

**A SYSTEMATIC REVIEW AND META-ANALYSIS OF
PREVALENCE OF MENTAL HEALTH ON CHILDREN
AND ADOLESCENTS DURING COVID-19 PANDEMIC**

BY

DR NIK MARIAM BINTI NIK MUHAMMAD KAMIL

**DISSERTATION SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF MEDICINE (FAMILY
MEDICINE)**



UNIVERSITI SAINS MALAYSIA

2022

ACKNOWLEDGMENT

Alhamdulillah, praises to Allah S.W.T, the Almighty for the blessings throughout my research writing, completing, and publishing my research successfully. This thesis would have not become a reality with the kind support and help of many wonderful individuals including my colleagues.

It is a genuine pleasure to express my deep sense of thanks and gratitude to my supervisor, Professor Dr Shaiful Bahari Ismail and co-supervisor, Dr Nur Suhaila Idris, who made this work possible. Their guidance and advice carried me through all the stages of writing my research manuscript. Debt gratitude is also owed to Associate Professor Dr Norhayati Mohd Noor for helping in statistical analysis and providing advice.

I also would like to express my gratitude to thank my husband, Dr Muhamad Hazmi bin Juaidi, for his constant encouragement, support, and sacrifices throughout my research journey. Not to forget my three wonderful sons, Umar Al-Faruq, Uwais Al-Qarni and Usamah Al Hibb for their thoughtful prayer and for unconditional love.

I am extremely thankful to my parents. Mr Nik Muhammad Kamil bin Nik Muhammad and Mrs. Rohana binti Hashim for their prayer and undivided support.

TABLE OF CONTENT

	TITLE	PAGE
	ACKNOWLEDGMENT	ii
	TABLE OF CONTENTS	iii
	ABSTRAK	iv
	ABSTRACT	v
	CHAPTER 1: INTRODUCTION	
1.1	Introduction	1
	CHAPTER 2: OBJECTIVES AND OUTCOMES OF THE STUDY	
2.1	Objectives	3
2.2	Outcomes	3
	CHAPTER 3: MANUSCRIPT	
3.1	Title Page	4
3.2	Abstract	5
3.3	Introduction	6
3.4	Materials and Method	8
3.5	Results	11
3.6	Discussion	20
3.7	Limitation	23
3.8	Conclusion	24
3.9	References	25
3.10	Guidelines / Instructions to Authors of Selected Journal	36
	CHAPTER 4: STUDY PROTOCOL	
4.1	International prospective register of systematic reviews (PROSPERO)	80
	CHAPTER 5: APPENDICES	
5.1	Critical appraisal tools for use in Joanna Briggs Institute systematic reviews	85

ABSTRAK

Latar belakang: Pandemi COVID-19 telah diumumkan sebagai kecemasan kesihatan global dan telah memberi kesan psikologi yang ketara bukan sahaja kepada golongan dewasa tetapi juga kepada golongan kanak-kanak dan remaja. Kajian ini bertujuan untuk mensintesis dan menganalisis kajian sedia ada terhadap anggaran prevalens keseluruhan berkaitan masalah kesihatan mental dalam kalangan kanak-kanak dan remaja di era pandemik COVID.

Metodologi: Kami telah menjalankan kajian ini mengikut garis panduan PRISMA 2009. Protokol kajian ini telah didaftarkan di dalam PROSPERO (CRD42021230792). Pangkalan data yang digunakan adalah Medline, PubMed, Google Scholar, PsycINFO dan Scopus. Kajian telah diekstrak mengikut kriteria kelayakan dan risiko bias telah dijalankan.

Keputusan: Sebanyak 23 kajian yang melibatkan 25,433 orang kanak-kanak dan remaja telah dimasukkan ke dalam kajian meta-analisis, dengan prevalens keseluruhan kemurungan, kebimbangan, tekanan, kerisauan dan ketakutan adalah sebanyak 38.6% (95% CI: 31.17, 46.03), 31.72% (95% CI: 25.66, 37.78), 22.10% (95% CI: 14.88, 29.31), 46.88% (95% CI: 19.66, 74.09) dan 44.8% (95% CI: -0.42, 90.3). Analisis subkumpulan menunjukkan prevalens kemurungan dan kebimbangan adalah lebih tinggi di negara membangun dan dalam kalangan mereka yang tidak mempunyai komorbiditi berbanding mereka di negara maju dan dalam kalangan yang mempunyai komorbiditi.

Kesimpulan: Di dalam kajian ini, prevalens kesihatan mental pada kanak-kanak dan remaja adalah lebih tinggi ketika pandemic COVID-19. Strategi, teknik, dan intervensi psikologi yang sesuai harus digunakan untuk mereka. Oleh itu, kesihatan mental dapat dipelihara dan bertambah baik dalam populasi ini.

ABSTRACT

Background: COVID-19 pandemic was declared a global emergency health and gave a significant psychological effect not only on adults but also on children and adolescents. This review aims to synthesize and analyze existing evidence on the estimate of pooled prevalence of mental health problems among children and adolescents during this pandemic era.

Methodology: We conducted this study in accordance with PRISMA guidelines 2009. The protocol of this review was registered in PROSPERO (CRD42021230792). The databases used were Medline, PubMed, Google Scholar, PsycINFO and Scopus. The studies were extracted according to eligibility criteria and risk of bias was conducted.

Results: A total of 23 studies involving 25,433 children and adolescents were included in the meta-analysis, with the pooled prevalence of depression, anxiety, stress, worry and fear of 38.6% (95% CI: 31.17, 46.03), 31.72% (95% CI: 25.66, 37.78), 22.10% (95% CI: 14.88, 29.31), 46.88% (95% CI: 19.66, 74.09) and 44.8% (95% CI: -0.42, 90.3) respectively. Subgroup analysis revealed that the prevalence of depression and anxiety were higher in developing countries and among those with no comorbidity compared to developed countries and with comorbidity respectively.

Conclusions: In this review, the prevalence of mental health on children and adolescents were higher during this pandemic COVID-19 infection. Appropriate psychological strategies, techniques, and interventions should be applied for them. Thus, the mental health can be preserved and improves in this population.

Keywords: COVID-19, children, adolescents, mental health, depression, anxiety, stress, fear, worry

CHAPTER 1

INTRODUCTION

1.1 Introduction

Coronavirus is an enveloped, positive single-strand RNA virus and belongs to the Orthocoronavirinae subfamily. The virus has the characteristic of ‘crown-like’ spikes on its surfaces [1]. It remains unclear about the exact location, origin, and natural reservoir of the COVID-19, although the majority believe that the virus is zoonotic and bats maybe the possible reservoir [1, 2]. The virus can be transmitted from animal to human and at the same time, it can also spread from human to human [3]. COVID-19 spreads through respiratory droplets and other environmental factors such as demographic population, the dynamic of the spread, individual protection measures, with restriction of social mobility also plays a role in this transmission [4].

Coronavirus disease 2019 (COVID-19) can be defined as an illness caused by a novel coronavirus formerly called 2019-nCoV. Twenty-seven cases of pneumonia of unknown etiology were first identified in 2019 by the Chinese Center for Disease Control and Prevention and all cases were linked to Wuhan Huanan Seafood Wholesale Market [5-7]. These patients presented dyspnea symptoms, dry cough, and fever, and evidence of bilateral lung infiltrates on radiological imaging. WHO then declared the COVID-19 outbreak as a global health emergency and has become a pandemic since then [8, 9].

COVID-19 has been spreading rapidly every day for the last two years and the number of cases has been increasing in trend. Thus, many countries had applied a standard operating procedure (SOP) and very strict restrictions among citizens such

as lockdown, working from home, school closure/ online learning, and quarantine to slow down the pandemic outbreak [10]. One of the methods taken during lockdown has been closing schools, educational institutions, and activity areas in this restriction. These new rules were beyond normal experience in this era. Hence, there were leading to stress, anxiety, and feeling helplessness [11]. Apart from the positive effects gained by the lockdown in reducing the transmission of the virus/ disease, lockdown measures also had affected on the mental health around the globe. The World Health Organization (WHO) defines mental health as “a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community” [12].

The COVID-19 pandemic and lockdown have led to short and long-term psychosocial and mental health implications for children and adolescents [11]. The literature found that the related mental health issues are depression [13], anxiety [14], obsessive-compulsive symptom [15], fear [16] and, worry [17]. Prolonged stay at home is associated with a range of negative outcomes, such as reduced physical activity, reduced social interaction, heightened academic pressures due to sudden changes in learning methods, and increased conflicts with parents [18-20]. The online education system prompts the students to spend more time surfing the internet, which contributes to uncertainty about the examination, that finally leads to mental illness among adolescents [21, 22]. The aim of this study is to examine and systematically review the impact of the pandemic on the children and adolescents worldwide with regards to their mental health. We aimed to examine the prevalence of depression, anxiety, stress, worry, and fear symptoms during the active phase of the pandemic from 2019 to 2020. The prevalence of mental health among children and adolescents with and without comorbidity were also examined.

CHAPTER 2

OBJECTIVES AND OUTCOMES OF THE STUDY

2.1 Objectives

1. To identify the prevalence of, or any other reported evidence on, mental health outcomes in children and adolescents during the COVID-19 pandemic.

2.2 Outcomes

2.2.1 Primary outcomes

- i) Mental health outcomes in children and adolescent, either positive or negative (depression, anxiety, stress, worry and fear) associated with the COVID-19 pandemic

CHAPTER 3

MANUSCRIPT

3.1 TITLE PAGE

Prevalence of mental health on children and adolescents during COVID-19 pandemic: A systematic review and meta-analysis

Author:

Nik Mariam Nik Muhammad Kamil ¹, Shaiful Bahari Ismail ^{1,*}, Norhayati Mohd Noor ¹, Nur Suhaila Idris ¹, and Norzila Zakaria ²

¹ Department of Family Medicine, School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia; nikmariam@student.usm.my, shaifulb@usm.my, hayatikk@usm.my, nursuhaila@usm.my

² Department of Psychiatric, School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia; norzilakck@usm.my

- Correspondence: shaifulb@usm.my

3.2 ABSTRACT

(1) Background: COVID-19 pandemic was declared a global emergency health and gave a significant psychological effect not only on adults but also on children and adolescents. This review aims to synthesize and analyze existing evidence on the estimate of pooled prevalence of mental health problems among children and adolescents during this pandemic era. (2) Methods: We conducted this study in accordance with PRISMA guidelines 2009. The protocol of this review was registered in PROSPERO (CRD42021230792). The databases used were Medline, PubMed, Google Scholar, PsycINFO and Scopus. The studies were extracted according to eligibility criteria and risk of bias was conducted. (3) Results: A total of 23 studies involving 25,433 children and adolescents were included in the meta-analysis, with the pooled prevalence of depression, anxiety, stress, worry and fear of 38.6% (95% CI: 31.17, 46.03), 31.72% (95% CI: 25.66, 37.78), 22.10% (95% CI: 14.88, 29.31), 46.88% (95% CI: 19.66, 74.09) and 44.8% (95% CI: -0.42, 90.3) respectively. Subgroup analysis revealed that the prevalence of depression and anxiety were higher in developing countries and among those with no comorbidity compared to developed countries and with comorbidity respectively. (4) Conclusions: In this review, the prevalence of mental health on children and adolescents were higher during this pandemic COVID-19 infection. Appropriate psychological strategies, techniques, and interventions should be applied for them. Thus, the mental health can be preserved and improves in this population.

Keywords: COVID-19, children, adolescents, mental health, depression, anxiety, stress, fear, worry

3.3 INTRODUCTION

Coronavirus is an enveloped, positive single-strand RNA virus and belongs to the Orthocoronavirinae subfamily. The virus has the characteristic of ‘crown-like’ spikes on its surfaces [1]. It remains unclear about the exact location, origin, and natural reservoir of the COVID-19, although the majority believe that the virus is zoonotic and bats maybe the possible reservoir [1, 2]. The virus can be transmitted from animal to human and at the same time, it can also spread from human to human [3]. COVID-19 spreads through respiratory droplets and other environmental factors such as demographic population, the dynamic of the spread, individual protection measures, with restriction of social mobility also plays a role in this transmission [4].

Coronavirus disease 2019 (COVID-19) can be defined as an illness caused by a novel coronavirus formerly called 2019-nCoV. Twenty-seven cases of pneumonia of unknown etiology were first identified in December 2019 by the Chinese Center for Disease Control and Prevention and all cases were linked to Wuhan Huanan Seafood Wholesale Market [5-7]. These patients presented dyspnea symptoms, dry cough, and fever, and evidence of bilateral lung infiltrates on radiological imaging. WHO then declared the COVID-19 outbreak as a global health emergency and has become a pandemic since then [8, 9].

COVID-19 has been spreading rapidly every day for the last two years and the number of cases has been increasing in trend. Thus, many countries had applied a standard operating procedure (SOP) and very strict restrictions among citizens such as lockdown, working from home, school closure/ online learning, and quarantine to slow down the pandemic outbreak [10]. One of the methods taken during lockdown has been closing schools, educational institutions, and activity areas in this restriction. These new rules were beyond normal experience in this era. Hence, there were leading to stress, anxiety, and feeling helplessness [11]. Apart from the positive effects gained by the lockdown in reducing the transmission of the virus/ disease, lockdown measures also had affected on the mental health around the globe. The World Health Organization (WHO) defines mental health as “a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community” [12].

The COVID-19 pandemic and lockdown have led to short and long-term psychosocial and mental health implications for children and adolescents [11]. The literature found that the related mental health issues are depression [13], anxiety [14], obsessive-compulsive symptom [15], fear [16] and, worry [17]. Prolonged stay at home is associated with a range of negative outcomes, such as reduced physical activity, reduced social interaction, heightened academic pressures due to sudden changes in learning methods, and increased conflicts with parents [18-20]. The online education system prompts the students to spend more time surfing the internet, which contributes to uncertainty about the examination, that finally leads to mental illness among adolescents [21, 22]. The aim of this study is to examine and systematically review the impact of the pandemic on the children and adolescents worldwide with regards to their mental health. We aimed to examine

the prevalence of depression, anxiety, stress, worry, and fear symptoms during the active phase of the pandemic from 2019 to 2020. The prevalence of mental health among children and adolescents with and without comorbidity were also examined.

3.4 MATERIALS AND METHODS

3.4.1 Study Design and Setting

The present systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

3.4.2 Search Strategy

A systematic search was conducted in the Medline (PubMed), Google Scholar, PsycINFO and Scopus databases. The search was done using the Medical Subject Headings (MeSH) search terms: “COVID-19”, “children”, and “adolescent”. Generic free-text search terms, synonymous with “mental health” such as “psychological” and “mental hygiene” were used. The search terms were then tailored to various electronic databases. to find additional potentially eligible studies, reference lists of included citations were cross-checked.

3.4.3 Eligibility Criteria

The inclusion criteria included studies that reported the impact of COVID-19 on children’s and adolescents’ mental health Studies with cross-sectional, case-control and cohort designs published in English from 2019 until 1st week of January 2021, conducted in the community or the health institution levels were also included. Case series/reports, conference papers, proceedings, articles available only in abstract form editorial reviews, and letters of communications, commentaries, preprint articles, systematic reviews and qualitative studies were excluded.

3.4.4 Definition of Outcome Interest

The primary outcome of this study was mental health conditions in children and adolescents associated with the COVID-19 pandemic.

3.4.5 Study Selection and Screening

All records identified by our search strategy were exported to EndNote X8 software (Philadelphia Clarivate Analytics). Duplicate articles were removed. Two independent reviewers screened the titles and abstracts of the identified articles. The full texts of eligible studies were then obtained and read thoroughly to assess their suitability. In the event of a conflict between the two reviewers, a consensus discussion was held, and a third reviewer was consulted. The search method was presented in the PRISMA flow chart showing the studies that were included and excluded with the reasons provided for exclusion.

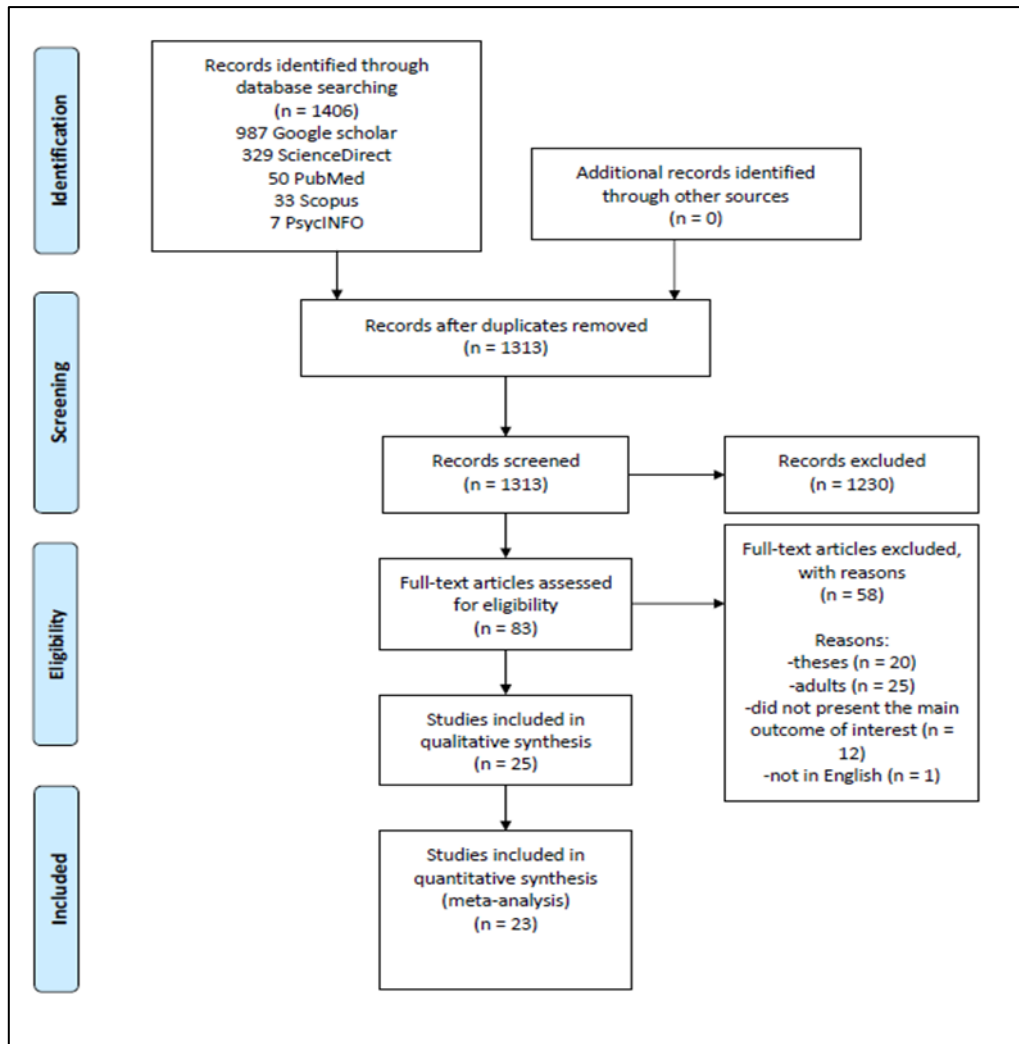


Figure 1. PRISMA Flow Chart

3.4.6 Quality Assessment and Bias

A critical appraisal was performed to assess the data quality using the Joanna Briggs Institute Meta-Analysis for cross-sectional, case-control, and cohort studies [23]. A score of 1 was given if the response was “yes” and 0 if the response was “no”, “unclear” or “not applicable”. The quality of the study was determined by summing the scores given for each item. The articles have been categorized as high risk of bias (score below 50%), moderate risk of bias (score between 50-69%), and low risk of bias (score of 70% and above). The low-risk articles were selected for the systematic review and meta-analysis phases.

3.4.7 Data Extraction Process

The data was extracted into Microsoft Excel (United State Microsoft Corporation). This included the first author, year of publication, study location, study design, screening tools, sample size, setting, data on mental health, and any other COVID-19-related information about the study that was regarded as necessary.

3.4.8 Statistical Analysis

The cumulative estimates of the mental health outcomes were reported in odds ratio and 95% confidence interval. The analysis was performed with Review Manager Software version 5.4 (Nordic Cochrane Centre). We used a random-effects model to pool data. The I^2 statistic was used to assess heterogeneity and used the guide as outlined: 0% to 40% might not be important; 30% to 60% may represent moderate heterogeneity; 50% to 90% may represent substantial heterogeneity; and 75% to 100% would be considerable heterogeneity [24]. Afterward, subgroup analysis was performed based on countries (developed and developing countries) and the presence of comorbidities. Funnel plots were used to assess the publication bias if there were sufficient studies.

3.5 RESULTS

The original search identified 1406 references, then, 93 articles were removed due to duplication. Out of the remaining 1313 studies, 1230 articles were removed at the screening stage after assessing their titles and abstracts and considering the inclusion and exclusion criteria. At the eligibility evaluation phase, out of the remaining 83 studies, 58 articles were removed after the examination of their full text. At the quality evaluation phase, 25 articles were assessed based on the Joanna Briggs Institute Meta-Analysis scoring system [23]. Two cross-sectional studies were assessed as moderate methodological quality works and thus were eliminated from this review. Finally, 23 studies were analyzed in this systemic review and meta-analysis (Fig. 1).

The detailed descriptions of the included studies are shown in Table 1. It involved 22 cross-sectional studies [13, 25-45] and one longitudinal study [46]. Seven studies were conducted in China [13, 29, 34, 42-45], four studies in India [30, 37, 39, 40], three studies in Bangladesh [35, 36, 41], two studies in United State of America [27, 31], and one study each in the Netherlands [25], Portugal [26], Italy [28], Brazil [32], Greece [33], Pakistan [38] and Australia [46]. Twenty studies reported the data collection date, while three other studies did not report the exact dates for data collection [29, 30, 40]. Due to COVID-19 restrictions, 18 studies were collected online[13, 28-30, 32-37, 39, 41-46], two studies were collected via telephone interview [25, 26], two studies extracted via record review [27, 31] and one study did not clearly mention the dates for data collection [40].

Eighteen studies involved non-clinical samples [13, 27, 29-39, 42-45], one study focused on children with obesity [25], one study in children with Autism Spectrum Disorder (ASD) [26], one study in children and adolescents with Tourette Syndrome [28], one study in children and adolescent with Attention Deficit and Hyperactive Disorder (ADHD) [46] and one study conducted in children and adolescents who underwent quarantine period [40].

The total number of participants was 25,433 children and adolescents. The number of participants in each study varied from the lowest of 34 to the highest of 8079. Thirteen studies had no inconclusive data on sex breakdown information [13, 25, 28, 29, 34-41, 46], nine studies gave information regarding gender background [26, 27, 30-33, 42, 43, 45] and one study conducted in female adolescents' group [44].

Seventeen studies measured the depression outcomes [13, 27-31, 33, 35, 37-39, 41-46], 16 measured anxieties [25-28, 31-39, 42, 43, 45], five studies reported stress [27,

37, 39, 42, 45] and worry [27, 30, 38, 40, 46] and three studies measured fear as an outcome for mental health [27, 38, 40].

Table 1. Summary of descriptions of included studies.

No	Author	Publication Year	Study Area (Region/Country)	Study Design	Sample Size	Data Collection Period	Data Collection Method	Study Population	Assessment	Mental Health Outcome	Quality Appraisal
1	Abawi, O., et al. [25]	2020	Netherlands	Cross-sectional	75	2-23 April 2020	Semi-structured telephone interview (parents)	Children with obesity	PedsQL questionnaire	Anxiety	High
2	Amorim, R., et al. [26]	2020	Portugal	Cross-sectional	99	April 2020	Telephone interview (parents), email (online form)	Children with autism spectrum disorder	Child Anxiety Score	Anxiety	High
3	Chawla, M., et al. [30]	2020	India	Cross-sectional	216	NR	Online survey	Adolescents	Structured questionnaire was formed based on various tools review, used 5-point Likert scale	Depression, worry	High
4	Cohen, C., et al. [27]	2020	Florida	Cross-sectional	359	14-26 May 2020	Retrospectively reviewed survey data	Adolescents	5-point Likert scale	Anxiety, depression, stress, worry, fear	High
5	Conte, G., et al. [28]	2020	Italy	Cross-sectional	238	1-14 April 2020	Online survey (parents)	General population including children and adolescents with Tourette Syndrome	5-point Likert scale	Anxiety, depression	High
6	Duan, L., et al. [29]	2020	China	Cross-sectional	3613	NR	Website survey	Children, adolescents	Spence Child Anxiety Scale, Child Depression Inventory	Depression	High
7	Ferrando, S.J., et al. [31]	2020	Suburban New York	Cross-sectional	65	1 March-30 April 2020	Data survey	General population including children and adolescents	COVID-19-related stressors	Anxiety, depression	High
8	Garcia de Avila, M.A., et al. [32]	2020	Brazil	Cross-sectional	289	25 April-25 May 2020	Online survey	Children	Children's Anxiety scale	Anxiety	High
9	Giannopolou, I., et al. [33]	2020	Greece	Cross-sectional	442	16-30 April 2020	Website survey	Senior high school students	PHQ-9 modified for teens, GAD-7 scale	Anxiety, depression	High
10	Huang, Y., et al. [34]	2020	China	Cross-sectional	287	14 February-29 March 2020	Online survey	General population including	GAD-7 scale	Anxiety	High

								children and adolescent			
11	Islam, M.A., et al. [35]	2020	Bangladesh	Cross-sectional	115	6-12 May 2020	Website survey	University students, n=115 aged between 17-20 years old	PHQ-9 scale, GAD-7 scale	Anxiety, depression	High
12	Islam, M.S., et al. [36]	2020	Bangladesh	Cross-sectional	306	29 March-4 April 2020	Online survey	General population including adolescents	GAD-7 scale	Anxiety	High
13	Kazmi, S.S.H., et al. [37]	2020	Uttar Pradesh	Cross-sectional	180	April 2020	Online survey	General population including adolescents	DASS-21	Anxiety, depression, stress	High
14	Liu, X., et al. [13]	2020	China	Cross-sectional	34	30 January-3 February 2020	Online survey	General population including age <18 years old	Self-Rating Depression scale	Depression	High
15	Majeed, S., et al. [38]	2020	Lahore	Cross-sectional	63	20 April-19 May 2020	Online survey	Adolescents	Questionnaire including items developed by authors especially DSM-5 criteria for depression and anxiety, COVID-19 fear	Anxiety, depression, worry, fear	High
16	Reddy, V., et al. [39]	2020	India	Cross-sectional	122	21 April-12 May 2020	Online survey	General population, including age between 16-20 years old	DASS-21	Anxiety, depression, stress	High
17	Saurabh, K., et al. [40]	2020	India	Cross-sectional	121	NR	Interview children and parents	Quarantine children and adolescents (quarantine at home/quarantine center)	Preformed questionnaire which assessed adolescents' psychological impacts	Worry, stress	High
18	Sciberras, E., et al. [46]	2020	Australia	Longitudinal study	174	May 2020	Online parent survey	Children and adolescent with ADHD	Coronavirus Health Impact Survey (CRISIS), Child COVID-19 stress and worry	Depression, worry	High
19	Tang, S., et al. [45]	2020	Shanghai	Cross-sectional	4342	13-23 March 2020	Online survey	Children and adolescents	DASS-21	Anxiety, Depression, Stress	High
20	Yeasmin, S., et al. [41]	2020	Bangladesh	Cross-sectional	384	25 April-9 May 2020	Online survey	Children	Revised Child Anxiety and Depression scale	Depression	High
21	Zhang, C., et al. [42]	2020	Guangzhou	Cross-sectional	1025	7-24 April 2020	Online survey	High school students	DASS-21	Anxiety, Depression, Stress	High

22	Zhou, J., et al. [44]	2020	China	Cross- sectional	4805	20-27 February 2020	Online survey	Adolescents	Center for Epidemiological Studies Depression Scale (CES-D)	Depression	High
23	Zhou, S- J., et al. [43]	2020	China	Cross- sectional	8079	8-15 March 2020	Online survey	Female adolescents	PHQ-9, GAD-7	Anxiety, Depression	High

3.5.1 Depression

A total of 17 studies involving 24,256 participants measured depression for mental health impacts [13, 27-31, 33, 35, 37-39, 41-46]. The pooled prevalence of depression was 38.6% (95% CI: 31.17, 46.03) (Figure 2). Subgroup analysis on the prevalence of depression conducted on 14 developing countries was 60.8% (95% CI: 46.90, 74.76) [13, 27-31, 33, 37, 39, 42-46] and on three developed countries was 33.9% (95% CI: 25.99, 41.84) [35, 38, 41] (Figure 3). In addition, the prevalence of depression from 15 studies involving participants with no co-morbid condition was 40.4% (95% CI: 32.51, 48.26) [13, 27, 29-31, 33, 35, 37-39, 41-46] and two studies with co-morbid disease was 25.6% (95% CI: -5.08, 56.26) [28, 46] (Figure 4). Funnel plot for publication bias in prevalence of depression is asymmetry (Figure 5).

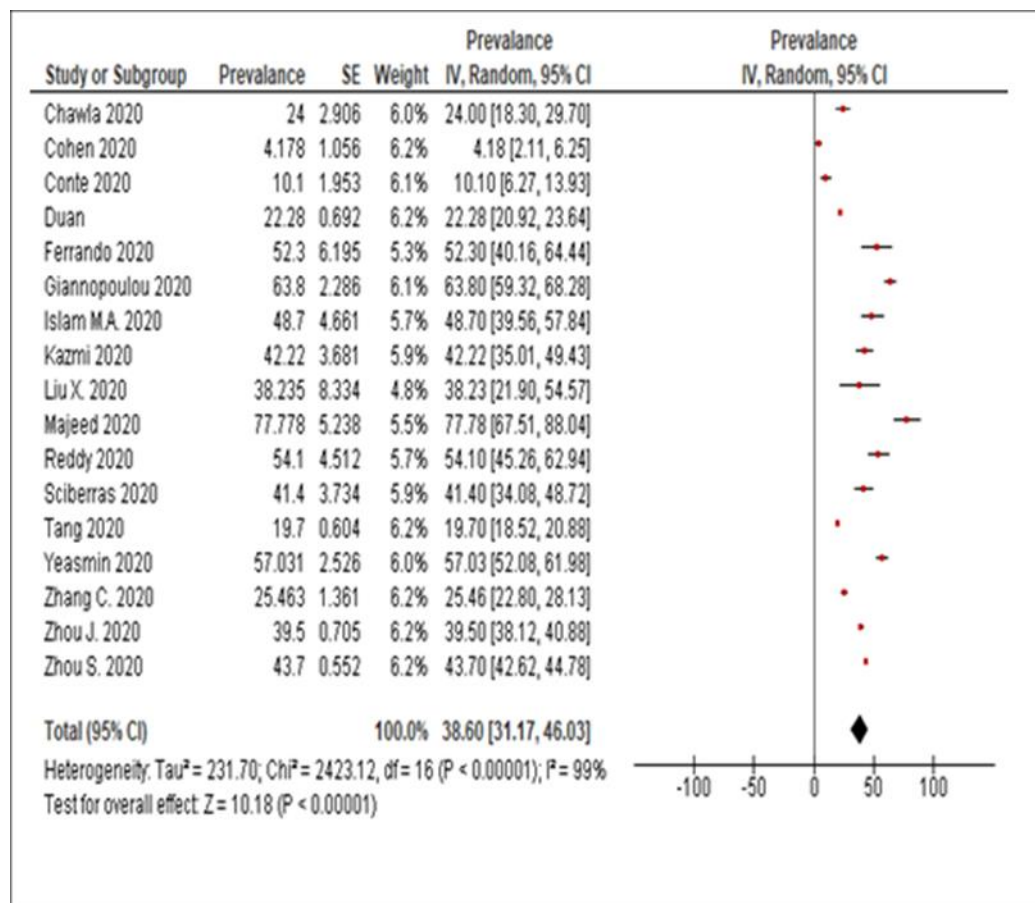


Figure 2. Forest plot of the pooled prevalence of depression.

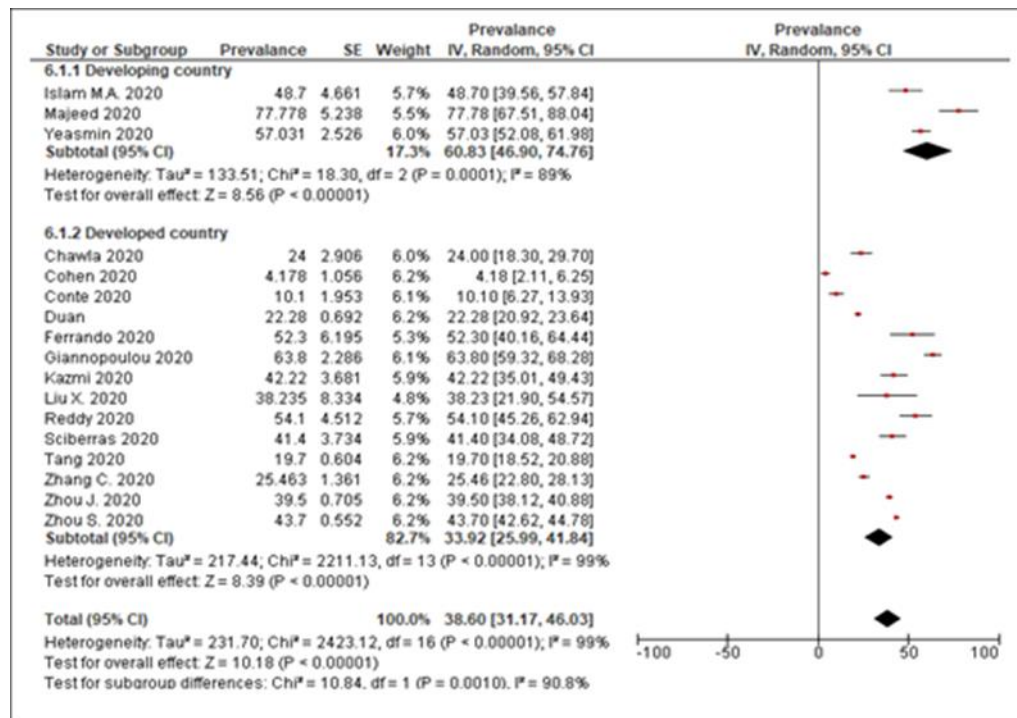


Figure 3. Forest plot of the prevalence of depression in the developing and developed countries

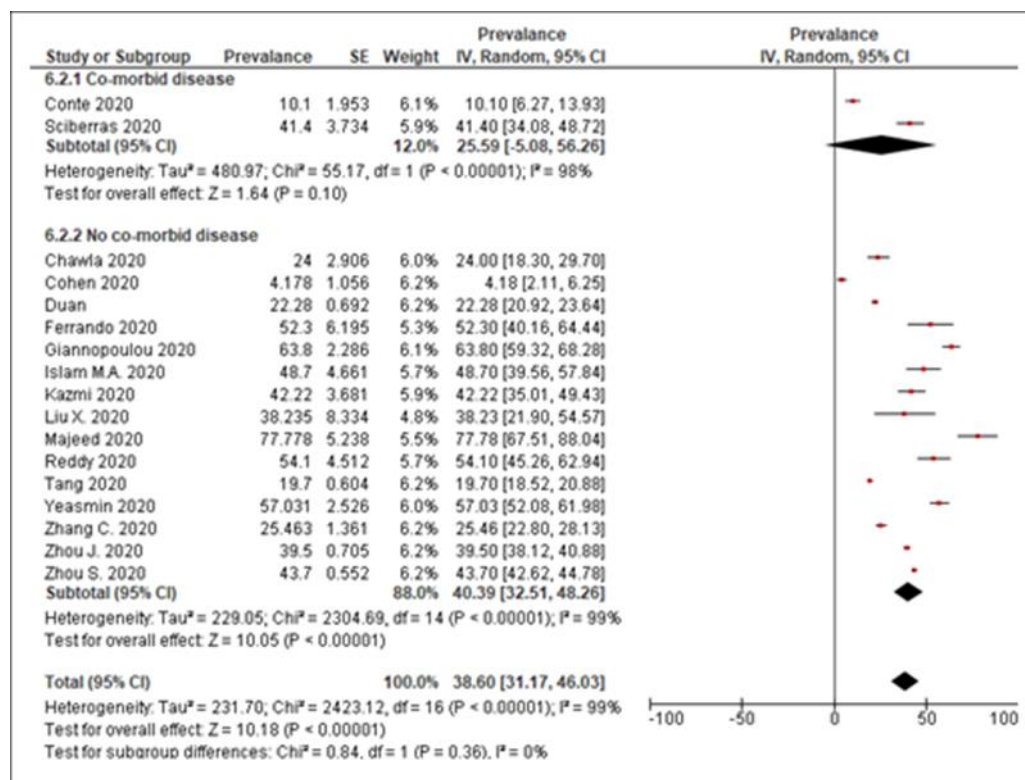


Figure 4. The prevalence of depression in participants with co-morbid and no co-morbid disease.

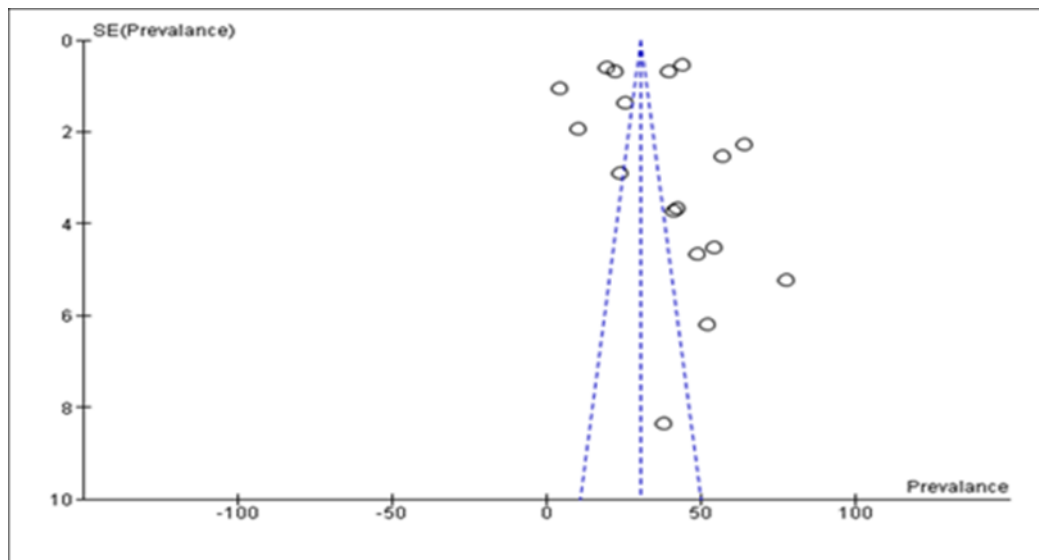


Figure 5. Funnel plot of results of prevalence of depression among the children and adolescents during COVID-19 pandemic.

3.5.2 Anxiety

A total of 16 studies measured anxiety as an indicator for the psychological distress involving 16,086 participants [25-28, 31-39, 42, 43, 45]. The overall prevalence for anxiety was 31.7% (95% CI: 25.66, 37.78) (Figure 6). Subgroup analysis on the prevalence of anxiety conducted on three developing countries was 46.4% (95% CI: 23.98, 68.90) [35, 36, 38] and on 13 developed countries was 28.6% (95% CI: 22.02, 35.24) [25-27, 31-34, 37, 39, 42, 43, 45]. Apart from that, the prevalence of anxiety conducted on 13 studies with no co-morbid disease was 31.9% (95% CI: 25.14, 38.69) [27, 31-39, 42, 43, 45] and on three studies with co-morbid disease was 30.4% (95% CI: 20.87, 39.99) [25, 26, 28]. Funnel plot for publication bias in prevalence of anxiety is asymmetry.

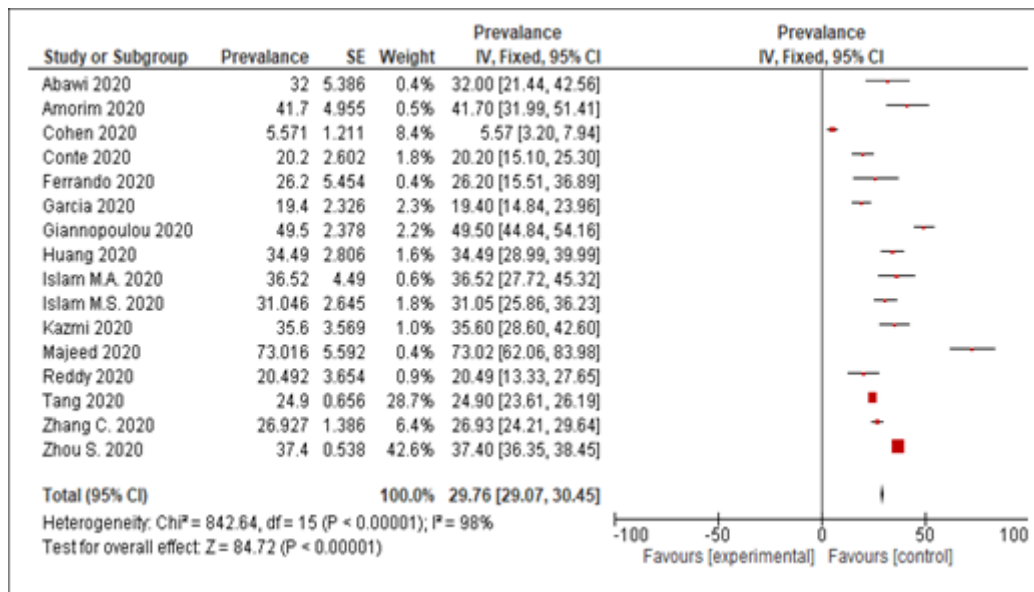


Figure 6. Forest plot of the pooled prevalence of anxiety.

3.5.3 Stress

Five papers reported stress as an impact on mental health involving 6028 children and adolescents [27, 37, 39, 42, 45]. All five studies were conducted in developed countries and involved participants without co-morbid background. The pooled prevalence of stress was 22.1% (95% CI: 14.88, 29.31). Funnel plot for publication bias in prevalence of stress is asymmetry.

3.5.4 Worry

Other than depression, anxiety and stress, worry is also measured as one of the psychological impacts. Five studies involving 933 participants was conducted [27, 30, 38, 40, 46]. The overall prevalence of worry was 46.9% (95% CI: 19.66, 74.09). Four of them were from developed countries [27, 30, 40, 46] and one from developing country [38]. Four were among participants without co-morbid [27, 30, 38, 40] and one among with co-morbid diseases [46]. Subgroup analysis were not feasible due to limited data. Funnel plot for publication bias in prevalence of worry is asymmetry.

3.5.5 Fear

The other less commonly reported indicator is fear. It involved three studies with a total number of 543 participants [27, 38, 40]. The pooled prevalence of fear was 44.8% (95% CI: -0.42, 90.3). Among them, two studies from developed countries [27, 40] and one from developing country [38]. Subgroup analysis for country was not performed due to limited data available. There was no study involving participant with background of co-morbid diseases. Funnel plot for publication bias in the prevalence of fear is asymmetry.

3.6 DISCUSSION

COVID-19 pandemic has significant consequences on the psychological aspect of the children and adolescents by disrupting their daily life routine [47]. Additionally, there is an increased negative effect to parents during the pandemic period compared to the pre-pandemic era that may indirectly affect the children and adolescent age groups [48]. The prevalence of depression, anxiety, stress, worry, and fear due to the pandemic in children and adolescents age group are 38.6%, 31.72%, 22.1%, 46.9%, and 44.8%, respectively. Compared with a review in the general population, the prevalence of depression, anxiety, and stress during the COVID-19 crisis were 33.7%, 31.9% and 29.6%, respectively. It shows the considerable effect of the pandemic on the whole population of age [49]. Another review found out the prevalence of depression, anxiety and distress that involved seven different populations including general population, non-infectious chronic disease patients, students, health care workers, non-medical staff workers, quarantined persons and COVID-19 patients was 31.4%, 31.9% and 41.2%, respectively [50]. Among 88,661 teachers from three cities in Henan, China, 58.61% of them reported to be very worried during COVID-19 pandemic which was relatively higher than current study among children and adolescents [51].

Reviews of previous outbreaks showed that about 35% of severe acute respiratory syndrome (SARS) survivors in Hong Kong and 31.2% of quarantined persons due to SARS in Toronto reported anxiety and/or depressive symptoms [52]. In comparison with other infectious diseases such as the Ebola virus, a meta-analysis study revealed that the prevalence of depression was 19.92% [53]. The differences in mental health outcomes between the Ebola outbreak and the COVID-19 pandemic could be explained by rapidly transmitted viruses worldwide in COVID-19 infection [52].

Before this pandemic, the prevalence of depression in children and adolescents was lower than in current reviews. 24.3% of adolescents in China's secondary schools experienced depressive symptoms, while the prevalence of depression among children and adolescents exposed to trauma was 24.2% [54, 55]. Apart from that, a systematic review among Iranian's children and adolescents showed the prevalence of 0.54% to 12.8% for generalized anxiety; it is much lower in normal circumstance compared to current reviews [56]. COVID-19 outbreak is a vital risk of depression for children and adolescents. A similar finding for depression among American adults also showed a lower prevalence of depression symptoms before COVID-19 crisis (8.5%) than during the pandemic (27.8%). There was a more than 3-fold higher prevalence rate of depression symptoms in the general population [57]. It was supported by the United States of America (USA) Census Bureau that found three times higher of USA adults had anxiety and depressive symptoms during the COVID-19 pandemic compared to the previous year in 2019. The prevalence of anxiety and depression was 8.2% and 6.6% prior to the pandemic and 30.8% and 23.5% during the crisis, respectively [58].

A previous study found that the prevalence estimated for depression (0-28%) and anxiety (8-27%) in youth for low- and middle-income countries (LMIC) were comparable with high income countries as a reported rate of 2-25% for depression and 9-30% for

anxiety in the absence of pandemic [59]. However, our subgroup analysis shows that developing countries have a higher prevalence of depression (60.83%) and anxiety (46.44%) compared to developed countries (33.92% and 28.63%, respectively) which may be due to children, parents, or environmental factors. In developing countries, the underprivileged children face acute nutrition deprivation and overall protection during the COVID-19 pandemic [60]. Uncertainty about health status, follow-up patients, treatment care and inefficiency in these countries increased the vulnerability of such communities to the psychological effects of COVID-19 [49]. Study shows that wearing masks and practicing excellent hygiene like sanitizing your hands can reduce anxiety and depression during the outbreak [61]. However, in low- and middle-income countries, the inability to provide a good public health system and intervention during the pandemic leads to physical and mental health compromise. Rapid testing contact tracing and isolation intervention may be challenging to implement in these countries [62]. In Bangladesh, personal protective measures are not widely enforced due to limited supplies [35]. In addition, poverty, financial issues, and unemployment lead to stress among the breadwinners, indirectly affecting young children physically and mentally. They tend to be neglected and abused by their parents due to COVID-19 stressors. This can make the child more vulnerable to depression and anxiety [63].

Children and adolescents with chronic physical illness such as asthma, diabetes, cancer, migraine, and epilepsy were found to have higher levels of depressive symptoms than their healthy peers [64]. There was an exacerbation of symptoms among adolescents with special needs, such as ADHD during this global pandemic [65]. However, current reviews showed the prevalence of depression is lower in a group with co-morbid diseases (Tourette syndrome and ADHD) (20.59%) than a group with no underlying comorbidity (40.39%). It may be due to better coping measurements among them. Stay connected with

others, received strong group and parents' support play important role in reducing mental health burdens such as depression and stress among special need children during this pandemic [65, 66]. Our finding suggested children and adolescents with no pre-existing conditions are at a higher risk of psychological distress and should be targeted for psychological assessment and appropriate intervention. However, there is no significant difference between the prevalence of anxiety in groups with comorbidity (obesity, ASD, and Tourette syndrome) (30.43%) and no co-morbid diseases (31.92%). However, subgroup analysis was not conducted based on pre-existing comorbidity and country for stress, worry, and fear symptoms, because there is limited and no data available.

Our study had important clinical and public health implications. Enrollment of psychological services and intervention programs including their family members are crucial. A cooperative approach model suggests that psychological services should include social, school, and family systems simultaneously for synergistic effect [67]. A systematic review of clinician satisfaction with telehealth in mental healthcare using video conferencing showed overall attitudes were largely positive [68]. Hence, this should be considered at the young age population, especially those who have been affected by restriction measures during COVID-19. Besides, improved knowledge, awareness and self-coping strategies are needed in dealing with the current situation.

3.7 LIMITATIONS

This study was not without limitations. Firstly, the review was limited to only articles published in the English language Secondly, all the studies on our analysis were cross-sectional surveys which could reflect the populations' psychological state over time. Therefore, it is necessary to portray the psychological impacts of the COVID-19 over a longer and more forward-looking period. Follow-up studies can be helpful in clarifying the mental state of the population in future, thirdly, some studies in this meta-analysis

have used different tools and cut-of-score for assessment possibly introduced great study heterogeneity.

To advance research in this area, it is important to prioritize studies targeting children and adolescents. Several key areas of improvement can be identified. Firstly, there is a need for longitudinal studies that examine the long-term implications of the COVID-19 pandemic on mental health in this population. Secondly, it is necessary to conduct more studies in developing countries to gain insights into the global impacts of the pandemic on the mental health of children and adolescents. Lastly, there is a need for further studies focusing on children and adolescents with comorbid conditions, such as chronic illness and psychiatric conditions, to better understand their unique challenges during the pandemic.

3.8 CONCLUSIONS

In the study, the prevalence of mental health such as depression, anxiety, stress, worry, and fear are comparable with adults' population during this devastating pandemic worldwide. The prevalence of mental health is also higher during COVID-19 outbreak. Therefore, in the current crisis, it is vital to identify individuals prone to psychological disorders within the young age population. Appropriately, psychological strategies, techniques and interventions can be preserved and improved with all layers of populations' mental health. Emphasis should be given to those who are living in developing countries and with no comorbidity background.