  | <0.001                 |
| **Education**                    |        |                |                     |                         |                        |
| No education                     |        | 545 (39.3)     | 843 (60.7)          | 282 (20.3)              | 1106 (79.7)            |
| Primary                          |        | 824 (30.1)     | 1844 (69.1)         | 466 (17.5)              | 2220 (82.5)            |
| Secondary                        |        | 475 (13.3)     | 3101 (86.7)         | 367 (10.3)              | 3209 (89.7)            |
| Higher                           |        | 25 (12.1)      | 1181 (87.9)         | 27 (12.0)               | 1179 (87.9)            |
| *P*-value                        |        | <0.001         |                     | 0.959                   | 0.038                  |
| **Age (cont.)**                  |        |                |                     |                         |                        |
| Mean (SD)                        |        | 26.54 (6.02)   | 25.78 (5.47)        | 25.92 (5.73)            | 25.94 (5.58)           |
| *P*-value                        |        | <0.001         |                     | 0.088                   | <0.001                 |
| **Wealth quintile**              |        |                |                     |                         |                        |
| Poorest                          |        | 988 (36.2)     | 1744 (63.8)         | 515 (18.9)              | 2217 (81.1)            |
| Poorer                           |        | 528 (24.7)     | 1608 (75.3)         | 326 (15.3)              | 1810 (84.7)            |
| Middle                           |        | 241 (14.1)     | 1474 (85.9)         | 191 (11.1)              | 1524 (88.9)            |
| Richer                           |        | 85 (6.6)       | 1196 (93.4)         | 82 (6.40)               | 1199 (93.6)            |
| Richest                          |        | 27 (2.80)      | 947 (97.2)          | 28 (2.90)               | 946 (97.1)             |
| *P*-value                        |        | <0.001         |                     | <0.001                  | <0.001                 |
| **Distance to health facility**  |        |                |                     |                         |                        |
| <1 km                            |        | 267 (16.6)     | 1339 (83.4)         | 194 (12.1)              | 1412 (87.9)            |
| 1–2 kms                          |        | 610 (21.3)     | 2252 (78.7)         | 373 (13.0)              | 2489 (87.0)            |
| 3–5 kms                          |        | 825 (22.8)     | 2789 (77.2)         | 485 (13.4)              | 3129 (86.6)            |
| >5 kms                           |        | 167 (22.1)     | 589 (77.9)          | 90 (11.9)               | 666 (88.1)             |
| *P*-value                        |        | <0.001         |                     | 0.469                   | 0.017                  |
| **Ownership of mobile phones**   |        |                |                     |                         |                        |
| No                               |        | 1044 (32.8)    | 2136 (67.2)         | 563 (17.7)              | 2617 (82.3)            |
| Yes                              |        | 825 (14.6)     | 4833 (85.4)         | 579 (10.2)              | 5079 (89.8)            |
| *P*-value                        |        | <0.001         |                     | 0.038                   | 0.023                  |
| **Media exposure**               |        |                |                     |                         |                        |
| No                               |        | 416 (39.2)     | 646 (60.8)          | 235 (22.1)              | 827 (77.9)             |
| Yes                              |        | 1453 (18.7)    | 6223 (81.3)         | 907 (11.7)              | 6869 (88.3)            |
| *P*-value                        |        | <0.001         |                     | <0.001                  | <0.001                 |

kms = kilometers, CC = City Corporation.
sociodemographic variables that achieved significant bivariate associations with the outcomes were further fitted in the regression models (Table 2).

The fitted regression models (Table 2) showed that ownership of mobile phones and exposure to media had significant associations with antenatal care, delivery assistance, and postnatal care of mothers; with the exception of postnatal care of mothers not being influenced by media exposure. However, neither of these factors had associations with postnatal care for children when the models were adjusted for the remaining sociodemographic covariates. Having a personal mobile phone was associated with respective 48%, 34% and 31% significant increases in accessing antenatal, delivery and postnatal care for mothers. Further, respondents who watched TV or listened to the radio or read a newspaper at least once a week had a 1.38 and 1.46 times higher chance of seeking antenatal and delivery care respectively compared to those who were not exposed to such media.

**Discussion**

The results provide evidence that ownership of mobile phones and exposure to mass media can lead to increased access to maternal health services by Bangladeshi women living in urban areas; however, only for some services, specifically, antenatal care and delivery assistance. Adjusting for sociodemographic factors, these relationships remained significant. In contrast, no associations were demonstrated with postnatal care of children and postnatal care of mothers was only associated with mobile phone ownership.

These findings are consistent with previous research that found mobile phones could improve outcomes such as facilitating pregnant women keeping in touch with health workers, seeking help during urgent need, and receiving reminders from health facilitators in low- and-middle-income countries (Källander et al. 2013). As a portable communication device, mobile phones have been found to ensure a quicker connection between health workers and pregnant mothers in such settings (Peter, Barron, and Pillay 2016). In some areas of Bangladesh, community workers or health personnel provide maternal care or check-ups at home, which is gaining momentum across the country (Rahman et al. 2010; El Arifeen et al. 2013). Health facilitators can provide better services to mothers if they can reach the mother at any time (Hall et al. 2014). Similarly, mothers can seek help during urgent matters or health hazards (Little et al. 2013). More importantly, regular reminders regarding check-ups ensure that mothers are well aware of required health care, and this could potentially lead to changes in traditional, less health-orientated behaviors (Noordam et al. 2011).

Furthermore, access to mobile phones can play a vital role in improving social and health supports for mothers at the time of newborn delivery, as owning a mobile phone can help expedite contact with husbands, relatives and/or health care personnel (Noordam et al. 2011). This is particularly beneficial in terms of the health care professionals because late arrivals or non-attendance during delivery is associated with postpartum hemorrhage leading to death of the mother (Limwattananon, Tangcharoensathien, and Sirilak 2011; Mbizvo and Say 2012). Moreover, in the patriarchal society of Bangladesh, women are not generally empowered to participate in family decisions, and having a mobile phone provides them a support tool to ask for help and reach out to the nearest health facility (Lund 2009; Lund et al. 2010). Receiving regular calls and text messages from health facilitators

| Covariates                | Antenatal care | Delivery assistance | Postnatal care (mother) | Postnatal care (child) |
|---------------------------|----------------|---------------------|-------------------------|------------------------|
| Ownership of mobile phone | Yes            | 1.48 (1.29, 1.71)   | 1.34 (1.13, 1.58)       | 1.31 (1.16, 1.48)      |
| Media exposure            | Yes            | 1.38 (1.16, 1.64)   | 1.46 (1.15, 1.86)       | 1.17 (0.97, 1.41)      |

The models are adjusted by the sociodemographic factors mentioned in Table 1.
following delivery has been shown to reduce the risk of postnatal complications (DeRenzi et al. 2011; Cormick et al. 2012); however, whether follow-ups are properly conducted is a major concern in the societal context of Bangladesh. Also, more insight is needed regarding access to mobile phones by categorization between smart versus traditional phones, given smart phones can provide additional tools for health services (Chow et al. 2016). Data on types of phones or cost of the phones were not available in UHS 2013. However, this could be an avenue for future studies and a consideration for upcoming national surveys, as well as access to relevant (free and fee-based) smart phone applications.

Mass media campaigns have previously been found to be effective awareness dissemination tools in regions with low literacy rates in Bangladesh (Kabir and Islam 2000; Islam and Hasan 2000). There are several advantages of media in such campaigns: a focused message could reach a larger audience; the same messages could be repeated numerous times; awareness could be spread through entertainment avenues; and a community intervention could be possible (Sharma, Sawangdee, and Sirirassamee 2007; Wakefield, Loken, and Hornik 2010; Boles et al. 2014). Campaigns have proven to be productive in rural Bangladesh, with women showing improved health-seeking behaviors (Haque et al. 2012; El Arifeen et al. 2014). This suggests potential should be greater for people living in urban areas of Bangladesh, who have access to better education and are more exposed to media compared to remote rural residents (Jesmin, Chaudhuri, and Abdullah 2013). The results from this study confirm that urban women can benefit from media exposures in terms of accessing antenatal and delivery care. Thus, even in urban areas, which have more readily available health facilities than rural areas (Ononokpono and Azfredrick 2014), mass media might still play a vital role in mothers accessing these facilities.

Furthermore, awareness through media might be a particularly effective mechanism in a patriarchal society such as Bangladesh. Communities that are aware of the benefits of maternal care can put pressure on the father or the partner or the in-laws of a pregnant woman to take action and provide due care for the mother (Singh, Kumar, and Pranjali 2014; Davis, Luchters, and Holmes 2013). Improving fathers’ knowledge on pregnancy and complications can aid this process as well (Mullany, Becker, and Hindin 2006; Chattopadhyay 2012; Story et al. 2012; Thapa and Niehof 2013). Such community contributions can lead to better maternal care.

However, an opposite result, where media exposure had a negative association in terms of access to a trained health care service, has been previously reported by Amin, Shah, and Becker (2010), who themselves found it ‘puzzling’. The current study also failed to find an association between media exposure and postnatal care services, for both mothers and children, as well as between mobile phone ownership and postnatal health care of children. The study methods did not allow the reasons behind this to be explored; however, following the familial context of Bangladesh, one speculation would be the cultural priority of the babies’ health over that of their mothers. In Bangladeshi society, more often health care of a child is viewed of greater importance compared to that of the adult mother. Thus, the antenatal or delivery care of the mothers could often be compromised, whereas regular health checks for newborns are likely inherently prioritized despite ownership of mobile phones or exposure to media. This could be one of the reasons why no association between mobile phones or mass media and postnatal care of infants was found in the current study.

Another possible explanation of media exposure having no association on postnatal care of both mother and child could be that the media campaigns to which the mothers were exposed emphasized pre-birth services and were lacking in relation to postnatal complications; this was not able to be determined in the current study. As Sood, Shefner-Rogers, and Skinner (2014) explained, frameworks and theories of media campaigns in developing countries should look beyond Western patterns and focus on ‘small-scale community-based efforts as the norm for health communication campaigns in developing countries’ (82). Furthermore, parents or guardians of the newborns might be complacent after delivery of a healthy baby and might not seek postnatal care. To bring a behavioral change in these communities, health communications and promotions should avoid ‘one model fits all’ campaigns and concentrate on social contexts of the target groups (Naugle...
The study findings suggest that post-natal care for the mother should be a specific emphasis.

To continue with the progress Bangladesh has made in public health over the years, there is a need to push beyond the traditional means of reaching mass people, such as person-to-person contact through health workers or orthodox electronic media campaigns. In recent years, various eHealth applications have been commonly used in developed nations to keep track of individuals’ health status (Wallwiener et al. 2016; Parati et al. 2017). With the push for digitalization at present, the Bangladesh Government has taken the initiative to develop and implement an electronic management information system (eMIS) to provide greater delivery of health services (MEASURE Evaluation 2019). Initiatives such as this and innovative applications of everyday technology such as smartphone applications offer possible avenues to ensure that public health progress in Bangladesh remains on the right track.

This study was limited by several factors. Firstly, the data was cross-sectional, and the analysis was based on this observed data. Hence, there was minimal scope to draw causal inference from this study. However, a randomized control trial in this social context might not be feasible due to ethical issues, although an inferential discussion from this study could input into future study or survey designs (Hernán 2018). Secondly, media exposure was collapsed into one group and not specific to the particular medium. Future studies could explore the different effect of TV, radio, and newspaper campaigns and the specific services promoted, included by focusing on data obtained through stratified sampling. As this study was limited to secondary data, future studies could explicitly collect experimental data in this context in order to reach a causal conclusion. Thirdly, the absence of rural survey respondents compromised the scope to contrast and compare between residence of women (urban vs rural) and their exposure to mobile phones or media; these might account for differences that underlie the unexpected lack of associations compared to previous research. As the data is limited to only urban women of Bangladesh, the study conclusions should be carefully generalized. Fourthly, the data dates back to 2013 and with more recent changes in technology, both in mobile phones and media. However, exposure of such technology for women in low- and-middle-income South Asian countries such as Bangladesh is still relevant (Rashid 2011; Hossain and Beresford 2012). Furthermore, the findings contribute support for various eHealth initiatives that have since emerged and continue in Bangladesh (Ahmed et al. 2014; Hoque, Mazmum, and Bao 2014). Finally, as the national survey employed was not designed for this particular study, it must be acknowledged that it was not possible to control for other potential confounding factors.

**Conclusion**

With an attempt to understand if and how mobile phone ownership or mass media exposure affects the maternal health care of urban women in Bangladesh, this study observed a significant positive association between these two factors and the antenatal and delivery care of mothers, also between mobile phone ownership and post-natal care of mothers, but no relationships for post-natal care of children. Mobile phones and mass media have the potential to enlighten a greater number of people regarding maternal health care services, including males, females, and communities in general. This might be particularly important in Bangladesh as a large section of the population lacks institutional health literacy and the patriarchal culture might otherwise disempower women to seek services. Furthermore, strengthening the healthcare system and improving accessibility to the masses, is reliant on good governance and efficient service delivery (Chowdhury and Raza 2018). This is required to reduce bureaucratic complications that can delay private–public investments to create an urban-centric healthcare system in Bangladesh. Inclusion of technology in this system could be a possible avenue to improve service delivery.

Despite greater health care accessibility in urban areas, mobile phone ownership and mass media exposure were found to be independent contributors to various aspects of maternal health care among urban mothers in Bangladesh. Hence, it can be concluded that mobile phones and mass
media can be useful mediums to help access to maternal health services and lead to fewer fatal consequences for mothers and newborn children. Thus, increased investment on mobile phone network reach and awareness campaigns targeting relevant communities are worthwhile public health initiatives.

**Disclosure statement**

No potential conflict of interest was reported by the author(s).

**Notes on contributors**

**Raaj Kishore Biswas**, statistician by training, is a PhD scholar at the Transport and Road Safety (TARS) Research Centre in University of New South Wales, Sydney. His research focuses on the risk associated with everyday driving in Australia and big data analytics in road safety. His area of expertise includes biostatistics and public health, particularly focusing on health policy evaluation, health care system and health care accessibility in developing countries. Environmental statistics, behavioral analysis and spatial techniques are also part of his area of interest.

**Nusma Rahman** is working as a Lecturer in Department of Statistics, Jagannath University, Dhaka, Bangladesh. Her research areas include application of biostatistics in developing randomized clinical design, public health and epidemiology.

**Humayera Islam** is currently a PhD student at Institute for Data Science and Informatics at University of Missouri-Columbia, Missouri, USA. She also serves as Lecturer (currently on study leave) of Applied Statistics at Institute of Statistical Research and Training, University of Dhaka, Bangladesh. Her research interests include application of artificial intelligence in areas of healthcare, mining massive unstructured data, clinical data and electronic health record data for predictive analytics, telemedicine applications in healthcare and applications of mhealth consumer health and public health informatics.

**Teresa Senserrick** PhD is a Professor at Queensland University of Technology (QUT) in the Centre for Accident Research and Road Safety – Queensland (CARRS-Q). She has over 20 years of research expertise in public health and injury prevention in Australia and internationally. Broadly, her research centres on policy and practice relevant research to improve health and safety outcomes, with a focus on disadvantaged and vulnerable communities.

**Dr Jahar Bhowmik** is an Associate Professor and postgraduate applied statistics course director at the Department of Statistics, Data Science and Epidemiology at Swinburne University of Technology. His research interests are biostatistics, public health and wellbeing, research design, experimental design, applied epidemiology, applied statistics and econometrics. He has co-authored on around 70 peer reviewed publications including two book chapters in the area of public health, biostatistics, research design, experimental design, applied epidemiology and econometrics. Jahar supervises PhD and Masters students in many areas including applied epidemiology, biostatistics, experimental design and health related data modeling.

**ORCID**

Jahar Bhowmik [http://orcid.org/0000-0001-9697-1968](http://orcid.org/0000-0001-9697-1968)

**References**

Afroz, T. 2012. “Delivery of Mobile Phone Aided Health Services in Rural Bangladesh: A Study on Two Upazilas.” Master in Public Policy and Governance Program, Department of General and Continuing Education, North South University, Bangladesh. Accessed 25 June 2015. [www.mppg-nsu.org](http://www.mppg-nsu.org).

Agresti, A., and M. Kateri. 2011. “Categorical Data Analysis.” In *International Encyclopedia of Statistical Science*, 206–208. Berlin: Springer.

Ahmed, S. M., T. G. Evans, H. Standing, and S. Mahmud. 2013. “Harnessing Pluralism for Better Health in Bangladesh.” *The Lancet* 382: 1746–1755.

Ahmed, T., H. Lucas, A. S. Khan, R. Islam, A. Bhuiya, and M. Iqbal. 2014. “eHealth and mHealth Initiatives in Bangladesh: A Scoping Study.” *BMC Health Services Research* 14: 260.

Aljaid, B. 2015. “Health Communication and Islam: A Critique of Saudi Arabia’s Efforts to Prevent Substance Abuse”. PhD thesis., University of Stirling, Scotland.

Allabouche, K., O. Diouri, A. Gaga, N. E. A. El Idrissi, et al. 2016. “Mobile Phones’ Social Impacts on Sustainable Human Development: Case Studies, Morocco and Italy.” *Entrepreneurship and Sustainability Issues* 4: 64–73.
Allsop, T. 2006. Getting the Message Across: The Mass Media and the Response to AIDS. Geneva: UNAIDS.

Amin, R., N. M. Shah, and S. Becker. 2010. “Socioeconomic Factors Differentiating Maternal and Child Health-Seeking Behavior in Rural Bangladesh: A Cross-Sectional Analysis.” International Journal for Equity in Health 9: 9. https://doi.org/10.1186/1475-9276-9-9.

Ashraf, M. M., N. L. Ansari, B. T. Malik, and B. Rashid. 2010, November 10–11. “Evaluating the Impact of Mobile Phone Based ‘Health Helpline’ Service in Rural Bangladesh.” The 2nd International Conference on M4D Mobile Communication Technology for Development M4D, Kampala, Uganda.

Bayes, A. 2001. “Infrastructure and Rural Development: Insights from a Grameen Bank Village Phone Initiative in Bangladesh.” Agricultural Economics 25: 261–272.

Benjamin, D. J., J. O. Berger, M. Johannesson, B. A. Nosek, R. Berk, K. A. Bollen, et al. 2018. “Redefine Statistical Significance.” Nature Human Behaviour 2: 6–10. https://doi.org/10.1038/s41562-017-0189-z

Beratarrechea, A., A. G. Lee, J. M. Willner, E. Jahangir, A. Ciapponi, and A. Rubinstein. 2014. “The Impact of Mobile Health Interventions on Chronic Disease Outcomes in Developing Countries: A Systematic Review.” Telemedicine and e-Health 20: 75–82.

Blauw, S., and P. H. Fransen. 2016. “Off the Hook: Measuring the Impact of Mobile Telephone use on Economic Development of Households in Uganda Using Copulas.” The Journal of Development Studies 52: 315–330.

Boles, M., A. Adams, A. Gredler, and S. Manhas. 2014. “Ability of a Mass Media Campaign to Influence Knowledge, Attitudes, and Behaviors About Sugary Drinks and Obesity.” Preventive Medicine 67: S40–S45.

Brunette, M., and W. Curioso. 2016. “Integrated Mobile Health Systems: Role of Socio-Cultural Factors and the Sociotechnical Systems Approach.” Revista Peruana de Medicina Experimental y Salud Publica 34: 544–550.

Cash, R. A., and A. M. R. Chowdhury. 2013. “Home-based Treatment: Teaching Matters.” The Lancet 382 (9903): 1482.

Chattopadhyay, A. 2012. “Men in Maternal Care: Evidence from India.” Journal of Biosocial Science 44: 129–153.

Chow, C. K., N. Ariyarathna, S. M. S. Islam, A. Thiagalingam, and J. Redfern. 2016. “mHealth in Cardiovascular Health Care.” Heart, Lung and Circulation 25 (8): 802–807.

Chowdhury, S., L. Banu, T. Chowdhury, S. Rubayet, and S. Khatoon. 2011. “Achieving Millennium Development Goals 4 and 5 in Bangladesh.” BJOG: An International Journal of Obstetrics & Gynaecology 118: 36–46.

Chowdhury, A. M. R., A. Bhuiya, M. E. Chowdhury, S. Rasheed, Z. Hussain, and L. C. Chen. 2013. “The Bangladesh Paradox: Exceptional Health Achievement Despite Economic Poverty.” The Lancet 382: 1734–1745.

Chowdhury, A. R., and R. A. Cash. 1996. A Simple Solution: Teaching Millions to Treat Diarrhoea at Home. Dhaka: Dhaka University Press.

Chowdhury, M., and W. Raza. 2018. “Opinion: Why has the Decline of Maternal Deaths Stalled in Bangladesh?” [online] Devex. Accessed 25 January 2020. https://www.devex.com/news/opinion-why-has-the-decline-of-maternal-deaths-stalled-in-bangladesh-93573.

Clayman, M. L., J. A. Manganello, K. Viswanath, B. W. Hesse, and N. K. Arora. 2010. “Providing Health Messages to Hispanics/Latinos: Understanding the Importance of Language, Trust in Health Information Sources, and Media use.” Journal of Health Communication 25: 252–263.

Cormick, G., N. A. Kim, A. Rodgers, L. Gibbons, P. M. Buekens, J. M. Belizan, and F. Althabe. 2012. “Interest of Pregnant Women in the use of SMS (Short Message Service) Text Messages for the Improvement of Perinatal and Postnatal Care.” Reproductive Health 9: 9.

Dairo, M., and K. Owoyokun. 2010. “Factors Affecting the Utilization of Antenatal Care Services in Ibadan, Nigeria.” Benin Journal of Postgraduate Medicine 12: 3–13.

Davis, J., S. Luchters, and W. Holmes. 2013. Men and Maternal and Newborn Health. Centre for International Health, Burnet Institute, Australia.

DeRenzi, B., G. Borriello, J. Jackson, V. S. Kumar, T. S. Parikh, P. Virk, and N. Lesh. 2011. “Mobile Phone Tools for Field-Based Health Care Workers in Low-Income Countries.” Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine 78: 406–418.

Do, M. P., and D. L. Kincaid. 2006. “Impact of an Entertainment-Education Television Drama on Health Knowledge and Behavior in Bangladesh: an Application of Propensity Score Matching.” Journal of Health Communication 11: 301–325.

Donner, J. 2008. “Research Approaches to Mobile use in the Developing World: A Review of the Literature.” The Information Society 24: 140–159.

El Arifeen, S., A. Christou, L. Reichenbach, F. A. Osman, K. Azad, K. S. Islam, F. Ahmed, H. B. Perry, and D. H. Peters. 2013. “Community-based Approaches and Partnerships: Innovations in Health-Service Delivery in Bangladesh.” The Lancet 382: 2012–2026.

El Arifeen, S., K. Hill, K. Z. Ahsan, K. Jamil, Q. Nahar, and P. K. Streetfield. 2014. “Maternal Mortality in Bangladesh: A Countdown to 2015 Country Case Study.” The Lancet 384: 1366–1374.

Farrelly, M. C., J. C. Duke, K. C. Davis, J. M. Nonnemaker, K. Kamyaob, J. G. Willett, and H. R. Juster. 2012. “Promotion of Smoking Cessation with Emotional and/or Graphic Antismoking Advertising.” American Journal of Preventive Medicine 43: 475–482.

Flax, V. L., A. U. Ibrahim, M. Negerie, D. Yakubu, S. Leatherman, and M. E. Bentley. 2017. “Group Cell Phones are Feasible and Acceptable for Promoting Optimal Breastfeeding Practices in a Women’s Microcredit Program in Nigeria.” Maternal & Child Nutrition 13: 1–9.
Little, A., A. Medhanyie, H. Yebyo, M. Spigt, G. J. Dinant, and R. Blanco. 2013. “Meeting Community Health Worker Needs for Maternal Health Care Service Delivery Using Appropriate Mobile Technologies in Ethiopia.” *PLoS One* 8: e77563.

Lozano, R., H. Wang, K. J. Foreman, J. K. Rajaratnam, M. Naghavi, J. R. Marcus, L. Dwyer-Lindgren, K. T. Lofgren, D. Phillips, C. Atkinson, et al. 2011. “Progress Towards Millennium Development Goals 4 and 5 on Maternal and Child Mortality: An Updated Systematic Analysis.” *The Lancet* 378: 1139–1165.

Lund, S. 2009. *Mobile Phones can Save Lives. Profile* / Global Health, University of Copenhagen, Copenhagen, 18–19.

Lund, S., M. Hemed, S. Khadija, and K. Said. 2010. *Wired Mothers: Use of Mobile Phones to Improve Maternal and Neonatal Health in Zanzibar.* University of Copenhagen. Danish Research Network for Health (ENRECA Health).

Madajewicz, M., A. Paff, A. Van Geen, J. Graziano, I. Hussein, H. Momotaj, R. Sylvi, and H. Ahsan. 2007. “Can Information Alone Change Behavior? Response to Arsenic Contamination of Groundwater in Bangladesh.” *Journal of Development Economics* 84: 731–754.

Mbizvo, M. T., and L. Say. 2012. “Global Progress and Potentially Effective Policy Responses to Reduce Maternal Mortality.” *International Journal of Gynecology & Obstetrics* 119: S9–S12.

MEASURE Evaluation. 2019. *Implementation of the Electronic Information System in Bangladesh: Experience and Lessons Learned.* Chapel Hill, NC: MEASURE Evaluation, University of North Carolina.

Morris, D. M., and G. R. Jenkins. 2018. “Preparing Physical and Occupational Therapists to be Health Promotion Practitioners: A Call for Action.” *International Journal of Environmental Research and Public Health* 15: 392.

Mullany, B. C., S. Becker, and M. Hindin. 2006. “The Impact of Including Husbands in Antenatal Health Education Services on Maternal Health Practices in Urban Nepal: Results from a Randomized Controlled Trial.” *Health Education Research* 22: 166–176.

Naugle, D. A., and R. C. Hornik. 2014. “Systematic Review of the Effectiveness of Mass Media Interventions for Child Survival in Low- and Middle-Income Countries.” *Journal of Health Communication* 19: 190–215.

NIPORT, icddr,b, and UNC-Chapel Hill. 2013. *Bangladesh Urban Health Survey 2013 Final Report.* https://www.measureevaluation.org/resources/publications/tr-15-117, funded by USAID.

Noordam, A. C., B. M. Kuepper, J. Stekelenburg, and A. Milen. 2011. “Improvement of Maternal Health Services Through the use of Mobile Phones.” *Tropical Medicine & International Health* 16: 622–626.

Ononokpono, D. N., and E. C. Azfredrick. 2014. “Intimate Partner Violence and the Utilization of Maternal Health Care Services in Nigeria.” *Health Care for Women International* 35: 973–989.

Parati, G., C. Torlasco, S. Omboni, and D. Pellegrini. 2017. “Smartphone Applications for Hypertension Management: a Potential Game-Changer That Needs More Control.” *Current Hypertension Reports* 19 (6): 48.

Peter, J., P. Barron, and Y. Pillay. 2016. “Using Mobile Technology to Improve Maternal, Child and Youth Health and Treatment of HIV Patients.” *SAMJ: South African Medical Journal* 106: 3–4.

Prue, C. S., K. L. Shannon, J. Khyang, S. Ahmed, M. Ram, T. Shields, M. S. Hossain, G. E. Glass, M. M. Nyunt, et al. 2013. “Mobile Phones Improve Case Detection and Management of Malaria in Rural Bangladesh.” *Malaria Journal* 12: 48.

Quayyum, Z., M. N. U. Khan, T. Quayyum, H. E. Nasreen, M. Chowdhury, and T. Ensor. 2013. “Can Community Level Interventions Have an Impact on Equity and Utilization of Maternal Health Care – Evidence from Rural Bangladesh.” *International Journal for Equity in Health* 12: 22.

Rabbi, A. F. 2012. “Mass Media Exposure and Its Impact on Fertility: Current Scenario of Bangladesh.” *Journal of Scientific Research* 4: 383.

Rahman, S. M., N. A. Ali, L. Jennings, M. H. R. Serajii, I. Mannan, R. Shah, A. B. Al-Mahmud, S. Bari, D. Hossain, M. K. Das, et al. 2010. “Factors Affecting Recruitment and Retention of Community Health Workers in a Newborn Care Intervention in Bangladesh.” *Human Resources for Health* 8: 12.

Rahman, M. S., and M. L. Rahman. 2007. “Media and Education Play a Tremendous Role in Mounting Aids Awareness among Married Couples in Bangladesh.” *AIDS Research and Therapy* 4: 10.

Rashid, A. T. 2011. “A Qualitative Exploration of Mobile Phone use by Non-Owners in Urban Bangladesh.” *Contemporary South Asia* 19: 395–408.

Sanghvi, T., R. Haque, S. Roy, K. Afsana, R. Seidel, S. Islam, A. Jimerson, and J. Baker. 2016. “Achieving Behaviour Change at Scale: Alive & Thrive’s Infant and Young Child Feeding Programme in Bangladesh.” *Maternal & Child Nutrition* 12: 141–154.

Sharma, S. K., Y. Sawangdee, and B. Sirirassamee. 2007. “Access to Health: Women’s Status and Utilization of Maternal Health Services in Nepal.” *Journal of Biosocial Science* 39: 671–692.

Silva, B. M., J. J. Rodrigues, I. de la Torre Diez, M. López-Coronado, and K. Saleem. 2015. “Mobile-health: A Review of Current State in 2015.” *Journal of Biomedical Informatics* 56: 265–272.

Singh, A., A. Kumar, and P. Pranjali. 2014. “Utilization of Maternal Healthcare among Adolescent Mothers in Urban India: Evidence from DLHS-3.” *PeerJ* 2: e592.

Sonke, J., and V. Pesata. 2015. “The Arts and Health Messaging: Exploring the Evidence and Lessons from the 2014 Ebola Outbreak.” *BMJ Outcomes* 1: 36–41.

Sood, S., C. Shefner-Rogers, and J. Skinner. 2014. “Health Communication Campaigns in Developing Countries.” *Journal of Creative Communications* 9: 67–84.

Story, W. T., S. A. Burgard, J. R. Lori, F. Taleb, N. A. Ali, and D. E. Hoque. 2012. “Husbands’ Involvement in Delivery Care Utilization in Rural Bangladesh: A Qualitative Study.” *BMC Pregnancy and Childbirth* 12: 28.
Stoyanov, S. R., L. Hides, D. J. Kavanagh, O. Zelenko, D. Tjondronegoro, and M. Mani. 2015. “Mobile App Rating Scale: A New Tool for Assessing the Quality of Health Mobile Apps.” *JMIR mHealth and uHealth* 3.

Strobach, T., and M. Zaumseil. 2007. “An Evaluation of a Micro-Credit System to Promote Health Knowledge among Poor Women in Bangladesh.” *Health Promotion International* 22: 129–136.

Thapa, D. K., and A. Niehof. 2013. “Women's Autonomy and Husbands' Involvement in Maternal Health Care in Nepal.” *Social Science & Medicine* 93: 1–10.

Titaey, C. R., C. L. Hunter, M. J. Dibley, and P. Heywood. 2010. “Why do Some Women Still Prefer Traditional Birth Attendants and Home Delivery?: A Qualitative Study on Delivery Care Services in West Java Province, Indonesia.” *BMC Pregnancy and Childbirth* 10: 43.

Uddin, J., T. Biswas, G. Adhikary, W. Ali, N. Alam, R. Palit, N. Uddin, A. Uddin, F. Khatun, and A. Bhuiya. 2017. “Impact of Mobile Phone-Based Technology to Improve Health, Population and Nutrition Services in Rural Bangladesh: A Study Protocol.” *BMC Medical Informatics and Decision Making* 17: 101.

Uddin, M. J., M. Shamsuzzaman, L. Horng, A. Labrique, L. Vasudevan, K. Zeller, M. Chowdhury, C. P. Larson, D. Bishai, and N. Alam. 2016. “Use of Mobile Phones for Improving Vaccination Coverage among Children Living in Rural Hard-to-Reach Areas and Urban Streets of Bangladesh.” *Vaccine* 34: 276–283.

Upton, G. J. 2016. *Categorical Data Analysis by Example*. Hoboken, New Jersey: Wiley.

Van Kleef, E., A. R. Fischer, M. Khan, and L. J. Frewer. 2010. “Risk and Benefit Perceptions of Mobile Phone and Base Station Technology in Bangladesh.” *Risk Analysis* 30: 1002–1015.

Varshney, U. 2014. “Mobile Health: Four Emerging Themes of Research.” *Decision Support Systems* 66: 20–35.

Wakefield, M. A., B. Loken, and R. C. Hornik. 2010. “Use of Mass Media Campaigns to Change Health Behaviour.” *The Lancet* 376: 1261–1271.

Wakefield, M., M. Spittal, H. Yong, S. Durkin, and R. Borland. 2011. “Effects of Mass Media Campaign Exposure Intensity and Durability on Quit Attempts in a Population-Based Cohort Study.” *Health Education Research* 26: 988–997.

Wallwiener, S., M. Müller, A. Doster, W. Laserer, C. Reck, J. Pauluschke-Fröhlich, S. Y. Brucker, C. W. Wallwiener, and M. Wallwiener. 2016. “Pregnancy eHealth and mHealth: User Proportions and Characteristics of Pregnant Women Using Web-Based Information Sources – a Cross-Sectional Study.” *Archives of Gynecology and Obstetrics* 294 (5): 937–944.

WHO. 2010. *World Health Statistics 2010*. World Health Organization.

WHO. 2014. *WHO Recommendations on Postnatal Care of the Mother and Newborn*. World Health Organization

WHO. 2016. *WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience*. World Health Organization.

WHO, UNICEF. 2012. *TRENDS in Maternal Mortality: 1990 to 2010: WHO, UNICEF, UNFPA and the World Bank Estimates*. WHO, UNICEF.