Impact on mental health due to COVID-19 pandemic: A cross-sectional study in Bangladesh

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ARTICLE INFO

ABSTRACT

The government of Bangladesh has implemented the "Stay Home" policy following the WHO recommendation to resist the community transmission of Covid-19. As a result, the routine activities of all government, semi-government establishments, including educational institutions, are severely affected, and the country's economic growth becomes slowed down. To overcome such a situation, the relevant authorities have introduced the "Work from Home" policy for the employees and "Remote Education" for students. However, due to the persistence of multi-dimensional socio-economic problems, many employees and students face big challenges in performing their regular jobs while adopting such a policy. Consequently, enormous psychological anxiety has been developed for all people, including students, parents, employees, etc., and concurrently created severe changes in their behavior. This study aims to analyze the reasons for the behavioral changes of the employees, students, academic staff, and family members of different ages due to psychological anxiety, stress, or physical issues. A comprehensive online-based survey has been carried out on people working in various sectors in Bangladesh. A modified Apriori Algorithm has been used to sort out the associations between the causes and types of behavioral changes. Analyzed data revealed a massive human behavioral change in most participants. This finding indicates that the negligence of those significant human behavioral changes may cause a higher risk of creating psychological imbalance. Therefore, there is a need to have a solid understanding of the reasons for the behavioral changes and set up standard guidelines to maintain "Work from Home" in this Covid-19 situation to avoid psychological imbalance. Based on this study, some suggestions have been given for implementation by the government on an urgent basis.
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1. Introduction

At present, the whole world is going through a pandemic situation due to the novel coronavirus disease (Covid-19), which was first spotted in December 2019 at Wuhan, China.[1–3] Since then, this virus has spread out worldwide within a short time. Bangladesh is also not free from this virus outbreak. As of May 22, 2022, worldwide, the Covid-19 infected confirmed cases are 527.3 M, death cases 6.3 M, and recovered 497.33 M from this virus infection.[4] Since this virus's characteristics are highly infectious, the World Health Organization (WHO) has provided guidelines to reduce the spread of this virus on a massive scale. Some of those significant guidelines are social distancing, stay home, using face masks while going outdoors, frequent hand washes with soap or hand sanitizer, social isolation, institutional and home quarantine, lockdown, etc.[5] The people of Bangladesh are by birth socialistic and renowned for their socialism. Therefore, to avoid the community transmission of Covid-19, the government of Bangladesh has ini-

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tially imposed a countrywide lockdown on Mar. 23, 2020, for two weeks, and later extended consecutively for more than 16 weeks,[6] and still, the lockdown extends as the second wave hits due to the mutation of the virus [7]. As a result, similar to the other countries, the people of Bangladesh live in captivity within the four walls. It means they are living in a state of suffocation being at home 24 by 7 h. Although people have become bored in their lockdown life for being at home, however in one way, the lockdown brings some advantages, especially for the family members of young (children) and old ages (grandparents). This is because they are now finding more companies from their working members/parents who usually stay far away from their families and children. The children are thrilled to have time more than before they had from their working parents, the happiness of the old parents is also overjoyed being closer to their working children more than before.[8]

On the other way, under this lockdown condition, the mechanical world has been paralyzed for the last five months, and the economy of the whole world, including Bangladesh, is showing a downward trend. Many organizations, including educational institutions, are facing extreme impairment. To overcome such impairment, many business organizations and educational institutions have introduced the "Work from Home" program for their employees.[9] In March, Bangladesh shut the entire of its educational institutions to reduce the spread of COVID-19. At first, on 17 March, when Bangladesh had 8 affirmed cases, the government announced all schools would be shut for the rest of March. Due to the extended period of lockdown, a significant change occurred in the daily lifestyle.[10] It is noticeable that the majority of the people's workload/work efficacy has increased significantly because they can do their work from home without spending/wasting any time traveling, outing, sightseeing, and various outdoor activities. However, in addition to the usual professional activities, people now have to do household activities, including cleaning, preparing multiple food items, etc. Due to the lockdown, most of the temporary/part-time workers (so-called housemaids) can't join in house service activities anymore; hence, such extra activities have to do by the family's senior members creates an irritable state of mind. It is worth mentioning that while working remotely under the "Work from Home" program, the employees, academic staff, and students find more difficulties than the conveniences, especially in Bangladesh.

In contrast, the developed countries usually have many facilities, including internet-based updated technology; thus, people are facing fewer problems than third-world countries like Bangladesh. As Bangladesh is one of the densely populated countries in the world, the overall socio-spatial condition (i.e., population density, educational status, social structure, cultural norms, and healthcare capacity) has significantly created a negative effect on human behavior following their confinement in the home.[11] Since the societal aspect is an essential part of human life, individuals who are isolated, are probably going to build up a wide range of symptoms of psychological stress and disorder, including low mood, insomnia, stress, anxiety, anger, irritability, emotional exhaustion, depression, and post-traumatic stress symptoms. Low mood and irritability individually stand out as being very common; the study notes.[12]

This study has international ramifications since it gives information on the psychological impact of the COVID-19 epidemic on a specific community in Bangladesh and is applicable to other third-world nations. It tackles the study gap in understanding the causes of behavioral changes in employees, students, academic staff, and family members of various ages during the pandemic due to psychological worry, stress, or medical concerns. The study also delves into the difficulties that employees and students encounter while implementing "Work from Home" policies and "Remote Education" in a developing nation like Bangladesh. Some

recent papers proposed robust theoretical framework about the psychological, social and economic impact on working population of India[13] and assessed challenge stressor as source of motivation among banking industry employees.[14] They evaluated their survey result from hypothesis-based outcome, where we tried to analyze the reason of these issues with machine learning algorithm. The modified Apriori Algorithm employed in this work may also be utilized to detect the reasons and types of behavioral changes in other scenarios. The study's findings and recommendations can help the government and relevant authorities of Bangladesh to set up standard guidelines to maintain "Work from Home" and support the mental health of its citizens during this pandemic. Overall, this study contributes to the growing body of research on the psychological impact of post COVID-19, and its widespread impact on people worldwide.

2. Literature review

As the COVID-19 pandemic drives us inside our homes, some institutions' working pattern has been found to have a significant change. For instance, in Bangladesh, most academic staff have to conduct online classes during the daytime and have to attend the official works/meeting, etc. at night. Moreover, at home, they have to do household work, including caring for and sharing with young and old age family members. Besides those, being engaged all time via online activities using a cellphone/other devices (continuous monitoring of email and messages via social media), excessive pressure to perform work (as if to ensure similar service like face-to-face mode) within the deadline, children's mischief, argue with the spouse for not doing household works, family crisis, reduction of salary, more significant imbalance in income-to-house expenses, etc. are also some critical reasons of mental pressure and stress during this lockdown time. The global outbreak of Covid-19 has impacted individuals from diverse backgrounds. In Bangladesh, those who operate rickshaws and rely on transporting commuters across the city are among the most susceptible population in terms of their economic stability.[15] The pandemic-caused decrease in economic profits has had a significant influence on the living conditions of Rickshaw pullers because of the precarious nature of their professions.[16] In Bangladesh, the hijras have been forced to live in poverty as a result of the national lockout during COVID-19. The hijra people's meager income has reached nil, making it difficult for them to survive.[17]

People from other professions such as staff/employees of private firms, software firms, banks, garments industry, government, semi-government organizations, etc. are also facing many problems, including their physical attendance to offices, especially the employee of service sectors, banks, etc. Although most of the employees performed their work via offline/online methods, many private firms reduced the staff's salary by almost 50% or higher. Besides this, some other effects, such as loss/demotion from positions, becoming sick or enduring mourning, have also been reported at a considerable level. During the Covid-19 pandemic and the period of distance learning, there has been an increase in students' independence, but a corresponding decrease in their discipline.[18] Regarding students, they face a significant problem in attending online classes because of reduced internet bandwidth. Moreover, students who have been moved to villages are finding more difficulties to participate in online classes due to the nonavailability of internet connection in village areas in Bangladesh.[19] On the other hand, those students who are still residing in the city areas are now facing a severe problem maintaining their daily livelihood. In Bangladesh, many students (who usually come to the city from village areas for higher studies) are generally engaged with temporary jobs like home tuitions, part-time services, etc. for

some extra earnings. Earning from such types of work helped them manage personal expenditure, including a part of the university education expenses. Implementation of lockdown mainly affected earnings from such temporary jobs.

Moreover, to attend the online classes, students need to purchase the right internet package, which becomes a significant challenge due to the lack of any earnings/sources of income. So, they aren't able to attend the online classes if they wish so. Considering the overall situation, students are also facing behavioral changes, which can be identified as chaos in their life. As a result, their behavior changes in every moment like they become short-tempered, rude, depressed, annoying, concentration breaks, etc. Traumatized family problems are another cause of mental stress for students, teachers, employed and unemployed people who belong to different fields during this lockdown time. Regarding age, youthful adults (18–30) and adults aged somewhere in the range of 31–59 years have more levels of stress, uneasiness, and sorrow in comparison with the older persons (60–82 years). Indeed, people with the most significant tension and sadness are the youthful adults in the 18 to 30-year age range.[20] In this uncertain period, most newly graduated students are jobless; they have no work to do in this lockdown time and suffer from depression.

The lockdown also brings an uncertain time for working females because they have to do household work and academic and administrative tasks.[21] Females appear to be more worried than men during the lockdown. The outcomes of an ongoing survey led to the ETimes Lifestyle Twitter account uncovering a similar certainty. Sixty-one percent of the respondents cast a ballot that ladies are more worried than men during the lockdown. Many women working in the private sector found it extremely difficult and stressful while working from home and doing household chores and other activities without much support from their partners. Male and children who used to go out for work and school respectively are now at home most of the time, which also creates a demanding situation for women.[22] Some of the common issues that all women face during the lockdown are related to and affected their health, such as a change in sleep patterns, feelings of frustration, pressure, guilt, fear, and anxiety.[23]

On the other hand, it seems that WHO takes the effect of the emergency on individuals' emotional well-being genuinely and is observing the circumstance along with public specialists, while giving data and direction to the legislatures and the normal mass.[24] The COVID-19 pandemic has made everybody pause and re-evaluates their physical wellbeing and prosperity. For an ordinarily solid individual with no physical disabilities to their physical wellbeing, this is something we underestimate which is also the reason for being depressed in people's life nowadays.

Emotional wellness is about our emotional, mental, and social prosperity. It influences our reasoning, sentiments, and exercises alongside the method for dealing with stress for pressure. It has been seen that a fourth of the total populace battles with psychological well-being issues in overseeing everyday job difficulties. Also, the stress of the respondents hampers the sound rest makes irritability, makes confusion in the family life, and even turns them to be self-destructive idolators.[25]

Developed countries have many facilities for overcoming mental health and physical differences but in our country, it seems very hard during this uncertain situation that causes changes in behavior and also the reason for getting bored being at home all the time. Here at this time, people are getting so worried about some sessional common diseases like fever, cough, headache, etc which are some mutual symptoms of COVID-19 also being one of the main reasons for being at home. Besides those physical activities in other countries are very rich but we are also legging behind from this as a result of our situation at this time is getting worst. It seems that physical activity has a significantly sure effect on mental health, by improving confidence and strength to stretch and reducing depression and anxiety.[26] We all know, diseases that spread have consistently been around, and it keeps on being significant for us to ensure ourselves and forestall the spread of this infection.[27] As Covid-19 cases continued developing at a disturbing rate since mid-March this year, the public authority had to force a cross-country lockdown for multi-week from April 5 to contain the spread. Even though shops and shopping centers were told to close down toward the start of the limitations, the public authority ultimately permitted them to open in a restricted limit in the midst of developing interest from retailers and representatives.[28] So that, the mental pressure is increasing days by days for how to manage family and their daily staffs.

Besides, the presentation of lock-down measures, monetary decreases, and a decrease in worldwide portability across the world have seriously affected Bangladeshi traveler laborers. It is imagined that around ten million Bangladeshis work abroad, particularly across the center east. Thousands of these workers have been forced to return to Bangladesh, largely because of job lay-offs. So many of them lost their jobs for this pandemic and still, they are jobless in Bangladesh. Moreover, Public vehicle administrations, including between area transports, can also continue operating at half capacity. However, everyone, including passengers, must wear masks and comply with health directives. So, it is hard to move on anywhere for work or any other working staff. As Bangladesh is a developing country it is too hard to manage economic stability. As many of them lost their job so many of them faced mental pressure for cannot be able to maintain their family expenses and it also affected their uncertain further career. Moreover, in many countries, children with the metropolitan zones, higher instructed guardians, both higher and lower family pay, smoking status (yes), parental depressive symptoms (threat, scream, hit, etc.), and the anomalous acting of the child,[29] we are also facing this in between our child's.

Considering the information mentioned above situation, this study intends to analyze human behavior due to the psychosocial and socio-economic crisis, amidst the COVID-19 pandemic in Bangladesh. Many reasons are found from this study for behavior changes. Among them, financial problems, sessional diseases, less sleep, significant weight gain or loss, bandwidth problems are some of the most common problems found. From the literature, we came to understand that behavioral changes are happening due to many detected problems, but it lacks the relation between problems with behavior changes. Not all causes are responsible for all the change of course. So, the primary goal of this study was to find out these relations, which very few people in our country care about. It is expected that the findings of this study may help the government, policymakers, and many individuals to take the necessary steps to set up standard guidelines in this after Covid-19 recovery situation to avoid psychological imbalance for Bangladeshi nationals.

3. Methods

3.1. Ethical approval

This survey content and topic was explained thoroughly to participants, who were requested to offer consent of voluntary acceptance prior to participation. The study never collected any identifiable private data such as name, email, national ID to guarantee anonymity in order to keep the participants' identities hidden. All methods involving human subjects in this study followed the principles of the 1964 Helsinki Declaration and its subsequent revisions, or similar ethical standards. Because this study relies on

an online questionnaire distributed to the general population of Bangladesh, no specific ethical approval was obtained.

3.2. Measurement and survey instrument

This study adopted a survey method using a structured questionnaire to collect data from the target respondents. The survey method is a suitable data collection technique when researchers want to select a representative sample from a large group of the population.[30] As this research aims at analyzing how the COVID-19 pandemic impacted human behavior, the structured questionnaire includes questions related to demographic, psychosocial information, and physical issues. This study did not adopt any previously validated scale or items. All the questions were self-generated and validated with subject experts. Respondents were provided with multiple-choice options to answer each question. To design the survey questionnaire, researchers interviewed two sociologists and one psychologist to finalize the possible behavioral changes and problems that arise during the COVID-19 pandemic when works from home. Experts suggested that short temper, rude, depressed, mentally disturbed, concentration loss, bored are the issues of a human being concerning behavioral change during the lockdown in COVID-19. Likewise, family work interruption, kids' disturbance, bandwidth problems were the suggested options to answer the question concerning the problems when working from home. Also, some sessional common diseases like fever, cough, dizziness, headache and some common problems like loss of taste, tiredness, and less sleep are considered as a physical problem. After the initial phase of expert suggestions, the survey questionnaire was sent to three academic experts who have expertise on this subject matter. They suggested including 'no option' in both questions. With this minor modification, the content validity of the survey questionnaire was established. Table 1

Table 1
Data collection form details.

Input Field	Response Options
Name	Text
Age	Number
Current City	Text
Marital Status	Yes/No
Have any Kids	Yes/No
Gender	Male/Female
Employment Status	Yes/No
Occupation	Text
A household working hour since lockdown for COVID-19	Number (working hour)
Study time in lockdown for COVID-19	Number (studying hour)
Mental Pressure Amount	Scale in 0 to 10
Noticed Behavior Changes	Short Temper/Rude/Depressed/ Mentally Disturbed/Concentration Loss/Bored/No change
Like work from home	Yes/No
Problems in work from home	Family work interruption/Kids disturbance/Bandwidth Problem/No problem
Increment of Productivity for work from home	Yes/No
Is household works are thankless job?	Yes/No
Any change in food habit	Yes/No
Noticeable nutrition problem	Yes/No
Noticeable weight change	Yes/No
Disease/Physical problem faced in this lockdown	Fever/Cough/Dizziness/Tiredness/ Headache/Diarrhea/Loss of taste/ Insomnia/No problem
Able to contact a doctor for the physical problem faced in this lockdown?	Yes/No

exhibits the list of questions and options included in the survey questionnaire.

3.3. Data collection and pre-processing

Due to lockdown and pandemic, an online-based questionnaire was prepared to conduct the survey. A questionnaire was distributed among people of different ages and working in various sectors. In this research, data on working people's mental health was compiled mostly from the Chittagong region in Bangladesh. A piece of introductory information with the objectives of this work was included in the questionnaire to understand the respondents better. It was assured that respondents had the experience of working from home. The survey question was shared via social media platforms such as Facebook, Messenger, Linked In, and WhatsApp. Data has been collected using a Google Form, where many input fields are defined, and users can fill this form according to their behavioral conditions. To ensure the privacy of the volunteers who took part in the survey, no private or sensitive information was collected.

Moreover, it has been declared that their given data will be used only for research purposes. The respondents were able to complete the survey once only and could terminate the study at any stage if they desired. The anonymity of the respondents and the confidentiality of the data were guaranteed.

The raw inputs were analyzed first and filter the copy data because a user could give multiple inputs since we didn't collect their email id for verification and privacy. For multiple-choice questions, we have divided the various choices into an individual column for applying the Apriori association algorithm. Then data has been converted into categorical values (i.e., if selected, then it will be 1, else 0). These absolute values were used to find the relation between the causes for behavioral changes. A sample set of processed data has been shown in Table 2.

3.4. Data analysis procedures

A modification of the Apriori Algorithm was developed and used to sort out the association of the causes and types of behavioral changes. Association rules mining is one of the significant data mining methods, and it may be the most widely recognized form of local-pattern discovery in unsupervised learning systems.[31] Apriori algorithm,[32] is the most traditional and significant calculation for continuous mining item sets. Agrawal raised a few improving strategies in person, like Apriori Tid, Apriori All, and so forth.[33] After that, many enhanced techniques were built dependent on the system of the Apriori algorithm. Apriori is utilized to locate all continuous item sets in a given database DB. The critical thought of the Apriori calculation is to make various disregards of the database. It utilizes an iterative methodology known as a breadth-first search (level-wise search) through the search space, where k-itemsets are used to explore (k + 1)-itemsets.[31,34] The primary limitation is the costly waste of time holding countless sets with many regular item sets, low minimum support, or large itemsets.[35] But Apriori is beneficial in small features based dataset like

Table 2
Processed categorical data for example - Person_1: (Short Temper, Rude, Depressed), Person_2: (Rude, Depressed), Person_3: (Bored).

PersonId	Short Temper	Rude	Depressed	Bored
Person_1	1	1	1	0
Person_2	0	1	1	0
Person_3	0	0	0	1

suicidal behavior association[36] or our dataset, and the time complexity to generate associations was minimal in our case.

4. Findings

After screening, a total of 512 persons' data, mostly aged from 18 to 35, were selected for further analysis. Most of the respondents are from the Chittagong region, while only a minor portion of respondents are from the other areas of Bangladesh. According to the collected data, 56.1% are male, 15.6% married, 14.1% have kids, and 25.6% are currently employed. People from different occupations and working in various institutions like the university, medical college, private farms, semi-government, government, IT field, etc. were participated in this survey study and submitted their opinions following the questionnaire. Among them, a maximum of 56.7% of people feel bored in this lockdown, together with other behavioral changing options shown in Fig. 1. A significant portion of them (around 38.6%) agreed that the unstable financial situation due to this COVID-19 is responsible for their behavioral disorders. For the lockdown situation, the majority of the people have to work from home. In this case, it is seen that 47.2% of people like this, and 24.8% of people select the "maybe" option, which in turn can be considered as a positive emotion. Working from home is not always an easy task. Many problems like a family interruption, kid's disturbance, bandwidth problems, and many other unknown problems can occur (See in Fig. 2).

Regarding work productivity, 36.2% think that their productivity can be improved while 35.1% of people don't feel like that, and 28.7% of people select the "maybe" option. Note that regular household jobs are mostly done by female family members in Bangladesh, treated mainly by other family members as thankless jobs. To evaluate such an issue, we set an option to find out what others think about it. It shows that 56.2% of people agree with the concept of thankless jobs or default jobs for women, which can also be considered a problem of behavioral changes. So, we analyze the data of household working hours for both males and females in the different age ranges to see the ratio of an average working hour, and found that women with ages >21 years old work more than men (shown in Fig. 3).

The idea of mental health is linked to the concept of physical health. In this lockdown, many physical problems and diseases have arrived. In Bangladesh, many sessional diseases have mixed up with the symptoms of the COVID-19, creating massive fear of virus attacks such as fever, cough, headache, dizziness, tiredness, insomnia, and some more as shown in Fig. 4. Along with these problems, the noticeable nutrition problem, change of food habit, less sleep problem, and significant weight loss or gain record has been shown in Fig. 5.

4.1. Problem analysis for behavioral changes

We analyzed the probability of different factors that may affect human behavior. In this lockdown for COVID-19, many persons stay in their homes and face many issues that are not common and cause severe effects for long steadiness. Many of them do not realize the impact of mental health on this kind of problem as such a lockdown situation was never faced earlier. We calculated the behavioral changes according to factors like gender, age, and current working status as a student or employee, and shown in Fig. 6. Many other factors are also responsible for these changes; for example, a significant amount of internet data is needed to continue work from home, family work interruption, kids' disturbance, worsening physical health, and diseases are some root causes. The mental pressure for these causes has been recorded in the range of 0 to 10, where 0 means no psychological stress, and ten means high mental pressure (shown in Fig. 7). We have found an association between the causes and changes of behavior by using the Apriori algorithm.

4.2. Association of problems

Apriori is an unsupervised algorithm by which we can generate a set of most frequently occurred associations. In this research, we have used this to find the association between frequent problems and behavioral changes with different ranges of minimum support count rates with the process shown in Fig. 8. As our collected dataset is relatively low, we have used a low minimum support count rate to find the associations. The library file "Apriori" in python
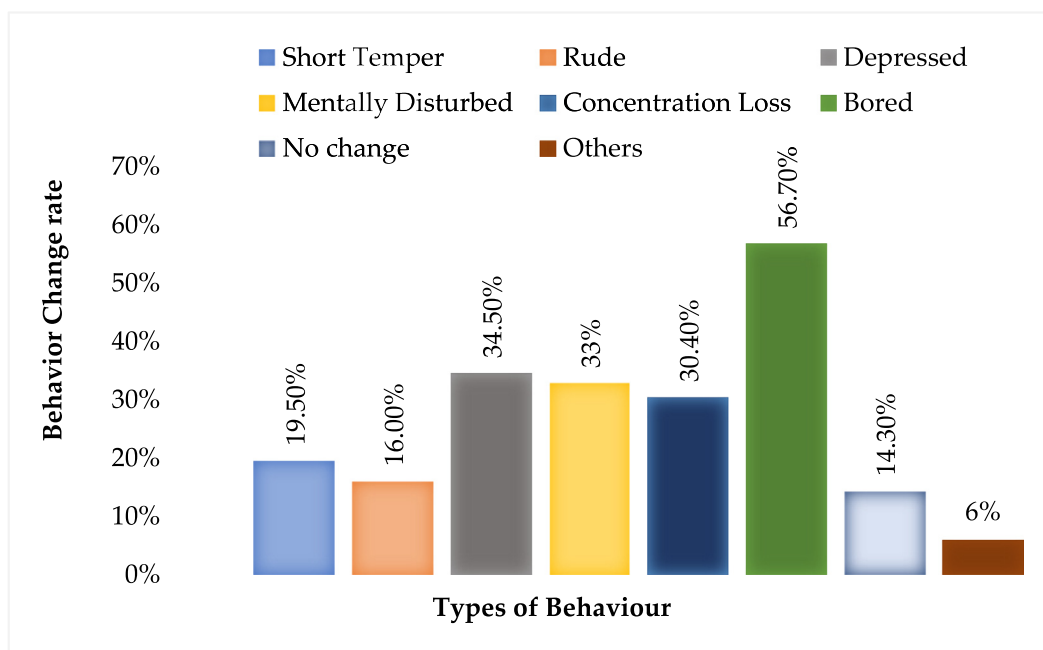

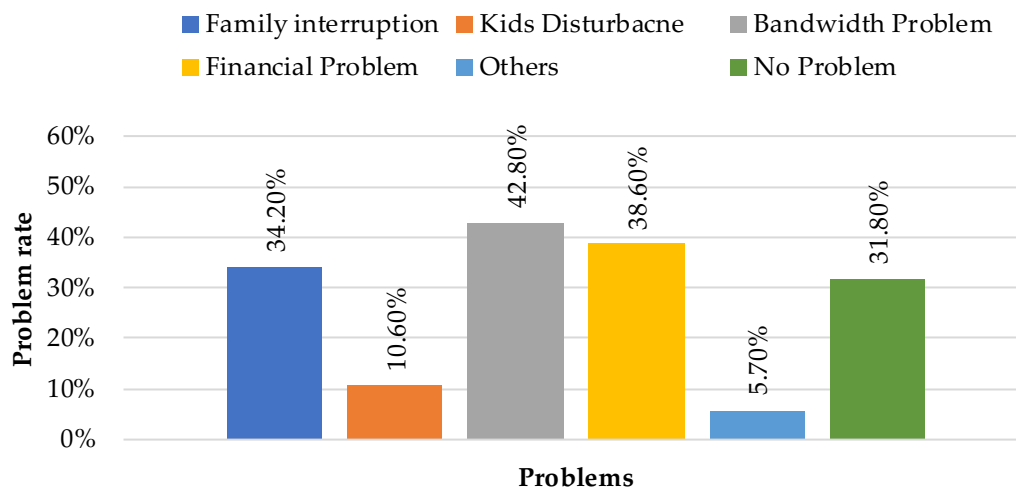**Fig. 1.** Different types of behavioral changes and their rate.

Fig. 2. Different types of problems and their rate of occurrences.
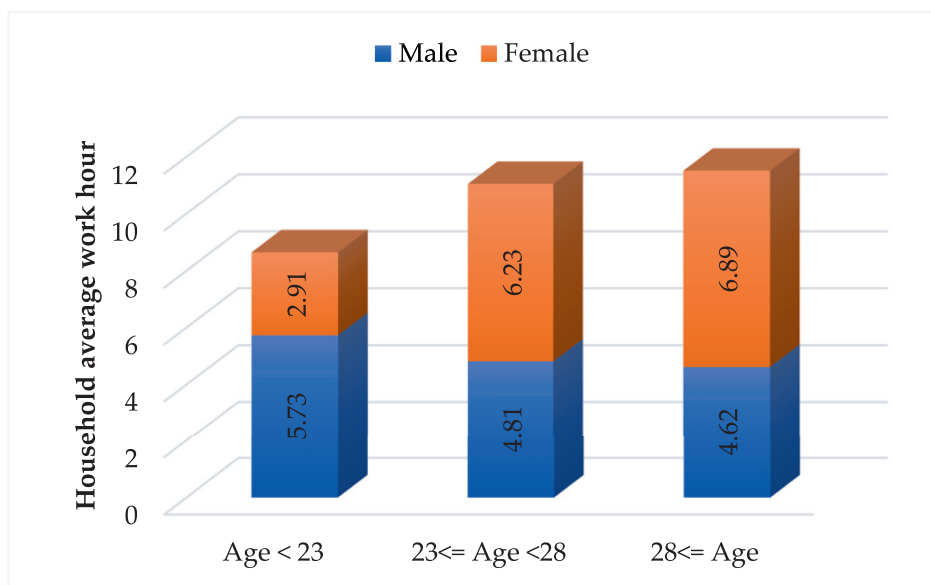

Fig. 3. Household average working hours for different age range comparing with gender.

language has been used with the processed categorical dataset and different minimum support count rates. A total of 11 columns have been used as causes (Bandwidth problem, Family work interruption, Kid's disturbance, Marital status, Employment status, Preference of work from home, Thankless household works, Less Sleep, Nutrition Problem, Change of Food Habit, Significant weight change) for finding the association of 6 behavioral changes (Depressed, Bored, Concentration loss, mentally disturbed, short temper, Rude). The summary of resulted association rules details that are connected with behavioral changes have been shown in Table 3, and frequent individual problems and habitual behavior changes have been displayed in Table 4.

5. Discussion

In this study, we have analyzed the human behavioral changes due to the uncertain lockdown situation following the COVID-19 outbreak in Bangladesh. To understand the different types of behavioral changes and associated reasons, some critical information was collected using a google form (online) from people working in different sectors in Bangladesh, mostly between the ages of

18 and 35. It has been found that various types of people took part in the survey: male, female, married, single, employed, unemployed, etc. After analyzing the collected data, many types of behavioral changes have been observed among Bangladeshi individuals. The analysis shows that employed persons face problems because of the shifting of their works to online-based platforms. The smooth completion of such works requires extra money to avail/purchase high-speed internet bandwidth, which requires a considerable financial budget that was not affordable to them, and eventually created some unavoidable behavioral changes. Fig. 6 shows the types of behavior and associated changes (%) for the people who took part in the survey. A higher percentage of some parameters such as depressed (67.23%), concentration loss (66.25%), mentally disturbed (54.15%), bored (73.15%) are found for males.

It should be noted that many people lost their jobs or were not getting a salary on time, which caused a severe financial problem and turned out to be the most significant problem for behavioral changes. Above and beyond the financial crises of low-income individuals, physical sickness has contributed to their financial burden; according to our poll, only 36.32% of people were able to visit a doctor during the lockout for checkups, resulting in a substantial
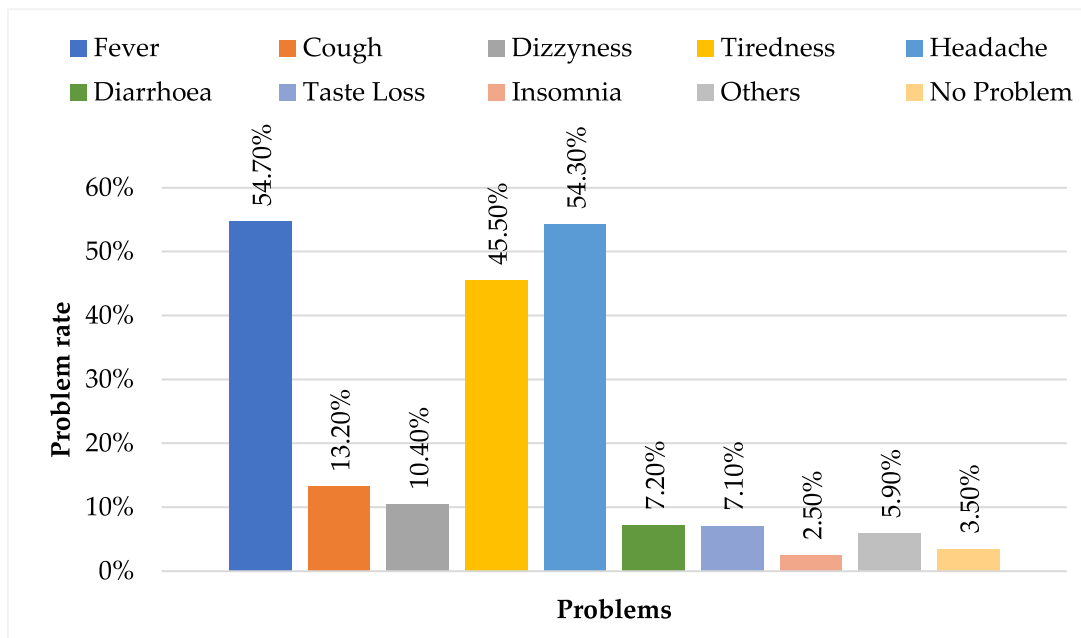
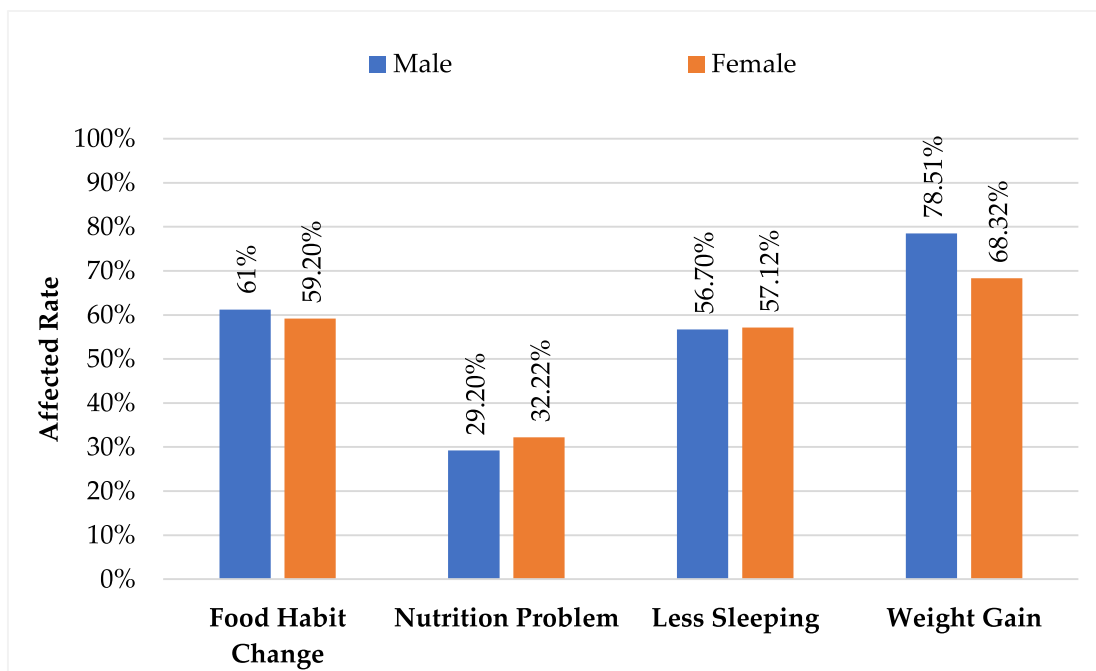**Fig. 4.** Common diseases are seen in this lockdown.

Fig. 5. Most common changes in physical health during this lockdown.

behavioral shift. On the other hand, females show higher behavioral changes for the parameters such as getting rude (59.57%) and short-tempered (53.57%) than the males. The possible reason could be the pressure of household works, and office works, and kids' disturbance, as in Bangladesh, females do the majority of household activities.

Moreover, people working in different sectors also faced many challenges in this uncertain lockdown. For instance, many nongovernment employees have lost their jobs. Many more have received half of their salary, and many day laborers have no work to do and find great difficulties (very miserable conditions) to man-

age their daily food. Based on our analysis, the unemployed (76.1%) people in academia are mainly facing a hard time during the lockdown period. Some of the parameters relevant to a hard time for academia are identified as online-based classes, feeling bored, having no friends/absence of friend's company, no chance for hanging out, etc. Overall, the socio-economic condition of the country largely influenced/affected the observed behavioral changes. Therefore, such a behavior change may vary with the individuals of developed countries.
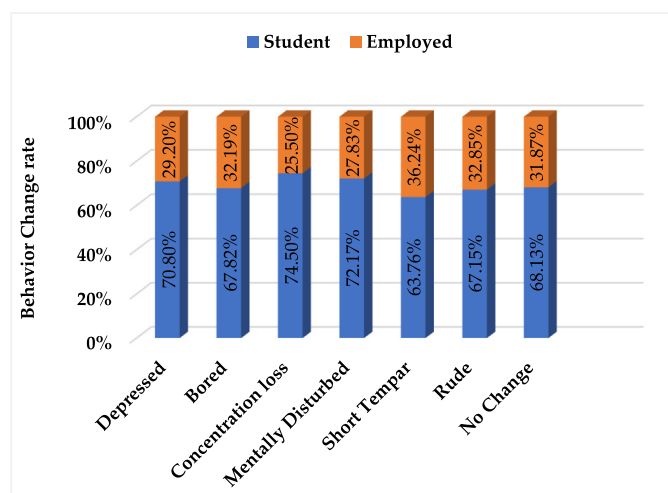
Now, quarantine and movement restrictions further serve to isolate many women trapped with their abusers from friends, fam-
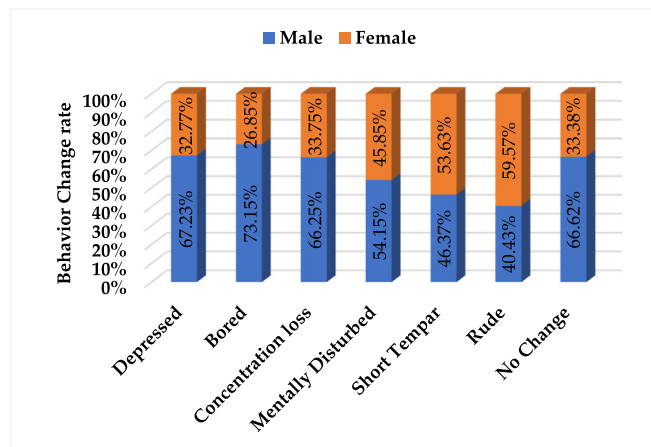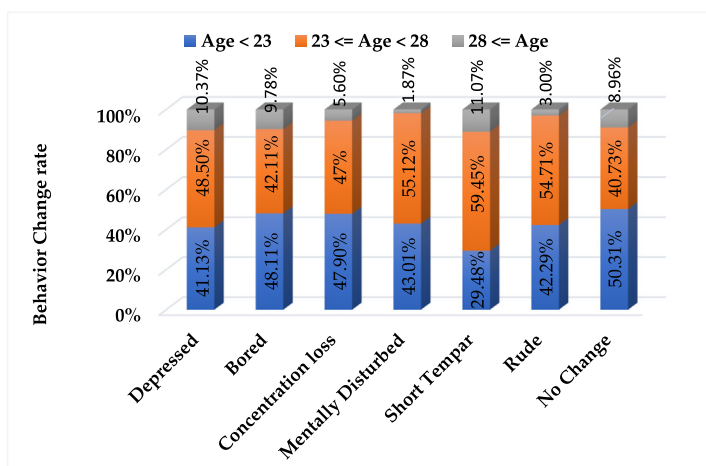
Fig. 6. Behavior change rate according to (a) Gender, (b) Age range and, (c) Work.

ilies, and other support networks. the conclusion of insignificant organizations implies that work no longer provides respite for many survivors and increased financial instability makes it harder for them to leave. Those who do manage to reach out, over-stretched wellbeing, social, judicial, and police services struggle to respond as resources are diverted to deal with the pandemic. The situation is worse in developing economies like us, where a larger share of people is employed in the informal economy in which there are far less friendly securities for health care coverage, paid wiped out leave, and more. Although globally informal
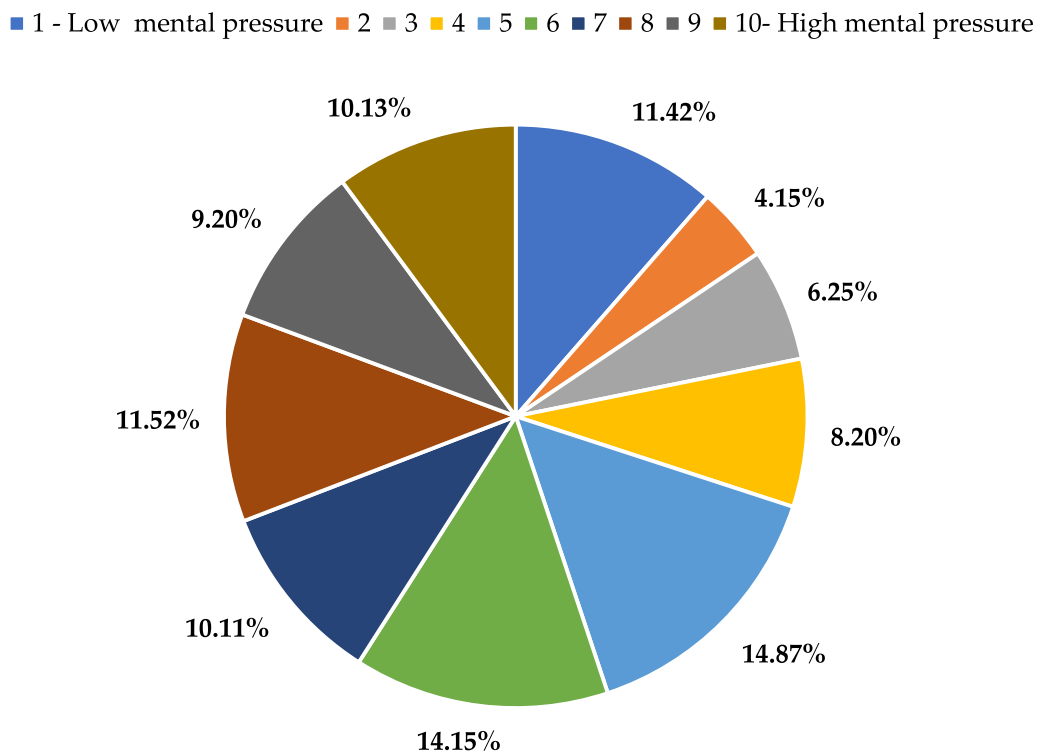
■ 1 - Low mental pressure ■ 2 ■ 3 ■ 4 ■ 5 ■ 6 ■ 7 ■ 8 ■ 9 ■ 10- High mental pressure

10.13%   11.42%

4.15%

9.20%   6.25%

11.52%   8.20%

10.11%   14.87%

14.15%

Fig. 7. Measurement of mental pressure level.

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1. **Input:** Categorical Data in csv format as S

2. **Output:** Set of Frequent Items in given minimum support and given length.

3. Initialize min_support as 0≤ min_support ≤1, and min_length ≥ 2

4. Produce FrequentItems in FreqSets[] and FilteredItems in Result[]

5. FreqSets[] ← null

6. Result [] ← null

7. Foreach Itemsets k in S:

8. If support ≥ min_support

9. FreqSets[] ← k

10. End If

11. End For

12. Foreach FilteredItemSets f in FreqSets :

13. If f.length ≥ min_length

14. Result [] ← f
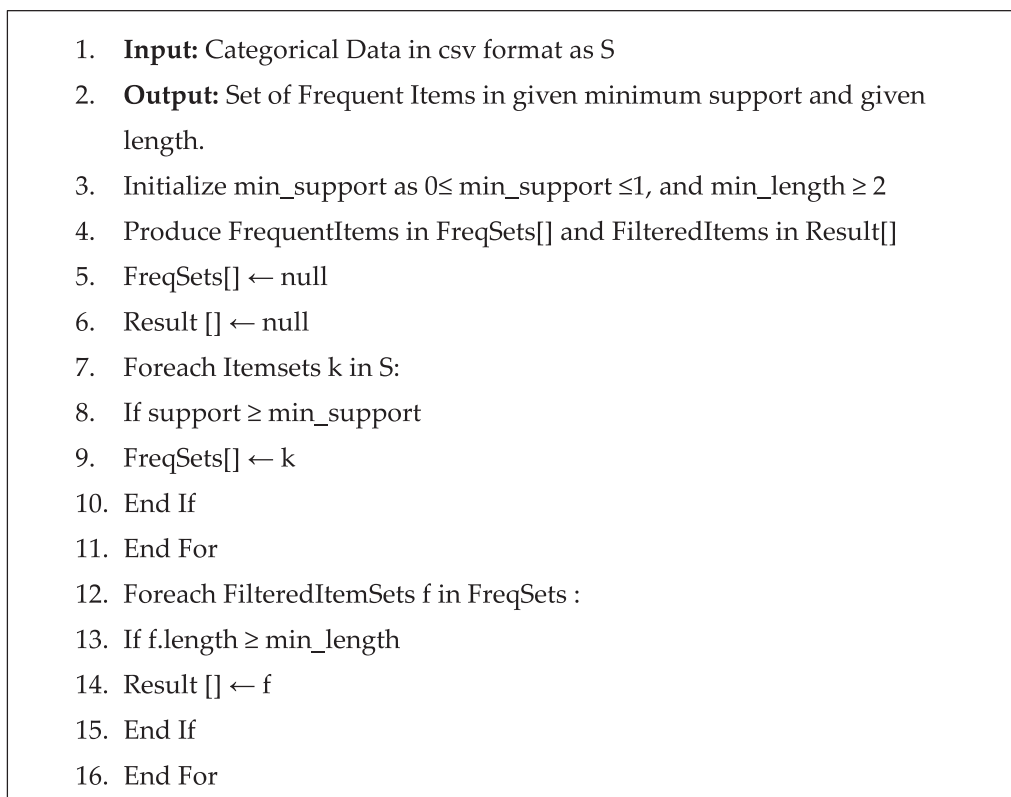
15. End If

16. End For

Fig. 8. Algorithm for generating and filtering associations of behavior changes.

employment is a greater source of employment for men (63 percent) than for women (58 percent), a higher proportion of women are in casual work than men in low and lower-middle-income countries. The world's economies and maintenance of our daily lives are built on women and girls' invisible and unpaid labor. Before the crisis started, women did nearly three times as much

Table 3
Association rules summery found by using the Apriori algorithm.

Minimum Support	Combinations found	Sampling item size	The maximum length of association rules	Maximum support found for highest rule length	Associations	
					Reasons	**Behavioral changes**
10%	1680	5	5	13.15%	Food habit, Bandwidth problem, Financial problems, Less sleep	Mentally Disturbed
8%	445	69	5	13.15%	Food habit, Bandwidth problem, Less sleep, Weight Change	Bored
6%	415	81	7	7.45%	Family work interruption, Financial problem, Weight Change	Depressed, Mentally Disturbed, Rude, Concentration Loss

Table 4
Association of frequent problems and frequent behavior changes.

	Minimum Association Length	Maximum Support	Association rules
Problems	5	14.25%	Food habit, Bandwidth problem, Less sleep, Weight Change, financial problem
	4	21.75%	Food habit, Weight Change, financial problem, Bandwidth problem
	3	32.63%	Food habit, Weight Change, Less sleep
Behavior	4	9.13 %	Short Temper, Rude, Mentally Disturbed, Depressed
	3	14.05%	Short Temper, Mentally Disturbed, Depressed
	2	23.85%	Mentally Disturbed, Depressed

unpaid care and domestic work as men. Social distancing measures, school closures, and overburdened health systems have put an increased demand on women and girls to cater to the basic survival needs of the family and care for the sick and the elderly. It affects our educational field for being closed to universities, colleges, schools many times for the pandemic situation. Students in their final years cannot complete their education so that they cannot participate in government running jobs. As a result, their dissatisfaction with their family's handling and their future employment had a psychological influence on their lives.

Another most related mental health-based study was conducted among Bangladeshi international students in Malaysia.[37] Among which 58.3% male and 55% female said they are facing financial stress and 96% male, and 51% female mentioned they have stress from home either in Bangladesh or in Malaysia or both. In our case, we have seen 38.60% overall financial stress and 34.20% stress from home. Which makes sense as people living in Bangladesh can back up better along with family and friends then people living in another country alone or living with very limited legal income source. Which also causes them (52.2% male and 56% female) to feel horrified. Which is significantly greater than our result if we map this with mentally disturbed category. Another direct mental health related work was done in Portugal and Brazil,[38] mostly with youth (88%) people like us. As developed countries, we saw lower number of percentages in their people with depression (22.6% in Portugal, 26.6% in Brazil) and anxiety (67.5% in Portugal, 74.7% in Brazil), where in our study we found 34.5% of average depression.

Note that people in Bangladesh usually live with so many problems (multi-dimensional) that most people suffer from a mental health problem, even before the outbreak of Covid-19. The root cause of the psychological problem is the high unemployment rate, especially for the educated population. As a result, suffering from mental health has not been considered a severe issue in our country. But, after the outbreak of Covid-19 and the associated lock-

down, the majority of people's mental health condition has deteriorated due to the already discussed (in this study) multi-dimensional socio-economic problems. In this regard, this study's findings bear great significance so that people may start caring for their loved ones' mental health and physical health. Even, many people do not acknowledge that any relationship exists between different causes and behavioral changes, so we applied the Apriori algorithm to generate a set of reasons which are the highest sequence length to cause a set of behavioral changes with different ranges of minimum support rate. By using this procedure, the association is found among the causes of problems with the types of issues.

5.1. Future direction

This study focuses on the association between cause and effect. Which can be integrated in an existing or whole new policy maker's plan. Often, we know the reasons of certain group of common problems. But it is difficult to identify specific reasoning which leads to a common policy that may or may not work for a large group of people. But it would be much easier if we knew the specific set of problems so that policy could be made regarding specific measures to prevent harm. Future research may incorporate integrating these reasoning to real life applicable policy to public health.

6. Conclusion

Implementation of lockdown due to COVID-19 has increased the mental stress of the Bangladeshi populace since the authority did not ensure fundamental needs. Levels of anxiety and depression were found to have a critical impact on the population's mental health. The closure of many organizations, including educational institutions, may increase the number of mentally depressed young people. In this study, we have analyzed human behavioral changes during the lockdown and found that a large number of people are suffering from stress, depression, short temper, etc. Many factors like gender, age, organizational, behavioral problems for work from home policy, diseases, and physical problems have been statistically analyzed. Using the Apriori Algorithm, we have sort out the association of the causes and types of behavioral changes during the lockdown period. From this study and analyzing association rules, it can be said that financial problem causes stress, depression; less sleep causes weight loss, food habit change; fever, cough and other these kinds of disease which are primary symptoms of COVID-19 causes serious mental and behavioral changes in human nature. These findings will help future research to explore the understanding of how behavioral problems and the physical setting of the working environment are related to work productivity and subjective well-being. Precisely, future research is welcome to develop any theoretical framework of explaining the work productivity and subjective well-being during any lockdown situation. Also, this study may help different private

and government organizations to reform the "Work from Home" policy and implement corrective measures to ensure employees' work-life balance. Though a significantly large amount of data was not analyzed to obtain substantial regional human behavioral changes, the use of the Apriori Algorithm was found sufficient to obtain the associated causes of the behavioral changes of people in a comparatively small region. Integrating this work, we might see behavioral changes for the whole country in the future.

Based on this study, the following suggestions should be implemented by the authority:

- The government of Bangladesh or the international donors (the developing partners of Bangladesh) should provide a marginal/flat rate/lumpsum of incentive (cash /month/person) to the affected employee (whose salary has been reduced to half compared to the pre-covid regime).
- The government or educational institutions authority should provide an internet data package of 1–2 GB/day to each student to ensure a smooth and effective online learning process as still many courses are happening online.
- Social awareness is extremely necessary in this factor. Government and concerning bodies can do mass operations through online or social media to make people aware of these conditions and how to value their family's mental health.

This study is limited to the data we have collected from Bangladesh but by characteristics may also be applicable to third world countries. Also in this study, we tried to associate the reasons of the behavioral changes, not to prove any hypothesis. And the amount of data collected may not be the best based on number, but it was enough to identify some core problems and their reasons.

CRediT authorship contribution statement

Refat Khan Pathan: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Munmun Biswas:** Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration. **Suraiya Yasmin:** Resources, Writing – original draft. **Mohammad Amaz Uddin:** Software, Formal analysis, Data curation, Writing – original draft, Visualization. **Anindya Das:** Resources, Supervision. **Mayeen Uddin Khandaker:** Writing – review & editing, Supervision, Project administration. **M.R.I. Faruque:** Supervision, Writing – review & editing. **Moniruzzaman Sarker:** Supervision, Writing – review & editing.

Declaration of Competing Interest

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

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