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Prevalence of COVID-19 in Bangladesh, April to October 2020—a cross-sectional study ☆,☆☆,★,★★

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ABSTRACT

Objective: The aim of this study was to estimate the proportion of symptomatic and asymptomatic laboratory-confirmed coronavirus disease 2019 (COVID-19) cases among the population of Bangladesh.

Methods: A cross-sectional survey was conducted in Dhaka City and other districts of Bangladesh between April 18 and October 12, 2020. A total of 32 districts outside Dhaka were randomly selected, and one village and one mahalla was selected from each district; 25 mahallas were selected from Dhaka City. From each village or mahalla, 120 households were enrolled through systematic random sampling.

Results: A total of 44 865 individuals were interviewed from 10 907 households. The majority (70%, n = 31 488) of the individuals were <40 years of age. Almost half of the individuals (49%, n = 21 888) reported more than four members in their household. It was estimated that 12.6% (n = 160) of the households had one or more severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-infected individuals, among whom 0.9% (n = 404) of individuals had at least one COVID-19-like symptom, at the national level. The prevalence of COVID-19 in the general population was 6.4%. Among the SARS-CoV-2-positive individuals, 87% were asymptomatic.

Conclusions: The substantial high number of asymptomatic cases all over Bangladesh suggests that community-level containment and mitigation measures are required to combat COVID-19. Future studies to understand the transmission capability could help to define mitigation and control measures.

1. Introduction

Globally, as of October 5, 2021, a total of 236 132 082 confirmed cases of coronavirus disease 2019 (COVID-19) and 4 822 472 deaths had been identified worldwide (World Health Organization, 2021). COVID-19 was first reported in Bangladesh on March 8, 2020 (GARDAWORLD, 2020). As of October 8, 2021, a total of 1 561 463 confirmed cases had been identified in Bangladesh, including 27 654 deaths (DGHS, 2021). Until recently, the variant with the D614G mutation in the spike glycoprotein was most common (98%) variant of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Bangladeshi isolates (Hasan et al., 2021).

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Most of the available studies showing the prevalence of COVID-19 have included data from hospitals and medical centre facilities, and estimates have been based on patients visiting facilities (Cummings et al., 2020; Liang et al., 2020; McMichael et al., 2020; Spellberg et al., 2020). In Bangladesh, most of the COVID-19 studies conducted have used hospital-based data or the government database (Islam et al., 2021; Mannan et al., 2021; Siam MHB et al., 2021). Many of the studies in this country have reported findings from specific hotspots or specific districts (Ali et al., 2021; Islam et al., 2021; Islam and Noman, 2020; Siam ZS et al., 2021). Furthermore, the presentation of the countrywide COVID-19 situation has mostly been based on mathematical modelling (Hridoy et al., 2020; Sarkar et al., 2021). Thus, information on the prevalence of COVID-19 from community-based studies remains limited.

In 2020, diagnostic testing for COVID-19 was mainly available in government health facilities and laboratories (Carlos del Rio and Malani, 2020; Paules et al., 2020). Furthermore, until recently, testing in Bangladesh was prioritized for persons showing symptoms (Islam and Noman, 2020). These results are an underestimation of the true prevalence of the disease, since studies have already noted a considerable number of asymptomatic cases of COVID-19 in many countries (Anderson et al., 2020; Bai et al., 2020; Gao et al., 2020; Kim et al., 2020), including Bangladesh (Ali et al., 2021; Chowdhury et al., 2021; Mannan et al., 2021), along with symptomatic cases. Both symptomatic and asymptomatic individuals with COVID-19 are capable of spreading the disease by person-to-person transmission (He et al., 2020). Studies have identified that transmission from asymptomatic individuals occurs during the incubation period (a week before the onset of COVID-19 illness) (Bai et al., 2020; Rothe et al., 2020; Yu et al., 2020) and a similar viral load has been noted in both symptomatic and asymptomatic individuals (Zou et al., 2020).

The reporting of infectious diseases, including COVID-19, is challenging, as in addition to asymptomatic individuals, people with mild symptoms do not seek care from healthcare facilities, and the actual burden of the disease remains unknown (Gibbons et al., 2014; Munster et al., 2020). Determining the prevalence of symptomatic and asymptomatic COVID-19 cases at the community level is of critical importance to estimate the true burden of COVID-19. This information could help redefine the current public health containment, mitigation, and long-term prevention strategies. Therefore, the aim of this study was to estimate the proportion of symptomatic and asymptomatic laboratory-confirmed COVID-19 cases among the population of Bangladesh.

2. Methods

2.1. Study design and sites

A nationwide community-based cross-sectional survey was conducted, including the Dhaka City Corporation area, between April 18 and October 12, 2020. A total of 32 districts out of the 64 districts of Bangladesh were randomly selected. From each selected district, one village (the smallest geographical unit of rural areas) and one mahalla (the smallest geographical unit of urban areas) were selected at random for data collection. Dhaka City was purposively selected from Dhaka District as the capital city of Bangladesh and the hotspots for COVID-19 cases. For the Dhaka City Corporation, 25 wards were randomly selected (i.e., the administrative and geographical unit of the City Corporation area) out of the 129 wards (Dhaka North City Corporation, 2019; Dhaka South City Corporation, 2019). From each selected ward, one mahalla was randomly selected. Next, 120 households from each selected mahalla and village were enrolled through systematic random sampling.

2.2. Household selection

Information was collected on the total number of households in each selected village/mahalla from the local administrative offices, and the total number of households was divided by the number of households required to be enrolled (i.e., 120) to determine the sampling interval. If the selected village/mahalla had fewer than 120 households, an adjacent village was also selected to enrol the required number of households. A side of the village/mahalla (north, south, east, or west) was randomly selected to select the entry point. To select the first household, we provided numbers to the first nine households starting from the closest household to the selected entry point, randomly took a Bangladeshi Taka (BDT) and used the last digit of its serial number (from 1 to 9) to select the first household on that side. Then we kept selecting households towards the direction of the opposite side (e.g., from north to south) with the calculated sampling interval. The same process of selection was then performed from another side of the village/mahalla until the sample size was reached. If any household refused to participate, the next household was selected.

2.3. Data collection

The study team interviewed an adult member of every enrolled household. They collected data on socio-demographics and illness related to COVID-19 for all household members of the selected household. The team conducted face-to-face interviews using a structured questionnaire with questions on symptoms, the onset of illness, smoking history, bacillus Calmette–Guérin (BCG) vaccine status, comorbid conditions, number of rooms in the household, and information on bathroom sharing. The team also collected the GPS (global positioning system) coordinates of all selected households. From the interviews, the team defined the household as symptomatic or asymptomatic based on the presence of individuals with any COVID-19 symptoms (fever, cough, sore throat, and dyspnoea). The team also followed up on the asymptomatic COVID-19 positive cases for up to 2 weeks to ascertain their asymptomatic status.

2.4. Symptomatic and asymptomatic household selection for sample (specimen) collection

If any member of the 120 households reported any symptom relevant to COVID-19 (fever or cough or sore throat or shortness of breath/dyspnoea) within the last 7 days, the household was enrolled as a symptomatic household.

Every 10th asymptomatic household (reporting no symptoms within the last 7 days for all members) within each village/mahalla was selected as an asymptomatic household for sample collection. The first household for selecting the asymptomatic household was the 10th household; the 10-household interval was used until 10 asymptomatic households were selected. If any member of the 10th household reported any symptom relevant to COVID-19 (symptomatic household) or the asymptomatic household refused to provide a sample, the next household was selected.

All individuals in symptomatic households and the selected asymptomatic households (every 10th) were eligible for sample collection. The team collected samples from the participants of those households present on the day of the survey who provided consent for sample collection. Regarding individuals who were absent from the households, the team communicated with them over the phone to determine whether they were willing to provide a sample. Teams also collected samples beyond duty hours or the next day if any participant wanted to provide specimens later.

2.5. Collection and testing of swab samples

Trained laboratory technicians collected nasopharyngeal swab samples in viral transport medium (VTM) from all of the selected and consented symptomatic and asymptomatic household members for COVID-19 diagnosis. The collected samples were stored in dry-shippers and transported to icddr,b Virology Laboratory (samples from Dhaka on the

Table 1
Demographic characteristics of the survey population at the national, urban, and rural levels, from April 18 to October 12, 2020

Characteristics	Urban (n = 28 621) Frequency (%)	Rural (n = 16 244 Frequency (%)	National (n = 44 865) Frequency (%)
Sex			
Male	14 306 (49.98)	8081 (49.75)	22 387 (49.90)
Female	14 313(50.01)	8162 (50.25)	22 475 (50.09)
Third gender	2 (0.01)	1 (0.01)	3 (0.01)
Age in years			
<10	4452 (15.56)	2919 (17.97)	7371 (16.43)
10–14	2749 (9.60)	1763 (10.85)	4512 (10.06)
15–19	2783 (9.72)	1651 (10.16)	4434 (9.88)
20–39	10 017 (35.00)	5154 (31.73)	15 171 (33.81)
40–59	6256 (21.86)	3260 (20.07)	9516 (21.21)
≥60	2364 (8.26)	1497 (9.22)	3861 (8.61)
Symptoms (day of visit and preceding 7 days)			
Symptomatic individuals	491 (1.72)	164 (1.01)	655 (1.46)
Fever	350 (1.22)	116 (0.71)	466 (1.04)
Cough	262 (0.92)	92 (0.57)	354 (0.79)
Sore throat	87 (0.30)	23 (0.14)	110 (0.25)
Shortness of breathing/ dyspnoea	45 (0.16)	8 (0.05)	53 (0.12))
Asymptomatic individuals	28 130 (98.28)	16 080 (98.99)	44 210 (98.54)
Shared bathroom			
Yes	6688 (23.37)	2681 (16.50)	9369 (20.88)
No	21 933 (76.63)	13 563 (83.50)	35 496 (79.12)
Household size			
≤4 members	15 271 (53.36)	7706 (47.44)	22 977 (51.21)
>4 members	13 350 (46.64)	8538 (52.56)	21 888 (48.79)
Number of living rooms			
1	5969 (20.86)	2393 (14.73)	8362 (18.64)
2	10 122 (35.37)	5958 (36.68)	16 080 (35.84)
3+	12 530 (43.78)	7893 (48.59)	20 423 (45.52)
BCG vaccine			
Yes	26 856 (93.83)	15 348 (94.48)	42 204 (94.07)
No/don't know	1765 (6.16)	896 (5.52)	2661 (5.93)
Person tested for COVID-19 before the survey			
Yes	90 (0.31)	20 (0.12)	110 (0.25)
No	28 531 (99.69)	16 224 (99.88)	44 755 (99.75)

BCG, bacillus Calmette–Guérin.

Table 2
Prevalence of COVID-19 cases at the national level in Bangladesh, from April 18 to October 12, 2020

Characteristics	Weighted prevalence of COVID-19		
	Symptomatic % (95% CI)	Asymptomatic % (95% CI)	Total % (95% CI)
Individual	17.97 (13.4–23.6)	6.41 (4.2–9.7)	6.44 (4.2–9.7)
Sex			
Male	21.72 (15.3–29.9)	5.84 (3.8–9.0)	5.89 (3.8–8.90)
Female	14.01 (8.5–22.2)	6.90 (4.0–11.6)	6.92 (4.1–11.6)
Age group (in years)			
<10	1.15 (0.3–4.2)	3.57 (1.4–9.1)	3.57 (1.4–9.1)
10–14	9.00 (1.9–33.7)	4.27 (1.1–16.3)	4.28 (1.0–16.2)
15–19	3.25 (0.9–10.6)	9.52 (4.2–20.1)	9.51 (4.2–20.1)
20–39	20.24 (11.4–33.3)	7.13 (4.6–10.9)	7.17 (4.6–11.0)
40–60	23.01(13.3–36.7)	5.71 (3.1–10.4)	5.76 (3.1–10.4)
≥60	29.04 (12.7–53.4)	7.69 (2.9–19.0)	7.76 (2.9–19.0)

CI, confidence interval.

day of collection; samples from outside Dhaka with an interval of 3 days) for real-time reverse transcription PCR (RT-PCR) to identify SARS-CoV-2 RNA.

RNA was extracted from the nasopharyngeal swab samples using the QIAamp Viral RNA Mini Kit (Qiagen, Hilden, Germany). A final volume of 60 μl RNA was eluted from a 140 μl sample. The RNA was tested for SARS-CoV-2 by RT-PCR targeting the ORF1ab and N genes using specific primers and probes and following the protocol of the Chinese Center for Disease Control and Prevention (China CDC). Amplification was performed using the iTaq Universal Probes One-Step Kit (Bio-Rad Laboratories, Inc., California, USA) in a Bio-Rad CFX96TM Real-Time PCR Detection System (Bio-Rad Laboratories, Inc.) under the following conditions: 50°C for 10 min, 95°C for 3 min, followed by 40 cycles of 95°C for 10 s, 60°C for 45 s (Data Acquisition).

2.6. Data analysis

All categorical variables were summarized using the frequency and percentage. For each sampling stage, the selection probability of sampling units was estimated using the existing sampling frame. We then multiplied all of the selection probabilities obtained from each stage to estimate the selection probability for each selected individual. The individual-level sampling weight was then estimated by taking the inverse of the selection probabilities. Finally, the weights were normalized and used to estimate the parameters. The prevalence of COVID-19 cases

Table 3
Weighted prevalence of COVID-19 in urban and rural areas

Characteristics	Urban			Rural		
COVID-19 positive	Symptomatic % (95% CI)	Asymptomatic % (95% CI)	Total % (95% CI)	Symptomatic % (95% CI)	Asymptomatic % (95% CI)	Total % (95% CI)
Individual	18.9 (13.1–26.6)	4.9 (3.3–7.2)	5 (3.3–7.2)	17.6 (11.8–25.5)	6.8 (4.0–11.4)	7 (4.1–11.3)
Male	18.8 (13.5–25.5)	5.2 (3.5–7.5)	5.2 (3.6–7.5)	22.7 (14.2–34.2)	6.0 (3.4–10.4)	6.1 (3.5–10.4)
Female	19.1 (10.7–31.9)	4.6 (2.9–7.1)	4.6 (3.0–7.2)	11.9 (5.6–23.2)	7.5 (3.9–13.9)	7.5 (4.0–13.9)

CI, confidence interval.

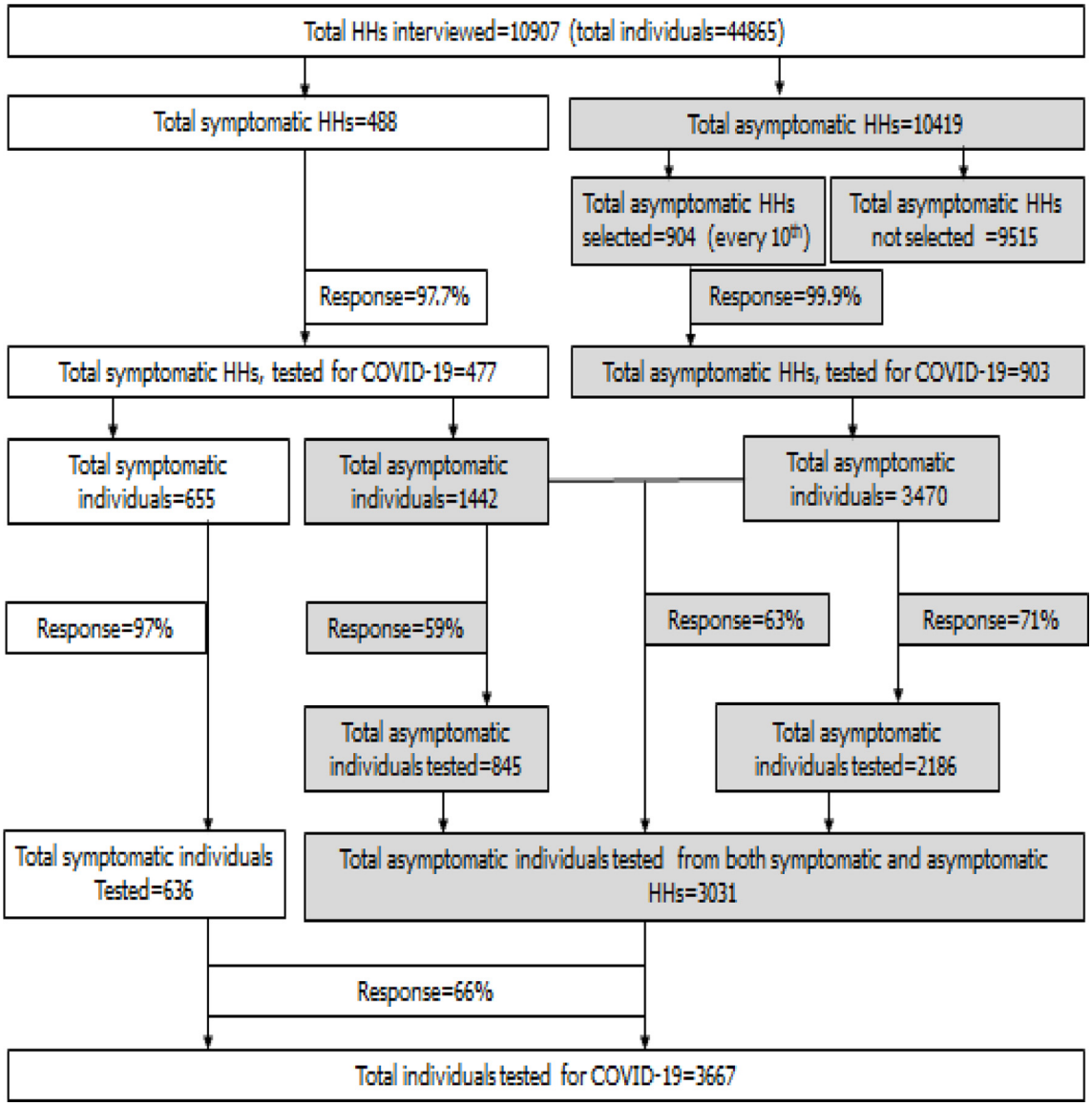

Figure 1. Households and individual enrolment status—Bangladesh, April 18 to October 12, 2020. (HH, household.)

was estimated with a 95% confidence interval (CI), adjusting for design weight and clustering effects. Stata version 13.0 was used for the data analysis.

2.7. Ethical considerations

The Research Review Committee and the Ethics Review Committee of icddr,b approved the study protocol. Written informed consent was obtained from all of the respondents before enrolment and data collection.

3. Results

A total of 44 865 individuals from 10 907 households were interviewed (Figure 1). The majority (70%, n = 31 488) of the individuals were <40 years of age (Table 1). Almost half of the individuals (49%, n = 21 888) reported more than four members in their household (Table 1). Fifty-four percent (n = 24 442) of individuals lived in houses with two or fewer rooms. Among the 10 907 households, 488 were symptomatic, and it was possible to enrol 477 symptomatic households with 655 symptomatic and 1442 asymptomatic individuals (Figure 1);

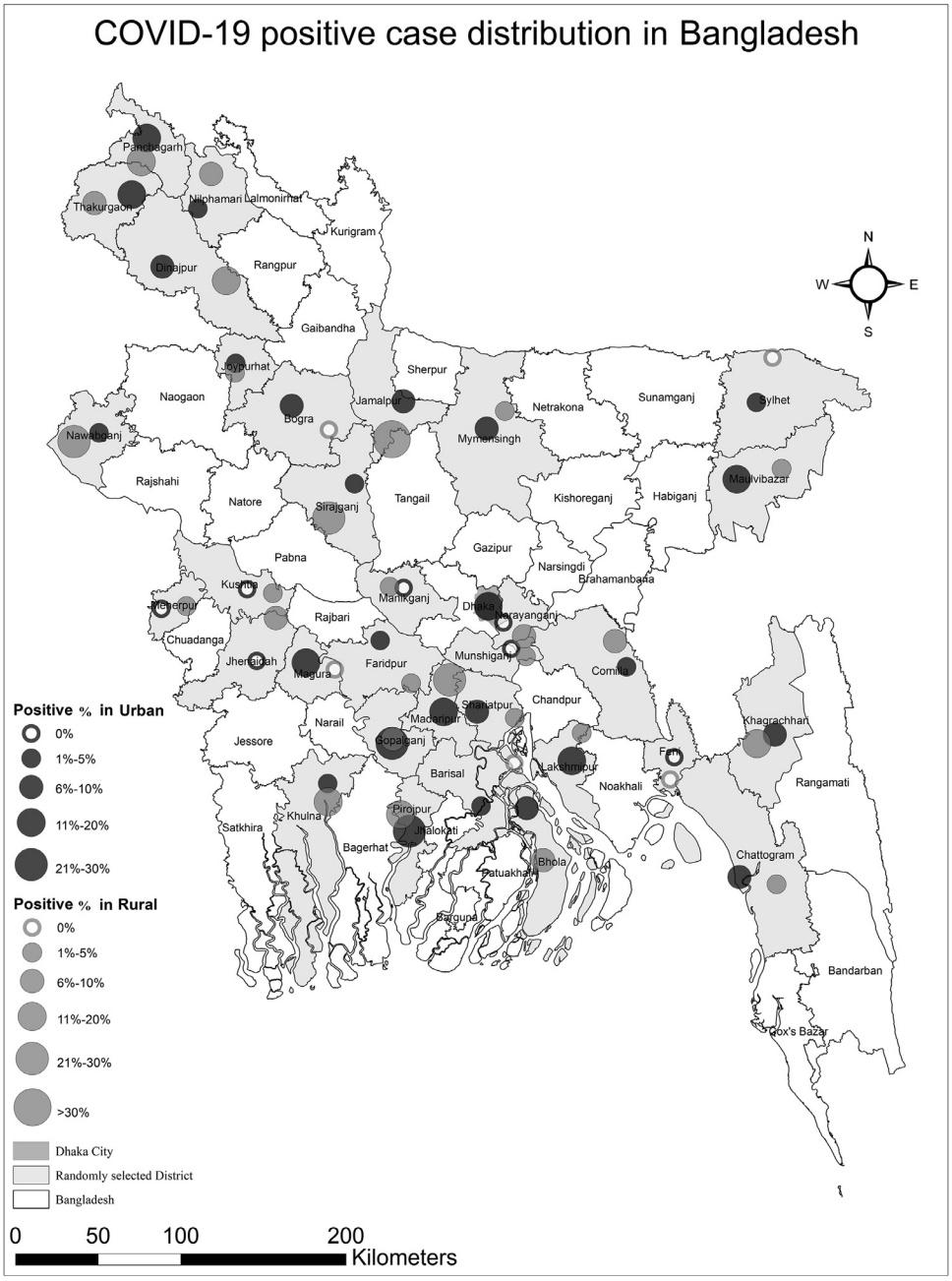

Figure 2. Selected study areas in Bangladesh, with the percentage positive for COVID-19 among the tested individuals; April 18 to October 12, 2020.

350 individuals tested positive for COVID-19. Among the 10 419 asymptomatic households, 903 asymptomatic households with 3470 asymptomatic individuals were enrolled (Figure 1). A total of 3667 individuals were tested to confirm SARS-CoV-2 infection (Figure 1). The response rate among all participants countrywide was 66% (3667/5567), where 97% (636/655) was from symptomatic individuals and 63% (2186/3470) was from asymptomatic individuals. Among the asymptomatic individuals, the response rate was 59% (845/1442) from symptomatic households and 71% (2186/3470) from asymptomatic households. The reason for non-response was not being at home during data collection or unwillingness to provide a swab sample.

After adjusting the sampling weight, it was estimated that 12.6% (n = 160) of the households had one or more SARS-CoV-2-infected individual. Among them, 0.9% (n = 404) of individuals at the national level had at least one COVID-19-like symptom, with the urban population (1.2%, n = 113) having more symptomatic individuals than the rural population (0.9%, n = 234) (P = 0.17).

The estimated point prevalence of COVID-19 nationally was 6.4% (95% CI 4.2–9.7%) (Table 2). The prevalence rate did not differ significantly between the rural population (7%, 95% CI 4.1–11.4%) and the urban population (5%, 95% CI 3.3–7.2%) (P = 0.30) (Table 3). The prevalence rate was similar among females (6.9%, 95% CI 4.1–11.6%) and males (5.9%, 95% CI 3.8–9.0%) (P = 0.52) (Table 2). The COVID-19 prevalence was highest among the adolescents (9.5%, 95% CI 4.2–20.0%), followed by individuals over 60 years of age (7.8%, 95% CI 2.9–19.1%) (Table 2).

After weighting, most of the symptomatic COVID-19 positive cases, i.e. 74%, had a fever; this was 85% in the urban population and 69% in the rural population. It was estimated that 55% of the survey population had a cough (similar proportions of urban and rural populations), 19% had a sore throat, and 6% had shortness of breath. The weighted prevalence of COVID-19 among the symptomatic individuals was 18% (95% CI 13–24%) and among the asymptomatic individuals was 6.4% (95% CI 4.1–9.6%) (Table 2). About 8.5% of individuals who were asymptomatic on the first day of sample collection later became symptomatic within

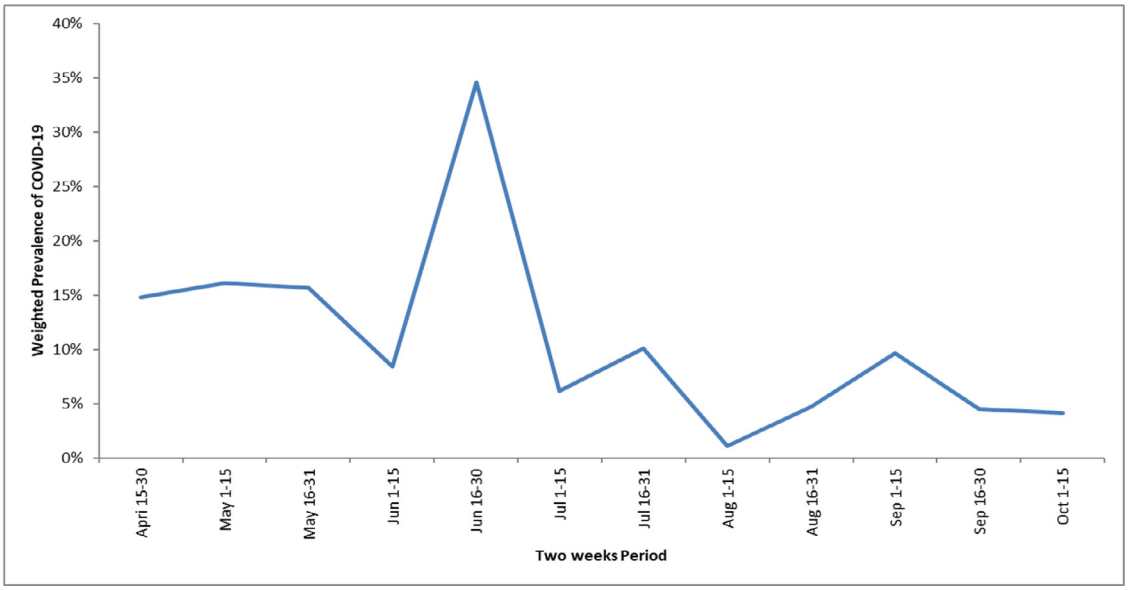

Figure 3. Distribution of COVID-19 point prevalence (weighted) nationally from April to October, 2020.

14 days of the COVID-19 test. Among all COVID-19 positive cases, 13% were symptomatic (showing symptoms between day 1 and day 14) and 87% were asymptomatic.

3.1. Distribution of COVID-19 cases in Bangladesh

All of the selected districts had at least one confirmed COVID-19 case except one district – Feni – located in the southwest part of the country. The highest positivity rate of COVID-19 was in Jamalpur (18%, 15/83) (Figure 2). The number of COVID-19 cases showed an upward trend from April to May 2020 and an increasing trend from June to July 2020, then decreased between August and October 2020 throughout the study. The highest peak of COVID-19 cases was observed in June 2020 (Figure 3).

4. Discussion

The estimated nationwide community-based prevalence of COVID-19 was 6.4% in Bangladesh between April and October 2020. The prevalence of COVID-19 was almost the same in urban (5%) and rural (7%) areas. Asymptomatic COVID-19 cases were estimated to be high (87%) among the positive cases of COVID-19, in the study population nationwide. The highest peak of COVID-19 cases was in June 2020, which was immediately after the end of the first nationwide restricted movement in Bangladesh.

Similar to other studies in different countries (Chen et al., 2020; Larsen et al., 2020; Michelen et al., 2020; Wang et al., 2020) and in Bangladesh (Ali et al., 2021; Chowdhury et al., 2021), it was found that fever was the prime symptom, followed by cough. A report from China showed that four of five COVID-19 confirmed cases were asymptomatic (Day, 2020), and a meta-analysis reported that 93% of the cases were asymptomatic (Kronbichler et al., 2020), which is comparable to the results of the present study. However, the study finding of a high prevalence of asymptomatic cases differs from the results of the other studies conducted in Bangladesh, as those studies found that 11–19% of the cases were asymptomatic (Ali et al., 2021; Chowdhury et al., 2021; Mannan et al., 2021). However, all of these studies were hospital-based, and most of the asymptomatic cases may not have visited healthcare facilities (Gibbons et al., 2014). The Integrated Disease Surveillance Programme (IDSP) of India estimated that 80% of COVID-19 cases were asymptomatic (Gosh, 2020; Munster et al., 2020). However, most of the available studies estimated asymptomatic prevalence based on small datasets and the findings of other studies conducted in specific settings. It appears that large empirical community-based studies detecting asymptomatic cases remain limited. The evident prevalence of asymptomatic cases identified in the present study suggests that asymptomatic cases may be responsible for significant transmission of COVID-19 at the community level.

As observed in this study, an increasing trend of COVID-19 prevalence in June 2020 was also observed in the database of the Government of Bangladesh (Siam et al., 2020) and in other studies in Bangladesh (Hridoy et al., 2020; Siam MHB et al., 2021). The Government of Bangladesh implemented a 66-day nationwide restricted movement policy from March 26 to May 31, 2020 (Siam et al., 2020). The upward trend of COVID-19 prevalence in June indicates that the increased movement of people in June may have contributed to the increasing prevalence of COVID-19 cases. This underscores the fact that the enforcement of social distancing measures may help control the spread of SARS-CoV-2 infection in densely populated settings, particularly when asymptomatic cases are prevalent within the community setting.

This study found similar infection rates among males and females, which is in agreement with the World Health Organization age and sex disaggregation global findings of COVID-19 cases (World Health Organization, 2020). Furthermore, other studies have noted similar susceptibility in males and females (Jin et al., 2020). However, the database of the Government of Bangladesh shows a higher prevalence of COVID-19 among males compared to females (Siam et al., 2020), which might be linked to the prioritization of males in healthcare-seeking practices in the Bangladeshi context (Ahmed et al., 2001; Chen et al., 1981; Najnin et al., 2011). Thus, men might have sought more care from the government COVID-19 reporting system. In the present study, all members of the households were approached to participate. Thus, the difference between our study findings and the government dataset might be explained by the prevailing social and contextual gender roles in Bangladesh.

This study has several limitations. Specimens for testing were collected from selected asymptomatic households instead of selecting all of the asymptomatic households due to resource and time limitations. However, this limitation was addressed by presenting the weighted prevalence of COVID-19 (including symptomatic and asymptomatic cases). Another limitation is that it was not possible to test a high proportion of asymptomatic individuals due to refusal or the individual not being present during data collection. Thus, interpretation of the prevalence of asymptomatic COVID-19 cases should be considered with cau-

tion. However, the findings of this study are similar to those of studies reporting the prevalence of COVID-19 cases in other settings (Day, 2020; Gosh, 2020; Kronbichler et al., 2020).

Furthermore, this study may also have been subject to the limitation of response bias: participants may have withheld their symptoms due to stigma, panic, or fear resulting from the massive dissemination of information through the media (Ahmad and Murad, 2020; Hasan, 2020). Also, this study presents findings from 2020, and many COVID-19 studies based on recent findings have already been published in Bangladesh (Chowdhury et al., 2021; Hridoy et al., 2020; Islam et al., 2021; Sarkar et al., 2021; Siam MHB et al., 2021). Nevertheless, it appears that this is the first attempt to estimate the community prevalence of COVID-19 from a community-based cross-sectional study, using a large sample size with a rigorous methodology in a low and middle-income (LMIC) country, which could be used to guide epidemic control efforts for COVID-19 and provide scope for future research endeavours.

In conclusion, the estimation of the point prevalence of COVID-19 in Bangladesh, including the symptomatic and asymptomatic point prevalence, provides us with an understanding of COVID-19 transmission and an insight into the epidemic spread. The substantially high number of asymptomatic cases suggests that community-level containment and mitigation measures are required to combat COVID-19. In future studies, an estimation of the basic reproduction number (R_0) for symptomatic and asymptomatic COVID-19 will be helpful to understand the transmission capability of SARS-CoV-2 and help define mitigation and control measures.

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Conflict of interest

There is no conflict of interest reported by any author.

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