IMPORTANCE Adolescents and young people have been historically understudied populations, and previous studies indicate that during epidemics, these populations, especially in low- and middle-income countries (LMICs), are at high risk of developing mental disturbances.

OBJECTIVE To identify the existing evidence regarding the association of mental health with outbreaks of the influenza A (H1N1), Zika, Ebola, and SARS-CoV-2 virus in exposed youth and adolescents in LMICs.

EVIDENCE REVIEW Across 6 databases (Embase, Cochrane Library, PubMed, PsycINFO, Scopus, and Web of Science), the mental health outcomes of adolescents and youth (aged 10-24 years) associated with 4 major pandemic outbreaks from January 2009 to January 2021 in LMICs were reviewed. A group of 3 authors at each stage carried out the screening, selection, and quality assessment using Joanna Briggs Institute checklists. The social determinants of adolescent well-being framework was used as a guide to organizing the review.

FINDINGS A total of 57 studies fulfilled the search criteria, 55 related to the SARS-CoV-2 (COVID-19) pandemic and 2 covered the H1N1 influenza epidemics. There were no studies associated with Zika or Ebola outbreaks that met screening criteria. The studies reported high rates of anxiety and depressive symptoms among adolescents, including posttraumatic stress disorder, general stress, and health-related anxiety. Potential risk factors associated with poor mental health outcomes included female sex; home residence in areas with strict lockdown limitations on social and physical movement; reduced physical activity; poor parental, family, or social support; previous exposure to COVID-19 infection; or being part of an already vulnerable group (eg, previous psychiatric conditions, childhood trauma, or HIV infection).

CONCLUSIONS AND RELEVANCE Results of this systematic scoping review suggest that the COVID-19 pandemic and H1N1 epidemic were associated with adverse mental health among adolescents and youth from LMICs. Vulnerable youth and adolescents may be at higher risk of developing mental health-related complications, requiring more responsive interventions and further research. Geographically localized disease outbreaks such as Ebola, Zika, and H1N1 influenza are highly understudied and warrant future investigation.
Individual, familial, and socioeconomic vulnerabilities and attitudes toward quarantine and other public health measures influence adolescents’ mental health during disease outbreaks. Many risk-taking behaviors, such as heavy drinking, substance use, or sexual risk-taking, begin during adolescence. Economic instability and changes in routine and recreational activities have severely affected family functioning and have led to increased high-risk behaviors.

Recent studies have revealed that, for adolescents, the consequences of the COVID-19 lockdown and protracted quarantine and closures could be severe anxiety and depression, acute stress disorders, and posttraumatic stress disorder (PTSD). In low- and middle-income countries (LMICs), these disturbances co-occur with multilevel risk factors and abject material conditions, known as social determinants of adolescent well-being, that affect life outcomes.

This systematic scoping review attempted to evaluate the associations of 4 major disease outbreaks with adolescent mental health in LMICs, considering all types of relevant study designs. The influenza A (H1N1) outbreak of 2009, popularly known as swine flu, the Zika virus pandemic of 2015, the Ebola hemorrhagic fever of 2014, and the most recent and ongoing COVID-19 pandemic, which started in late 2019, are studied. We also evaluated the potential psychological and mental health associations of vulnerable adolescent and youth populations with these outbreaks.

Method

Search Strategy

Based on our inclusion criteria, a comprehensive search strategy was used to identify potential studies from 6 electronic databases: Embase, Cochrane Library, PubMed, PsycINFO, Scopus, and Web of Science. H.A. and M.K. designed the search strategy, and H.A., with M.F.K. and M.H.T., searched databases. Where the database allowed, restrictions were added to ensure that only human studies were searched and published after 2009, when the first outbreak occurred. The search strategy for PubMed is available in eTable 2 in the Supplement. The search was carried out between January 15 to 17, 2021. The articles were imported, and duplicates were removed. This study followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Extension for Scoping Reviews statement.

Data Extraction and Presentation

Two authors (P.S., S.K.) independently reviewed the abstracts and titles using the Rayyan software. There was substantial agreement between the 2 authors (κ of 0.77). If there were any doubts concerning the fulfillment of these criteria, it was resolved through discussion between M.K., R.S., P.S., and H.A. (eAppendix in the Supplement).

Next, full-text articles were assessed by H.A., M.H.T., and M.F. to review if the included studies met the inclusion criteria. We emailed the corresponding author twice for the requested article if an article was unavailable. No restrictions were applied to languages. After selecting the eligible articles, 3 authors (H.A., M.H.T., and M.F.) separately extracted the required items based on the extraction form designed for the process (eTable 8 in the Supplement). Any discrepancies or disagreements in data extraction were resolved through discussions between M.H.T., M.F., and H.A. until a consensus was reached. We tabulated the results based on the selected items (eTable 9 in the Supplement) to systematically summarize the results of every disorder for each outbreak studied.

Risk of Bias Assessment

Along with the JBI SUMARI tool (Joanna Briggs Institute), we applied the JBI critical appraisal checklists (Appendix in the Supplement) to assess the methodological quality of the included studies. If the responses selected for each item in the checklist were yes, no, unclear, or not applicable (eTables 10-13 in the Supplement), we performed the risk of bias assessment for only those studies that exhibited a vigorous methodology.

Data Synthesis

In the final step, we synthesized the data based on a conceptual framework that builds on articulating risk and protective factors associated with the social determinants of health approach. Viner et al have approached the intersection of multilevel factors for adolescent mental health well-being in a similar conceptual model. We have framed our results and discussion, keeping these broad domains in sight (Figure 1).

Results

Search Results

A total of 57 studies were included in the analysis (Figure 2 and eTable 8 in the Supplement), of which 55 focused on the SARS-CoV-2 virus (COVID-19 pandemic), and 2 focused on influenza A (H1N1) and Ebola hemorrhagic fever.
on H1N1 (eTable 9 in the Supplement). None of the Zika or Ebola outbreak studies were included as they did not satisfy our inclusion criteria (Figure 2 and eTable 8 in the Supplement).

Characteristics of the Studies in the Review

Country
Most of the studies (35 [61%]) reported findings from China. Other countries that were represented included Argentina (1), Bangladesh (4), Brazil (1), Ethiopia (1), Egypt (1), Indonesia (1), India (6), Jordan (1), Kenya (1), Malaysia (1), Nepal (2), Nigeria (2), and Turkey (3) (Figures 3 and 4).

Study Designs
A total of 55 studies adopted a cross-sectional study design, and the majority of them used convenience or snowball sampling. One study used a longitudinal cohort, and 1 study was a randomized clinical trial.

Study Participants
The age range of study participants varied, although the participants in most studies belonged to the age group of 17 to 24 years. Certain studies with mixed participants were only partially included.

H1N1-Associated Outcome
Two H1N1 studies found and included in the review. These were mainly about the emotional challenges associated with misinformation or exposure to quarantine.

Age and Sex Analysis
One study done by Gu et al did not specifically assess the relationship between sex and age and the psychological effect of the H1N1 on youth and adolescents. Another study by Wang et al, which focused on the psychological effects of quarantine during the H1N1 epidemic, revealed no difference in scores associated with the psychological association between men and women who were under quarantine and those who were not. The same results found that age may not be significantly associated with the negative effect of quarantine.

In China, a study on H1N1 exposure in students of a university found that half of the included students had misconceptions about its transmission. The study found that among 10.7% of participants (88 of 825), high/very high fear of contracting H1N1 was associated with some form of mental distress, that is, panic, depression, or emotional disturbance (odds ratio [OR], 3.81; 95% CI, 1.95-7.44). Overall, 45% of participants (371 of 825) were worried that a family member would contract H1N1. In another study by Wang et al, there were no significant differences in the immediate negative psychological outcomes on those quarantined with H1N1 and those not quarantined; however, dissatisfaction with control measures was a predictor of positive scores on the Impact of Event Scale-Revised (OR, 2.22; 95% CI, 1.37-3.60; P = .049) and Self-Report Questionnaire-20 (OR, 2.22; 95% CI, 1.28-3.85; P = .005).

SARS-CoV-2–Associated Outcome
The vast majority of studies took place from July through December 2020. Depressive and anxiety symptoms were the most commonly studied and reported.

Age
Younger students (aged 15 years) reported less depressive and anxiety symptoms than older students across a few studies. Being a more senior student (older than 15 years) was also associated with PTSD symptoms in China (211 of 2485 students; mean [SD] score on Posttraumatic Stress Disorder Checklist–Civilian Version

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middle school (in high school had higher mood disturbance scores than those in
gingswerereportedinBangladesh(822of3122students;age,25-29
study44 amongseventhto12thgradersfoundthatfemalestudents
had significantly higher mood disturbance scores than their male
counterparts(21%forparticipantsaged20-24years;5%for15-19
school-age children, with older students less
likely to be anxious than younger students (adjusted OR, 0.56; 95% CI,
0.35-0.89; P = .02),26 although another study22 found that younger
students were more likely to experience PTSD (OR, 8.71; 95% CI, 1.97-
38.43). In Malaysia, the prevalence of psychological distress was
higheramongyouthaged18to24yearsthanintheadultpopula-
lation, with 57.8% (5811 of 10 053; mean [SD] 9-itemPatientHealth
Questionnairescore, 9.8 [6.2]) reportingbeingpossiblydepressed
incomparisonwith33.7% (3388 of 10 053; mean [SD] 9-itemPatientHealth
Questionnaire score, 5.6 [2.6]) in Malaysia (age >25 years; anxiety: adjusted OR, 0.56; 95% CI,
1.42-4.75; P = .009).30 In Bangladesh, students living with families were 1.8 times (95% CI, 1.02-3.31) more likely to have mild
tosevereanxietysymptoms.24

Family Environment and Social Support

Children with siblings were more likely than children without sib-
lings to have anxiety and depression symptoms (OR, 1.16; 95% CI,
1.06-1.27; P = .001).17 The quality of the family environment and
parent-child relationships were protective factors (OR, 0.62; 95% CI,
0.55-0.70; P < .001).17 In China, college students who had ex-
perienced sexual abuse could have a greater risk of anxiety (adjusted
OR, 1.39; 95% CI, 1.20-1.60; P < .001) and depression (adjusted OR,
1.96; 95% CI, 1.37-2.80; P < .001) in early adulthood and more than
twice the risk of acute stress reactions (adjusted OR, 2.73; 95% CI,
1.47-5.05; P = .001) during this outbreak than those who did not experience sexual abuse. For participants with 4 areas of early adversity during their childhood, the risk of acute stress reactions reached
2.92 (95% CI, 1.82-10.38; P = .002).30 Furthermore, they also re-
ported higher rates of PTSD after being exposed to SARS-CoV-2 in-
fec tion (95% CI, 1.82-10.38; P = .009).30 In Bangladesh, students
living with families reported higher depression (OR, 2.59; 95% CI,
1.42-4.75; P = .002).24,28 Perceived overprotective parenting and less
warmth from parents correlated with higher rates of anxiety among adolescents in China (overprotection: r = 0.16; P < .001; lack of emotional
warm th; r = −0.17, P < .001).38 In Turkey, it was found that poor
parental mental health during the COVID-19 pandemic may be linked
to poorer mental health outcomes in young adolescents ages 12 to
13 years. In Turkey, adolescents with previous psychiatric referrals
showed higher scores on anxiety scales (OR, 4.39; 95% CI, 2.48-
25.30; P = .01), along with those who had a family member with
COVID-19 infection (OR, 3.81; 95% CI, 1.78-13.57; P = .02).29 In
Kenya, youth with vertically transmitted HIV status reported higher
levels of depressive symptoms and were consistent in reporting older
adolescents having higher depressive symptoms than their younger
counterparts (21% for participants aged 20-24 years; 5% for 15-19
years; and 6% for 10-14 years; P < .001). This could be attributed to
the lockdown, which was associated with decreased social contact
and resources for support.30 In Ethiopia, young adults experienced
significant acute stress reaction symptoms (32 of 374 [29.4%]).46
In Uttar Pradesh and Bihar in India, young women were more likely
to report depressive symptoms than young men (β = 0.06; 95% CI,
0-0.11), and women with a history of experiencing violence were
likely to be depressed (β = 0.30; 95% CI, 0.13-0.48).34

Mental Health and Psychosocial Vulnerability

A study43 from Indonesia found that 10.6% of participants (12 of
113) were at risk of emotional problems, 15.0% (17 of 113) for con-
duct behavior, 38.1% (43 of 113) for peer-related problems, 8% (8 of 113) for hyperactivity, and 28.3% (32 of 113) for prosocial
behavior problems. The subjective sense of the participant’s men-
tal well-being amid the COVID-19 pandemic was not significantly
correlated with emotional problems (OR, 0.20; 95% CI, 0.04-
1.01). Meanwhile, the prosocial problem behaviors (OR, 0.14; 95% CI,
0.02-0.75) and parental support (OR, 0.09; 95% CI, 0.14-0.60)
reduced total difficulties and were associated with a personal
sense of mental well-being.43 Among college students in Indonesia,
those with sleep issues and less income reported higher rates of
probable depression, and in China, less than 6 hours of sleep
was associated with depression (β = 1.850; SE = 0.065; OR, 6.361;
95% CI, 5.60-72.23; P < .001).49 In Bangladesh, students living with
families were 1.8 times (95% CI, 1.02-3.31) more likely to have mild
to severe anxiety symptoms.24

Sex

Women were more likely than men to report higher rates of
depressive and anxiety symptoms (China: 57.4% of women [1201
of 7866] with anxiety symptoms);38,29,30 and lower rates of knowl-
edge about COVID-19 infection mitigation.34,36,44 In China, a study44 among seventh to 12th graders found that female students
had significantly higher mood disturbance scores than their male
counterparts (t[1,678] = −3.26; P < .01), and more senior students
in high school had higher mood disturbance scores than those in
middle school (F[5, 1674] = 6.82; P < .001). The only study on
insomnia found that women reported higher rates of insomnia than
men (OR, 1.38; 95% CI, 1.21-1.57).49 Being female was a risk factor for depression and anxiety in another study from China (OR, 1.33;
95% CI, 1.19-1.50; P < .001).18 A study46 from Jordan found that
female adolescents had higher rates of anxiety symptoms than their
male counterparts (mean anxiety scores: men, 77 vs women, 8.6;
P = .002).

trauma assessment, 23.4 [8.4]; F = 9.89; P < .001),38 and similar find-
ings were reported in Bangladesh (822 of 3122 students; age, 25-29
years; Depression, Anxiety, Stress Scale (DASS) mean [SD] score, 54.1
(29.5); β = 0.03; P = .047),23 China (OR, 2.89; 95% CI, 0.96-8.67),32
and Malaysia (age >25 years; anxiety: adjusted OR, 0.56; 95% CI,
0.35-0.89; P = .02),26 although another study22 found that younger
students were more likely to experience PTSD (OR, 8.71; 95% CI, 1.97-
38.43). In Malaysia, the prevalence of psychological distress was
52.8% in 408 of 772 school-age children, with older students less
likely to be anxious than younger students (adjusted OR, 0.56; 95% CI,
0.55-0.89; P = .02).26 In Argentina, depressive symptoms were
higher among youth aged 18 to 24 years than in the adult popula-
tion, with 57.8% (5811 of 10 053; mean [SD] 9-item Patient Health
Questionnaire score, 9.8 [6.2]) reportingbeingpossiblydepressed
in comparison with 33.7% (3388 of 10 053) for the total sample.39
In Brazil, anxiety symptoms were reported by 18% of youth (10 of
55) aged 10 to 11 years and 20% of youth (6 of 30) aged 12 years.52

Figure 2. The Preferred Reporting items for Systematic Reviews
and Meta-analyses (PRISMA) Diagram

3913 Records identified through
database searching
1454 Web of Science
1320 Scopus
632 PubMed
417 Embase
45 Cochrane
45 PsycINFO

0 Additional records identified through
other sources

2198 After duplicates removed
2198 Screened
2070 Excluded
128 Full-text articles assessed for eligibility
72 Excluded
57 Studies included in the qualitative synthesis

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Physical Activity and Lockdown Restrictions
Youth residing in areas with more restrictions experienced decreased recreational and physical activity compared with pre-COVID-19 pandemic times. Male students and older students were more likely to report depressive and anxiety symptoms in China (using DASS, depression: $\beta = -1.26; t = -7.96, P < .001$; anxiety: $\beta = -0.70; t = -5.64, P < .001$; stress: $\beta = -1.01; t = -6.21, P < .001$; total score: $\beta = -2.97; t = -7.20, P < .001$), and lower depressive scores were associated with regular exercise and an exercising schedule (depression: $B = -1.26; t = -7.96, P < .001$; anxiety: $\beta = -0.70$;...
Students who exercised at a level of moderate and high according to scores on the International Physical Activity Questionnaire Short Form reported less depression, confusion, anger, and fatigue symptoms compared with those with a low level of activity (depression: $\beta = -2.02; t = -9.17; P < .001$; anxiety: $\beta = -1.21; t = -6.21; P < .001$; total score: $\beta = -2.97; t = -7.20; P < .001$). Students who exercised at a level of moderate and high according to scores on the International Physical Activity Questionnaire Short Form reported less depression, confusion, anger, and fatigue symptoms compared with those with a low level of activity (depression: $\beta = -2.02; t = -9.17; P < .001$; anxiety: $\beta = -1.21; t = -6.21; P < .001$; total score: $\beta = -2.97; t = -7.20; P < .001$).

Medical Students and Young Health Workers

Certain studies included young health care workers and medical students, who are particularly prone to mental distress due to being on the front lines of the pandemic. In Malaysia, senior clinical students (years 4-5) reported less anxiety and stress than junior students (anxiety: adjusted OR, 0.55; 95% CI, 0.41-0.74; $P < .001$; stress: adjusted OR, 0.69; 95% CI, 0.50-0.96; $P = .01$). In Egypt, among nursing student interns, students with higher duration of internship and clinical experience (8 months vs 5 months) reported higher levels of psychological distress (OR, 3.78; 95% CI, 1.07-13.22; $P = .04$), and men reported much less psychological distress compared with women (OR, 0.17; 95% CI, 0.06-0.49; $P < .001$). Transmitting the illness to families was one of the concerns, a fear commonly identified in other articles (all adjusted ORs $\geq 1.21; P < .001$). However, in China, being a graduate student (adjusted OR, 2.03; 95% CI, 1.18-3.49; $P = .01$), having negative thoughts or actions (adjusted OR, 1.55; 95% CI, 1.38-1.73; $P < .001$), and feeling depressed (adjusted OR, 6.84; 95% CI, 4.00-11.71; $P < .001$) were associated with a higher risk of anxiety. Among a sample of medical students in China, probable PTSD prevalence was 2.7% (67 of 2485) and probable depression prevalence was 9.0% (224 of 2485), and those in Beijing reported less anxiety than those in the epicenter of Wuhan (adjusted OR, 0.9; 95% CI, 0.82-1.00; $P = .049$). In addition, women reported more depressive symptoms than men (adjusted OR, 1.98; 95% CI, 1.19-3.29; $P = .009$).

Discussion

In this systematic scoping review, the findings identified high rates of anxiety and depressive symptoms, with PTSD, general stress, and health-related anxiety in youth and adolescents. Almost all of the included studies were from the COVID-19 pandemic, and there were no studies assessing the effect of the Zika or Ebola outbreaks on adolescent and youth mental health. Due to the global nature of the COVID-19 infection and its high-reaching impact since being declared a global emergency by the WHO in March 2020, it is reasonable to see why there are vastly more studies of the COVID-19 pandemic than of the other outbreaks.

It is likely that the Zika and Ebola studies did not have such an extensive assessment of adolescent mental health compared with the others due to their regional nature. Both Zika and Ebola primarily affected Latin America and Africa. We included 2 H1N1 studies that came from China. There was certainly a paucity of literature evaluating the mental health consequences of these outbreaks in the countries where they were present. Evidence on the impact of loss and disruption on the psychological well-being of adolescents was even more limited. Of the studies included from the H1N1 outbreak, adolescents mostly feared contracting H1N1 and transmit-
ting it to their family members. We found a focus on coping strategies, parental communication, relationships, and an appraisal of panic, health anxiety, hyperactivity, behavioral disorders, and perceived social support (eTable 9 in the Supplement). In the 2 studies, psychological distress was not strongly associated with adoption of measures like quarantine, suggesting that these preventative measures may not fully mitigate distress.

Adolescent girls experienced worse mental health outcomes than boys. Sex-sensitive research focusing on addressing the impact of violence, abuse, and maltreatment seems to be critical. The impact of school closure on high school students is thought to be particularly challenging. These students, closer to their graduation date, may lose more by prolonged school closure or limited access to educational opportunities, leading to academic and social deterioration. Schools are a vital resource for students, especially for the low-income families who depend on these resources for their adolescents’ well-being. Students who felt more isolated had more associated depressive symptoms. A significant economic downturn due to the lockdown could be linked to depression among many, and across countries, families faced more hardships, due to inadequate support and resources from government and organizations. Measures used were the PTSD symptom scale, General Anxiety Disorder 7, State and Trait anxiety, Impact of Events Scale, and Patient Health Questionnaire-9. Although these tools cover common mental disorders, the study of social well-being, resilience, general functioning appropriate to age, and quality of life associated outcomes were not reported as frequently. It will be instructive to track multidimensional risk and protective factors in longitudinal and multinational studies to better understand the complex health and societal impact of the pandemic.

Regional Focus and Building Scientific Evidence Around Mental Health Burden

Research capabilities are an essential component of informing policy and practice, and good research enables the development of evidence-based practice guidelines. Recent studies have recommended that the clinical and research training-of-trainers model offers a low-cost, scalable strategy to develop technical skills and system-level capacity to carry out evidence-based research. However, as we found in our review, the Ebola and Zika outbreaks did not receive attention, which may have been attributable to their occurrence in economically constrained and marginalized countries.

Development of Multilevel Interventions Across Educational Settings

School-based mental health programs offered via radios and other digital means or through synchronous interfaces need to include education about coping mechanisms, risk, and protective factor information, and simple self-support strategies. Provision for the support of highly distressed or vulnerable pupils in the school context would add value. In addition, caregiver mental health support information and family interventions would be necessary (eTable 14 in the Supplement). Prioritizing selective and targeted prevention interventions where feasible and future preparedness for increased mental health problems after outbreaks are recommended.

Limitations

This review was not without its limitations. The majority of the studies were from China, and hence it was not possible to generalize the findings most studies report on the COVID-19 pandemic, with few studies on other outbreaks. Almost all studies used a cross-sectional design with no longitudinal follow-up, limiting the causality between the exposure and outcomes. With these kinds of studies, we explicitly acknowledge that we cannot prove any type of causality. Moreover, the used sampling method was mostly convenient or snowball sampling with limited generalizability. Future studies should include representative sampling methods to enhance generalizability and confidence in findings.

Conclusions

Results of this systematic scoping review suggest that during the COVID-19 pandemic and H1N1 outbreak, higher risks of developing mental disturbances were associated with being female sex, being young (<18 years) with concurrent psychiatric conditions, having a history of childhood trauma or HIV, being a medical health care worker, living in areas with high COVID-19 infection spread, and having weak family or social support. LMICs are particularly vulnerable due to poor health systems, workforce, and lack of accessible, affordable, youth-responsive mental health services.

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