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RESEARCH ARTICLE

Aspects of knowledge, attitude, and practices about COVID-19 in basic education students: A meta-analysis

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Abstract: Updated scientific material is needed to incorporate research-based COVID-19 interventions and strategies into basic education. This meta-analysis examined basic education students' COVID-19 Knowledge, Attitude, and Practices (KAP) across the globe. This study identified KAPs needed to integrate COVID-19 into Basic Education after the meta-analysis. Thirteen published studies on basic education students' KAPs toward COVID-19 were analyzed using meta-analysis. PRISMA was utilized in this study. JBI and STROBE checklists assessed these studies' quality. Three low-quality and ten high-quality published studies were identified. Sensitivity and subgroup analyses were used due to the studies' heterogeneity. Low-quality studies had higher KAP pooled levels. Although the pooled KAPs on COVID-19 between the study groups of elementary students only, elementary and high school students, and high school students only were only slightly different, more high school students had good and better KAPs toward COVID-19. Globally, basic education students had high COVID-19 KAPs. There were items in KAPs identified as essential topics for science lesson integration. These six items were identified as essential topics for lesson integration in knowledge, five in attitude, and four items in practice.

Keywords: basic education; COVID-19; KAPs; meta-analysis

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Introduction

The pandemic caused by COVID-19 has evolved into the most pressing issue in terms of public health since it has an impact on every part of life. The effects of COVID-19 are especially severe for individuals who already suffer from a chronic health condition. But the general population is not escaping the worrying situation brought on by the pandemic (Ejaz et al., 2020). Adults have been the subject of significant research and public health efforts. On the other hand, it is not yet clear how much of a role children and adolescents play in the development of COVID-19, how it is spread, or how it might be prevented. Children and teenagers were thought to be less susceptible to the virus compared to adults, and most cases in this age group were asymptomatic or only mild (Siebach et al., 2021). This could have led to incorrect anticipation of the prevalent condition among these children and adolescents. As a result of the resumption of schooling, students in basic education may once again be at risk of getting the virus and posing a danger to other family members who are particularly sensitive (Zhu et al., 2020).
Students, both at home and at school, should prioritize engaging in preventative behaviors as an essential component of an all-encompassing intervention package for public health. It is believed that the public response to a particular disease is influenced by students' knowledge and comprehension of the disease's causes, signs and symptoms, prevention, and even treatment, which can be translated into their attitudes and behaviors toward the disease (Ajzen, 1991; Schwarzer, 2008). If negative attitudes and behaviors among students cannot be assessed for the purpose of improvement, then the likelihood of disease outcomes among students will increase. Consequently, it is vital to evaluate the public's level of knowledge, perception, and experience in relation to COVID-19 in order to get a sense of how well-prepared they are for the pandemic. Because of this, the government and health authorities can better identify how to modify the programs to contain the outbreak. Knowledge, Attitude, and Practice (KAP) surveys are comprehensive investigations conducted on a representative sample of a certain community.

These surveys are designed to assess the level of knowledge, attitudes, and behaviors pertaining to a specific subject matter, such as the COVID-19 pandemic. The term "knowledge" encompasses an individual's comprehension of the causes, symptoms, prevention, and treatment of a disease. On the other hand, "attitude" pertains to the cognitive state that influences a person's reasoning behind their actions. Lastly, "practice" refers to the observable actions or behaviors that individuals engage in based on their understanding and attitude towards the disease. The completion of a Knowledge, Attitudes, and Practices (KAP) survey enables the assessment of the influence of knowledge levels, perceptions, and behaviors on the transmission of a disease, thereby providing insights on the population's readiness to manage the pandemic.

Several studies have been done to evaluate the levels of KAP that basic education students have on COVID-19. Despite this, a dearth of evidence was produced through a methodical investigation. On the other hand, just a few meta-analyses on the KAP regarding COVID-19 among the general public, healthcare workers, health professionals, as well as medical and university students have been published (Bhagavathula et al., 2020; Lake et al., 2021; L. Li et al., 2022; Raquib et al., 2022; Saadatjoo et al., 2021; Siddiquea et al., 2021; Tefera et al., 2020). A meta-analysis was carried out among children and adolescents, but the research only concentrated on the preventive actions those age groups took in response to COVID-19 (F. Li et al., 2022). There is either a lack of summary evidence or no evidence regarding the knowledge, attitudes, and practices that basic education students around the world have regarding COVID-19.

Due to the nature of the COVID-19 pandemic, it is crucial that the scientific literature be continually updated in order to begin incorporating research-based data on interventions and methods for combating the COVID-19 pandemic into the curriculum for basic education. To attain this objective, there is an immediate need for a comprehensive and current systematic review of the available evidence. As a result, this research aimed to carry out a meta-analysis of the KAPs of basic education students regarding COVID-19. Following the completion of the comprehensive review, the focus of this investigation shifted to determining which components of KAPs are necessary for incorporating COVID-19 into Basic Education.

This study contributes to biology education and the scope and concentration of this journal by presenting a comprehensive meta-analysis of the knowledge, attitudes, and practices (KAPs) of students in basic education regarding COVID-19. The purpose of this study is to gain a deeper comprehension of the students' awareness, perspective, and behavior in relation to the global pandemic. The study's findings have implications for biology curricula, health promotion strategies, and policy formation. In particular, it informs educators on how to incorporate evidence-based COVID-19 information into basic education and enlightens policymakers on how to formulate strategies to increase primary and secondary school students' engagement in pandemic response.

Method

A meta-analysis was the method of research that was used for this investigation. The results of the studies that were conducted on the KAPs of basic education students around the world regarding COVID-19 were provided with combined and analyzed data. This study began by accumulating, reviewing, and analyzing the outcomes of all previously conducted research on students' KAPs regarding COVID-19. The process included an assessment or evaluation of the content of the studies. The study's findings were subjected to a statistical meta-analysis in order to assess their quality. A meta-analysis is a scientific method that combines and evaluates multiple studies' findings in a way that is unbiased, reliable, and objective (Ahn & Kang, 2018).

The instruments used in the meta-analysis of KAP studies on COVID-19 among basic education students across the globe were adapted from the study conducted by Bhagavathula et al. (2020). Inclusion and exclusion criteria were used first in identifying eligible and ineligible studies in your review. The Joanna Briggs Institute's checklist for the critical assessment was utilized to assess or evaluate the level of methodological quality and the potential for bias present in each of the included studies (Munn et al., 2019). The purpose of this checklist, which consists of nine items, is to determine whether the sample represents the population in question. In addition, the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) scale was utilized in order to evaluate the level of methodological rigor present in each of the investigations (Elm et al., 2007; Vandenbroucke et al., 2014). The sole objective of the STROBE guidelines is to provide direction for reporting observational studies. However, it is also frequently employed as a tool for methodological quality assessment in systematic reviews, and it is sometimes utilized as a guideline for the design and execution of observational studies (Da Costa et al., 2011).

Using the principles illustrated and outlined in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) document, a meta-analysis on KAPs regarding COVID-19 was carried out among students in basic education. PRISMA was developed with the intention of assisting authors in producing better-quality reports of meta-analyses. PRISMA can also be used to assess the quality of

previously published meta-analyses; however, it is not a quality assessment tool and, therefore, cannot be used to evaluate the quality of a meta-analysis (Moher et al., 2009). The Preferred Reporting Item for Systematic Reviews and Meta-Analyses (PRISMA) Statement includes a checklist with 27 items (which may be found in Appendix C) and a flow diagram with four different stages. The four-phase flow diagram identified possible studies related to the given topic. Then the studies were screened, followed by determining the eligibility of the studies using the inclusion and exclusion criteria and then processing the included studies. Figure 1 shows the four-phase flow diagram of PRISMA.

Included in the meta-analysis were cross-sectional observational studies published between January 2020 and the current year and which investigated the KAP about COVID-19 among basic education students worldwide. MeSH (Medical Subject Headings) keywords were searched for in six databases of peer-reviewed published studies (PubMed, Google Scholar, Science Gate, ProQuest, Academic Search Premier [EBSCOhost], and Elsevier's Science Direct). This was done in order to conduct a literature search. The number of studies that were discovered in the database is presented in Table 1.

The following keywords were utilized: knowledge* OR attitude* OR perception* OR belief* OR practice*, AND cross-sectional studies*, AND questionnaire*, AND surveys*, AND observational* AND coronavirus* OR coronavirus infections*, OR novel coronavirus* OR covid-19*, OR severe acute respiratory syndrome* OR coronavirus disease* AND students* OR learners* OR elementary school students* OR high school students* OR secondary students* OR junior high school students* OR senior high school students* The field could only accept "title, abstract, and full paper," and the publication type could only be "pre-prints" or "journal articles" written in English. Additionally, the English language was the only supported language for the field.

Table 1. Number of articles or studies found in the database

Database	Number of Articles/Studies
PubMed	105
Google Scholar	213
Science Gate	70
ProQuest	261
Academic Search Premier (EBSCOhost)	16
Elsevier's Science Direct	305

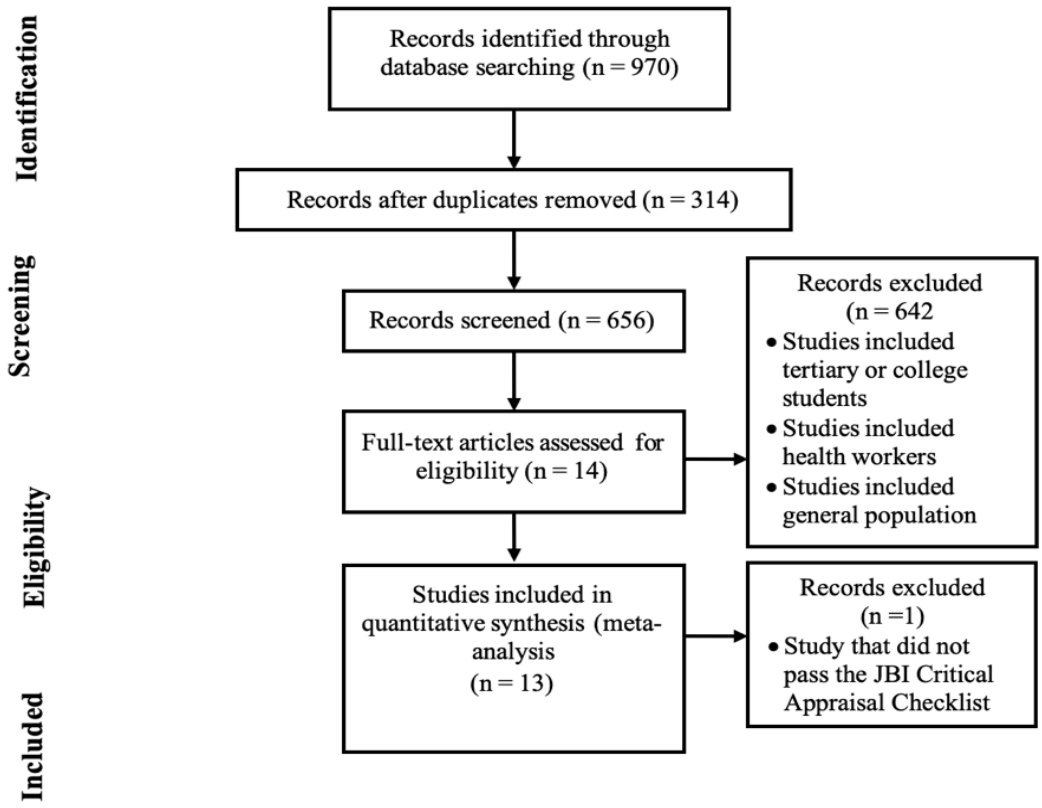

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA)

Case reports, letters to the editor, study protocols, and reviews were not a part of this research in any way. In addition, it did not consider any interventional trials. It was decided to delve even further into the reference list of the papers found throughout the search to find other articles. This evaluation was limited to the research that analyzed the KAPs of basic education students regarding COVID-19 using a standardized questionnaire.

Articles that included keywords relating to the KAP concerning COVID-19 among basic education students located all over the world were chosen for inclusion in the study in light of the inclusion and exclusion criteria outlined above. The researcher examined the abstracts and titles of the papers in order to classify those that met the criteria. Only full-text papers that are offered in the English language have been used in this study. Small alterations in the language were also disregarded when trying to comprehend the precise functional meaning of the phrases. The researcher did not consider duplicate studies, articles that did not fit the inclusion and exclusion criteria or studies in which the data were not provided adequately.

The following pieces of information were gleaned from the data for this analysis: author names, research design, research environment, sample methodologies, ways of administering the questionnaire, and the significant findings and results. These statistics were extracted from the chosen articles and entered into a spreadsheet for your convenience. The data that were reported from the research that was included in the review were examined. The researcher was able to resolve and clarify any discrepancies or contradictions that were related to the inclusion of certain studies. Using the checklist developed by the Joanna Briggs Institute for critical analysis, each study included in the review had its research methodology and potential for bias assessed (Munn et al., 2019). In addition, the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) scale was utilized in order to evaluate the overall quality of the research methods utilized in the investigations (Elm et al., 2007).

In most of the sections, descriptive analyses were performed, and the results of the pooled data were provided as a number or a percentage for items of data that were comparable. Each component was broken down into two distinct categories, which were as follows: knowledge, which was scored as "correct > 50" or "wrong < 50," attitude, which was scored as "positive > 50" or "negative < 50," and practice, which was scored as "practiced > 50" or "not practiced < 50." The software program Review Manager, version 5.4, was utilized to carry out the meta-analysis. The Q-test developed by Cochrane and the I^2 statistics were utilized to conduct the analysis of the studies' heterogeneity. The studies that showed heterogeneity according to the Cochrane Q $p < 0.10$ and the I^2 >50% were merged using the random-effects model. For the purpose of demonstrating the selected research in terms of estimations with a degree of confidence of 95%, a forest plot was utilized.

For the purpose of the sensitivity analysis, the studies were divided into two categories: high quality, satisfying more than 75% of the STROBE criteria, and low quality, satisfying less than 75% of the STROBE checklist. A sensitivity analysis is a method that involves removing one research from a meta-analysis in order to determine how the significance of a certain dependent variable is affected by the values of an independent variable (Tawfik et al., 2019).

The use of subgroup analysis allowed for the examination and assessment of the differences in knowledge, attitude, and practice that exist between the distinct groups. Subgroup analyses are a method for evaluating heterogeneous data and can also be used to address specific issues regarding specific patient groups, types of interventions, or types of studies. The first subgroup was the meta-analysis of KAPs in three groups of study: elementary students only, elementary and secondary students, and secondary students only. The second subgroup was the meta-analysis of KAPs items according to three constructs: knowledge, attitude, and practices. After determining the differences between the KAPs items in the three constructs (knowledge, attitude, practices), items that were below 70% were identified as the aspects of KAPs essential for integrating COVID-19 in basic education.

Results and Discussion

Study Characteristics

There were fourteen descriptive cross-sectional studies considered for the meta-analysis. There were nine studies conducted through online self-administered and three parent-administered questionnaires; one printed self-administered questionnaire and one face-to-face guided questionnaire through interviews. Among the fourteen studies included in this meta-analysis, three were from China, one was from Pakistan, one from Egypt, one from Ghana, one from Saudi Arabia, one from Iran, one from Malaysia, one from India, one from Italy, one from Nepal, and two from Ethiopia. The sample sizes ranged from 100 to 14216. The study's target population was elementary, junior, and senior high school students. The mean age ranged from 9 to 18. Three studies focused on elementary students only. Nine studies were conducted with only high school students as the research participants, and two were conducted for elementary and high school students. According to the STROBE checklist, three studies were considered low-quality, and ten were considered high-quality studies. Additional details of the

characteristics of the studies in the meta-analysis are reported in Table 2.

Study quality assessment

The Critical Appraisal Tool developed by the Joanna Briggs Institute was utilized to assess the study's quality. When assessing the reliability of the studies, a set of nine criteria was applied. This analysis intends to examine the level to which a particular research or study has considered the likelihood of bias in its design, methodology, and findings and to evaluate the quality of the study's methodological procedures (Munn et al., 2019). Using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist, the quality of the included studies has been evaluated and is presented in Table 3.

Table 2. Characteristics of the studies included in Systematic Review and Meta-analysis (N=30,076)

Lead Author, Year	Study Location	Study Design	Sample Size N	Mean age/ range	Focusing group	Questionnaire administration	Quality Assessment (STROBE)	Knowledge (overall good) Event n	Attitude (overall positive) Event n	Practices (overall good) Event n
Raza et al 2021	Pakistan	Descriptive Cross-Sectional Study	100	9	Elementary school students	Face-to-face guided assessment through interview	< 75%	83	98	88
Ayed et al 2020	Egypt	Descriptive Cross-Sectional Study	260	16.5	High school students	Online self-administered	> 75%	234	260	260
Dubik et al 2021	Ghana	Descriptive Cross-Sectional Study	175	17	High school students	Printed self-administered	> 75%	110	102	119
El Sayed et al 2021	Saudi Arabia	Descriptive Cross-Sectional Study	232	15.5	High school students	Online self-administered	> 75%	194	209	194
Ganaprakasam et al 2021	Malaysia	Descriptive Cross-Sectional Study	1207	10.5	Elementary school students	Online self-administered	> 75%	676	910	718
Getawa et al. 2022	Ethiopia	Descriptive Cross-Sectional Study	422	17	High school students	Online self-administered	> 75%	364	364	238
Hatami et al 2021	Iran	Descriptive Cross-Sectional Study	704	15.5	High school students	Online parent administrated	> 75%	634	644	591
Singh et al 2021	India	Descriptive Cross-Sectional Study	187	15.5	High school students	Online self-administered	< 75%	163	129	140
Souli & Dilucca 2020	Italy	Descriptive Cross-Sectional Study	2380	16.5	High school students	Online self-administered	< 75%	1589	2058	1891
Subedi et al 2020	Nepal	Descriptive Cross-Sectional Study	101	15.5	High school students	Online self-administered	> 75%	53	57	53
Wen et al 2020	China	Descriptive Cross-Sectional Study	8864	13	Elementary and High school students	Online self-administered	> 75%	5712	5689	5579
Xue et al 2021	China	Descriptive Cross-Sectional Study	1650	9	Elementary school students	Online parent administrated	> 75%	1403	837	1551
Yangmei et al 2021	China	Descriptive Cross-Sectional Study	14216	13	Elementary and High school students	Online parent administrated	< 75%	12201	13827	12966
Yesuf et al. 2022	Ethiopia	Descriptive Cross-Sectional Study	422	18	High school students	Online self-administered	> 75%	322	288	191

All studies displayed that the sample frame appropriately addressed the target population. Four studies needed to be more precise and specific on how the study participants were sampled (El Sayed & Mahmoud, 2021; Huang et al., 2021; Raza et al., 2021; Souli & Dilucca, 2020). However, there were ten studies wherein study participants were sampled appropriately. All studies' subjects and settings were described in detail. All studies' sample size was adequate except for the studies conducted by Subedi et al. (2020), Raza et al. (2021), and Dubik et al. (2021). The data analysis was carried out with adequate coverage of the specified sample across all studies incorporated into the review. In the investigations carried out by Raza et al. (2021), Singh et al. (2021), Wen et al. (2020), and Xue et al. (2021), the methods that were employed to identify the condition were not valid. In these investigations, neither the validity nor the reliability of the utilized instruments was discussed. As a result of the fact that each of the investigations relied on either self-administered or guided questionnaires to collect data, the condition was not evaluated consistently and dependably across all of the participants. Based on the checklist, the study conducted by Raza et al. (2021) was marked as excluded. Hence, this study was not included in the meta-analysis. Thirteen studies were included in the meta-analysis for KAPs towards COVID-19 among basic education students.

Knowledge about COVID-19

Global basic education students' knowledge was analyzed. Figure 2 shows the random effect model forest plot of COVID-19 knowledge among basic education students worldwide. Thirteen studies reported the overall knowledge of participants or students about COVID-19 as 52% (95% CI: 38% - 66%)

with a p-value of 0.00001 and I^2 equals 100%. It means that the students had good knowledge about COVID-19. Heterogeneity is detected in this meta-analysis based on the value of I^2 and p-value. These thirteen studies are relatively heterogeneous. Moreover, the z-value (7.09) and p-value (0.00001) indicate an association between basic education students' good and poor knowledge of COVID-19. This means that sensitivity analysis must be employed.

The pooled level of knowledge of the basic education students regarding COVID-19 is relatively lower than that found in meta-analyses conducted by Lake et al. (2021), Bhagavathula et al. (2020), L. Li et al. (2022), Saadatjoo et al. (2021), and Siddiquea et al. (2021). Since there was no evidence of systematic evaluation of basic education students' KAPs, the pooled knowledge was compared to the available information. Most of the participants answered the surveys are college students, health professionals, and in the general population (Bhagavathula et al., 2020; Lake et al., 2021; L. Li et al., 2022; Saadatjoo et al., 2021; Siddiquea et al., 2021). It could mean that basic education students have the slightest knowledge about COVID-19 than the study participants mentioned above. Most basic education students' familiar sources of facts on COVID-19 were friends, family members, the internet, social media like Facebook, WhatsApp (Ayed et al., 2021), Instagram, and newspapers (Singh et al., 2021; Souli & Dilucca, 2020).

Table 3. Study quality assessment of included studies using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist

Study	Was the sample frame appropriate to address the target population?	Were study participants sampled in an appropriate way?	Was the sample size is adequate ?	Were the study subjects and the setting described in detail?	Was the data analysis conducted with sufficient coverage of the identified sample?	Were valid methods used for the identification of the condition?	Was the condition measured in a standard, reliable way for all participants?	Was there appropriate statistical analysis?	Was the response rate adequate, and if not, was the low response rate managed appropriately?
Raza et al 2021	Yes	Not Clear	No	No	Yes	No	No	No	No
Ayed et al 2020	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Dubik et al 2021	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
El Sayed et al. 2021	Yes	Not Clear	Yes	Yes	Yes	Yes	No	Yes	No
Ganaprakasam et al 2021	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Getawa et al., 2022	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Hatami et al 2021	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Singh et al 2021	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
Souli & Dilucca 2020	Yes	Not Clear	Yes	Yes	Yes	Yes	No	Yes	No
Subedi et al 2020	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
Wen et al 2020	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
Xue et al 2021	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
Yangmei et al 2021	Yes	Not Clear	Yes	Yes	Yes	No	No	Yes	No
Yesuf et al., 2022	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No

Students only sometimes examine the information they read online (Walraven et al., 2009). The disparities in the students' information literacy skills indicate that schools and educators should assume more significant responsibility for instruction on information literacy (Braasch et al., 2009). The teacher can help the students guide on examining and determining the good and bad information on the internet (LaGarde & Hudgins, 2018). The role of a teacher is vital before and during a specific public health issue. Science teachers are crucial in helping students get credible information about the disease.

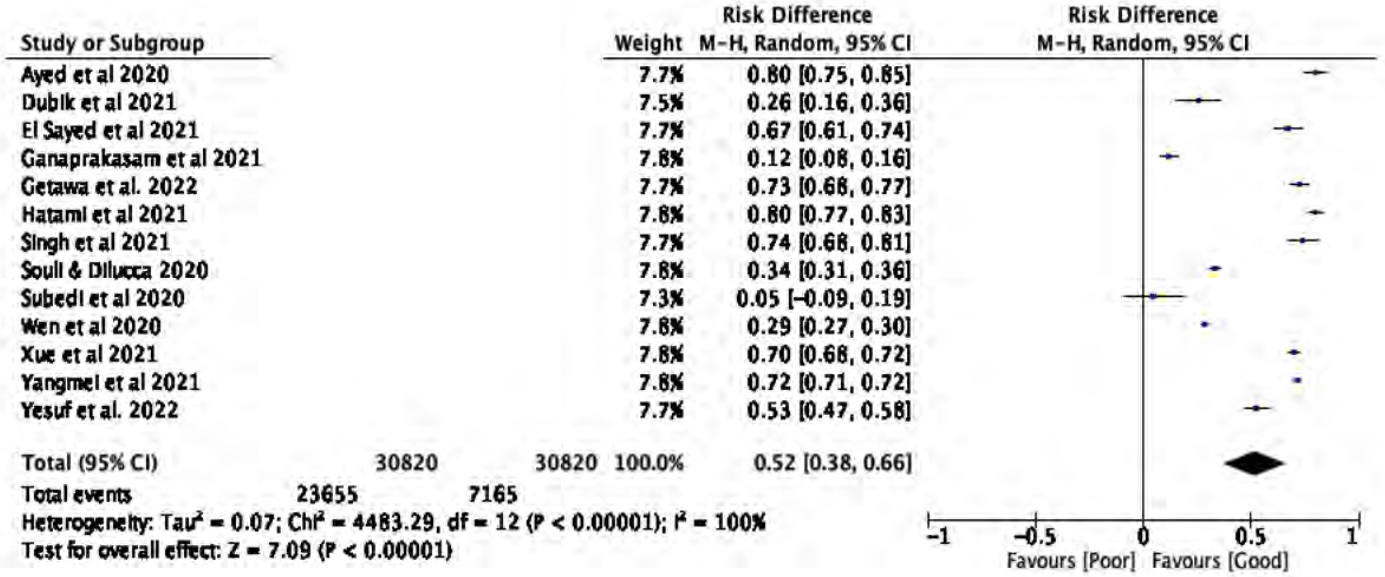

Figure 2. Random effect model forest plot of knowledge on COVID-19 among basic education students across the globe

COVID-19 education also needs more direct teacher-student contact. Due to the pandemic's economic and social effects, students learning about the disease and their mental and bodily health may suffer if they miss classes (Kuhfeld et al., 2020). Classrooms focused on analysis and problem-solving, a pleasant emotional climate, sensitivity to student views and needs, and diverse, engaging, and motivating instructional learning modalities had higher student achievement and information retention (Allen et al., 2013). Student expertise increases with learning frequency.

Attitude towards COVID-19

This study compiled and analyzed a global survey of students in both elementary and secondary schools. The attitudes of basic education students toward COVID-19 are depicted in a random effect model forest plot in Figure 3.

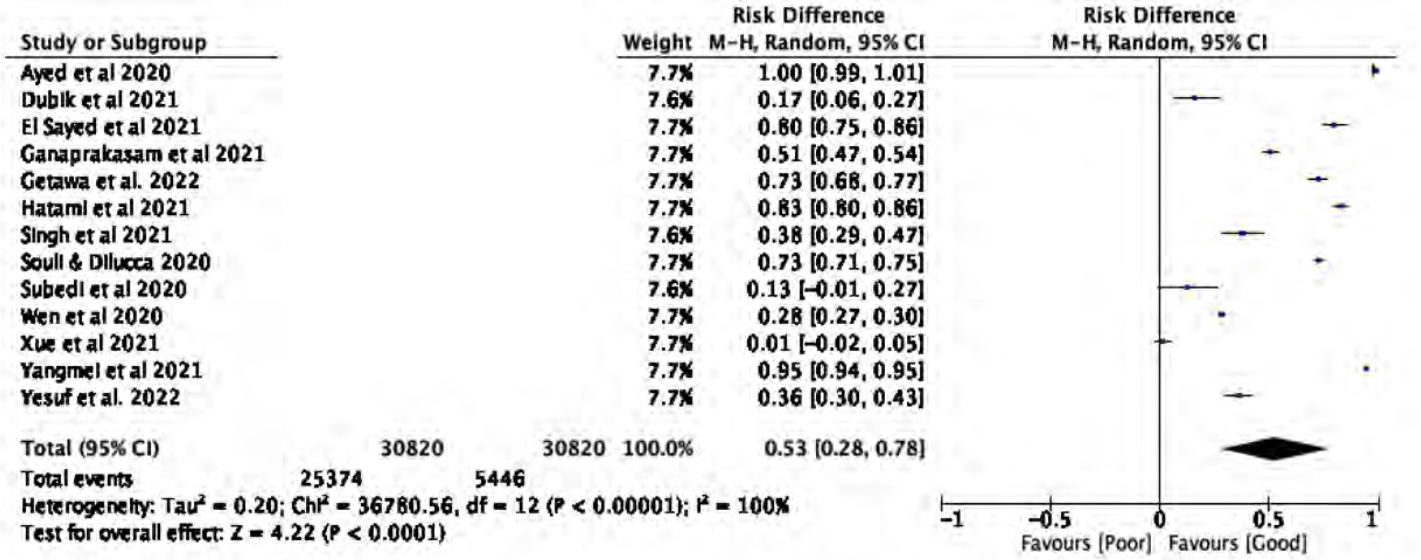

Figure 3. Random effect model forest plot of attitude towards COVID-19 among basic education students across the globe

Studies included in this meta-analysis reported the good attitudes of basic education students toward COVID-19 with an overall or total Risk Difference M-H of 53% (95% CI: 28% - 78%) with a p-value of 0.00001, and I^2 equals 100%. Heterogeneity is also found in Figure 3 based on the value of I^2. The studies included in this meta-analysis are relatively heterogeneous. The z-value (4.22) and p-value (0.00001) reveals an association between basic education students' good and poor attitude toward COVID-19. Hence, there is a need to do a sensitivity analysis.

The pooled level of attitude of the basic education students toward COVID-19 is also relatively lower than that found in meta-analyses (Lake et al., 2021; L. Li et al., 2022; Saadatjoo et al., 2021; Siddiquea et al., 2021). This finding is consistent with the pooled level of knowledge of the basic education students about COVID-19. It could mean that the attitude of the students toward COVID-19 is different from the students' attitude in the studies included in the meta-analyses. Students' attitudes toward COVID-19 could be linked to their knowledge about COVID-19. Thus, one's attitude is a complex interaction of knowledge, beliefs, ideals, and feelings. Thus, experimenting with knowledge can shape attitudes. According to Ul Haq et al. (2013), education improves attitude. Bradley et al. (1999) found that students who earned higher on knowledge questions had more positive views. This affects the teacher's ability to relate knowledge to students' attitudes. Teachers should include learning goals to improve students' pandemic attitudes.

Practice towards COVID-19

Global basic education students' behavior was analyzed. Figure 4 shows the random effect model forest plot of COVID-19 practice among basic education pupils worldwide.

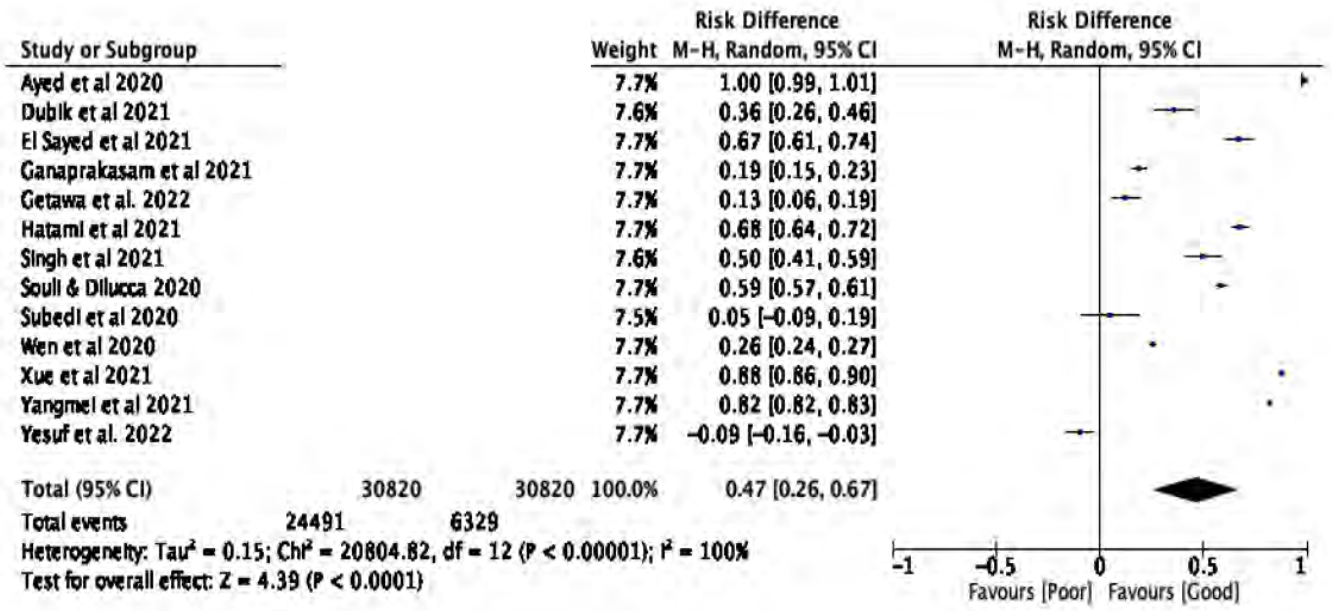

Figure 4. Random effect model forest plot of practice towards COVID-19 among basic education students across the globe

Studies included in this meta-analysis reported good practice toward COVID-19 with an overall or total Risk Difference M-H of 47% (95% CI: 26% - 67%) with a p-value of 0.00001 and I^2 equals 100%. Heterogeneity is detected based on the value of I^2. The studies included in this meta-analysis are relatively heterogeneous. The z-value (4.39) and p-value (0.00001) mean an association between basic education students' good and poor practices toward COVID-19, so a sensitivity analysis is needed.

Basic education students' pooled level of practice toward COVID-19 is relatively higher than that found among health professionals in Ethiopia (Lake et al., 2021). This is surprisingly different, knowing that health professionals are expected to better understand COVID-19 than basic education students. The reason for this could be more of the Ethiopian tradition and lifestyle. Greetings in Ethiopian society are distinctive and may include a handshake, a hug, or a kiss. Additionally, there is a tradition of sharing meals with whoever is nearby (Tesfaw et al., 2021). However, this pooled level of practice of basic education students toward COVID-19 is relatively lower than the pooled level of practice among college students in China (L. Li et al., 2022), the general population from Asia, Africa, America, and across all continents (Saadatjoo et al., 2021; Siddiquea et al., 2021). KAP studies link knowledge, attitude, and practices. Thus, KAP data-targeted awareness efforts should promote positive attitudes and behavior change. Students can apply their knowledge and mindset by practicing. According to a study, understanding infectious diseases is linked to correct protective behavior during public health crises and infectious disease outbreaks (Prue et al., 2017; Toppenberg-Pejcic et al., 2019). Tolvanen et al. (2012) and Siddiquea et al. (2021) found positive correlations between KAP components. COVID-19-specific knowledge, attitude, beliefs, and behaviors strongly predict disease-specific preventive actions (Bhagavathula et al., 2020). Teachers may need to integrate students' cognitive, psychomotor, and affective learning aims in the classroom.

Sensitivity analysis

The meta-analysis's previous works were categorized as high quality (more than 75%) or low quality (less than 75%) according to STROBE criteria to address heterogeneity. Table 4 shows the sensitivity analysis results on the meta-analysis papers' quality.

The studies conducted by Singh et al. (2021), Souli and Dilucca (2020), and also Huang et al. (2021) were considered low-quality studies using the STROBE checklist. Table 4 shows the subgroup analysis of high and low-quality studies on KAPs among basic education students across the globe. In high and low-quality studies, there is almost no difference between knowledge about disease, practice, and attitude toward the COVID-19 outbreak. This is the same as the results of the study done by Bhagavathula et al. (2020), in which there is no significant difference in the knowledge about the pandemic among the participants in their study. However, 45% of the students in high-quality studies had a good knowledge of COVID-19, which is lesser than those in low-quality studies (61%).

Only 36% of the students had a good attitude toward COVID-19 in high-quality studies compared to that 76% in low-quality studies. It is also apparent in Table 4 that 67% of students in low-quality studies have a satisfactory or good level of practice towards COVID-19 compared to the students in high-quality

studies, which is 31%. High-quality studies had lower pooled levels in KAPs than low-quality studies. This could mean that high-quality studies had fewer biases in the conduct of their studies. Low-quality studies could not ensure a clear presentation of what was planned, done, and found. These studies could hinder essential details of the results of the study. Empirical evidence about the students' KAPs toward COVID-19 is essential to help science education, and its advocates create possible adjustments in the teaching-learning processes in science subjects.

Table 4. Sensitivity analysis: Quality of studies

	No. of Studies	Sample Size	Risk Difference M-H, Random, 95% CI	P-value	I^2
High-Quality Studies					
Knowledge about COVID-19	10	14037	0.45 [0.38, 0.77]	<0.00001	99%
Attitude towards COVID-19	10	14037	0.36 [-0.10, 1.03]	<0.00001	100%
Practice towards COVID-19	10	14037	0.31 [0.00, 1.01]	<0.00001	100%
Low-Quality Studies					
Knowledge about COVID-19	3	16783	0.61 [0.37, 0.86]	<0.00001	100%
Attitude towards COVID-19	3	16783	0.76 [0.56, 0.96]	<0.00001	100%
Practice towards COVID-19	3	16783	0.67 [0.50, 0.84]	<0.00001	99%

The differences in KAPs toward COVID-19 across studies that focused on elementary students only, elementary and secondary school students, and secondary school students only were assessed using subgroup analysis. Table 5 shows the subgroup analysis of KAPs toward COVID-19 among various study groups.

Studies conducted by Ganaprakasam et al. (2021) and Xue et al. (2021) focused only on the KAPs of COVID-19 among elementary school students. Wen et al. (2020) and Huang et al. (2021) included elementary and high school students in their KAPs studies. While some research focused only on the KAPs on COVID-19 of high school students (Ayed et al., 2021; Dubik et al., 2021; El Sayed & Mahmoud, 2021; Getawa et al., 2022; Hatami et al., 2021; Singh et al., 2021; Souli & Dilucca, 2020; Subedi et al., 2020; Yesuf & Abdu, 2022). There is a slight difference between knowledge about COVID-19, practice, and attitude regarding COVID-19 in the different study groups. The student's knowledge is directly related to correct knowledge about COVID-19. The student's practice and attitude regarding COVID-19 are also linked to a positive attitude and good practice. The knowledge of COVID-19 among the participants in the studies that focused on elementary school students only is lower (49%) than those in the studies on elementary and secondary school students (50%) and high school students only (60%). Also, the attitude towards COVID-19 among the participants in the studies that focused on elementary school students only is lower (49%) than those in the studies on elementary and secondary school students (61%) and high school students only (58%). The practice of COVID-19 is much lower. Only 46% of elementary school students only have satisfactory or good practice towards COVID-19 students in elementary and secondary school students and high school students only studies.

Table 5. Subgroup analysis: Knowledge, Attitude, and Practice toward COVID-19 among different among various study groups

Study Groups	No. of Studies	Sample Size	Risk Difference M-H, Random, 95% CI	p-value	I^2
Elementary Students					
Knowledge about COVID-19	2	2857	0.49 [0.04, 0.95]	<0.00001	100%
Attitude towards COVID-19	2	2857	0.49 [-0.11, 1.09]	<0.00001	100%
Practice towards COVID-19	2	2857	0.46 [0.22, 0.71]	<0.00001	99%
Elementary and High School Students					
Knowledge about COVID-19	2	23080	0.50 [0.06, 0.94]	<0.00001	100%
Attitude towards COVID-19	2	23080	0.61 [-0.43, 1.66]	<0.00001	100%
Practice towards COVID-19	2	23080	0.54 [-0.09, 1.17]	<0.00001	100%
High School Students					
Knowledge about COVID-19	9	4883	0.60 [0.30, 0.75]	<0.00001	99%
Attitude towards COVID-19	9	4883	0.58 [0.38, 0.73]	<0.00001	99%
Practice towards COVID-19	9	4883	0.47 [0.03, 1.07]	<0.00001	100%

Although the pooled KAPs on COVID-19 between the study groups of elementary school only, elementary and secondary school students, and high school students only are slightly different, more high school students have good KAPs. Students learned about the outbreak from TikTok, Facebook, TV, radio, and other web sources. Outside of school, students use social media more (Lu et al., 2016). Kim et al. (2019) found that high school students have better ICT literacy, utilization, and management than primary students. ICT skills may have helped high schoolers understand COVID-19. High school

students like their peer connections and have better information and communications technology skills than elementary students. High schoolers encourage learning and participation.
Talking about learning and active engagement, Herrmann-Abell and DeBoer (2018) had different findings on this. They discovered that students' understanding of the knowledge defined in the learning process showed that elementary-level learners do well compared to expectations. This was shown by the fact that the students understood the knowledge. Even so, middle and high school students' performance does not meet expectations. This is also the same as the conclusion of Martin (2009) in which elementary school students were more motivated and engaged than high school students. A student's academic motivation to succeed rapidly declines from the early stages of elementary school into high school.

Subgroup analysis

To further address the heterogeneity of the pooled level of KAPs of the basic education students toward COVID-19, a subgroup analysis on the items or topics under KAPs was done. Table 6 shows the subgroup analysis of studies focused on the different constructs or topics of KAPs toward COVID-19.

Table 6. Subgroup analysis: Knowledge, Attitude, and Practice toward COVID-19

Constructs	No. of Studies	Sample Size	Risk Difference M-H, Random, 95% CI	P-value	I^2
Knowledge					
Knowledge on Complications of COVID-19	1	232	0.81 [0.76, 0.86]	-	-
Knowledge on Prevention from COVID-19	7	12833	0.53 [0.40, 0.66]	<0.00001	99%
Knowledge about Transmission	6	11283	0.60 [0.41, 0.78]	<0.00001	99%
Knowledge on Causes of COVID-19	6	3162	0.71 [0.02, 0.77]	<0.00001	97%
General knowledge on COVID-19	4	3325	0.31 [-0.21, 0.54]	<0.00001	97%
Knowledge on Health and Diet	4	11358	0.75 [0.18, 0.82]	<0.0001	93%
Knowledge on Recovery	3	1548	0.76 [0.25, 0.83]	<0.00001	99%
Knowledge on Susceptible Population	4	11007	0.42 [-0.07, 0.71]	<0.00001	100%
Knowledge on COVID-19 Signs and Symptoms	7	11895	0.37 [0.09, 0.52]	<0.00001	99%
Knowledge on Treatment	7	11895	0.73 [0.49, 0.83]	<0.00001	100%
Knowledge on COVID-19 Vaccine	2	805	-0.13 [-0.78, 0.51]	<0.00001	99%
Attitude					
Wearing a Facemask	2	275	0.73 [-0.37, 1.83]	<0.00001	100%
Social Distancing	3	433	0.54 [-0.16, 1.23]	<0.00001	100%
Health and diet	5	1037	0.42 [0.06, 0.79]	<0.00001	99%
Personal hygiene and handwashing	6	2519	0.53 [0.41, 0.90]	<0.00001	99%
Health Protocol Compliance	2	936	0.71 [0.23, 1.05]	<0.00001	99%
Avoiding Crowded Places	2	10071	0.59 [0.45, 0.55]	0.008	86%
COVID-19 vaccine (nature and perception)	2	805	0.18 [0.01, 0.55]	<0.00001	99%
Practice					
Avoiding Crowded Places	6	4108	0.71 [0.24, 0.74]	<0.00001	100%
Frequent Handwashing	9	12227	0.70 [0.27, 0.77]	<0.00001	97%
Social Distancing and Wearing Facemask	4	1780	0.49 [0.42, 0.81]	0.14	54%
Personal Hygiene	7	12263	0.50 [0.16, 1.04]	<0.00001	100%
COVID-19 vaccine and Health Protocol	2	805	0.17 [0.12, 0.61]	<0.00001	99%
Health and Diet	1	8864	0.38 [0.43, 0.45]	-	-

One study (El Sayed & Mahmoud, 2021) reported knowledge of complications of COVID-19, with 81% (95% CI: 76-86) of its participants correctly identifying the complications of COVID-19. This got the highest pooled level of knowledge among eleven topics or constructs of knowledge. However, two studies (Hatami et al., 2021; Subedi et al., 2020) revealed that only 13% (95% CI: -78 – 51) of students knew about the COVID-19 vaccine and its efficiency. This means the students in these two studies have less or no knowledge about the COVID-19 vaccine. El Sayed and Mahmoud (2021) study got the highest pooled level because it was the only study focused on COVID-19 complications.
There are more basic education students in the subgroup analysis who have good knowledge regarding the complications of the disease than knowledge of the prevention and transmission of the disease. Some studies had almost the same results as their study participants' knowledge of the disease transmission compared to the basic education students (Bhagavathula et al., 2020; L. Li et al., 2022;

Raquib et al., 2022; Saadatjoo et al., 2021; Siddiquea et al., 2021; Tefera et al., 2020). Also, the students' knowledge of the prevention of COVID-19 is almost the same as the study participants of Tefera et al. (2020), Saadatjoo et al. (2021), and L. Li et al. (2022). However, fewer students have good knowledge of the causes of COVID-19 and health and diet, recovery, susceptible population, COVID-19 signs and symptoms, and treatment. This contrasts the previous studies (Bhagavathula et al., 2020; L. Li et al., 2022; Raquib et al., 2022; Saadatjoo et al., 2021; Siddiquea et al., 2021; Tefera et al., 2020). It could mean that more students have uncertainties about COVID-19. Students during COVID-19 mostly got information about COVID-19 through social media. Social media could pose more threats of miscommunication than traditional media like TV and radio. Misinformation was comparatively more common on social media (S. Roy, 2020), while debunking myths and misinformation was relatively more common in traditional news (Bridgman et al., 2020). These students with uncertainties about COVID-19 can be related to Bakebillah et al.(2021), who indicated a significant association between a higher level of education and less misconception about COVID-19.

Furthermore, basic education students across the globe could have insufficient knowledge and even misconceptions about the COVID-19 vaccine. This poor knowledge and misconception about the vaccine could be associated with vaccine hesitancy. Hesitancy regarding vaccination is described by WHO as, despite the availability of vaccine services, a delay in accepting or declining immunizations can be seen as a risk factor (MacDonald et al., 2015). This may be due to the widespread dissemination of myths around vaccines, such as the belief that receiving excessive immunizations might cause the immune system to fail or that vaccines may have potentially fatal adverse effects (Geoghegan et al., 2020). These myths and misconceptions could be the effects of students' poor skills in examining and scrutinizing the integrity of the sources of information. Pilgrim and Vasinda (2021) emphasized that conducting online searches and examining online information is challenging for children and adolescents. The educator is essential in helping and encouraging students to determine credible information sources. Well-examined information about the pandemic contributes to the solution and mitigation. Hence, correct public knowledge of infectious diseases is strongly linked to vaccine confidence (El-Showk, 2019) and the right attitude toward the disease.

Two studies (Dubik et al., 2021; Raza et al., 2021) reported a good attitude of the students toward COVID-19 on wearing facemasks, which is 73% (95% CI: -37 – 183; p<0.00001) (Table 6). The number of basic education students who always wear face masks is quite the same as what was found in the some studies (Bhagavathula et al., 2020; Raquib et al., 2022; Siddiquea et al., 2021; Tefera et al., 2020). On the contrary, two studies (Hatami et al., 2021; Subedi et al., 2020) revealed that only 18% (95% CI: 1 – 55) of the students had a better and good attitude regarding COVID-19 vaccine, its nature, and the students' perception. This could mean that students' knowledge about the vaccine was related to their attitude and perception of the nature of the vaccine. Poor knowledge about the disease means a poor attitude towards it. A lack of well-examined knowledge about vaccines led to poor experience and could link to poor attitudes. Attitude is the result of experience, either good or bad. This implies that educators need to consider it an opportunity to educate them more about the vaccine and provide them with hands-on experience to build learning about vaccines constructively. Kapici et al. (2020) believed that hands-on experiences like experiments strongly impact the developing attitudes among middle school students. Experiments are fun for students because they allow them to expand their knowledge and satisfy their natural curiosity while helping them develop a more scientific mindset (Kurniawan et al., 2019).

Six studies (Dubik et al., 2021; El Sayed & Mahmoud, 2021; Ganaprakasam et al., 2021; Getawa et al., 2022; Wen et al., 2020; Yesuf & Abdu, 2022) presented the practice of avoiding crowded places during the COVID-19 pandemic, and there is 71% (95% CI: 24, 74) of the participants avoided the crowded places. However, fewer students practice avoiding crowded places than the study participants of Raquib et al. (2022). Because of this, the knowledge that these students have regarding the COVID-19 disease may be limited or scattered, which makes the disease more difficult to treat and eliminate due to a lack of attention paid to disease prevention procedures (D. Roy et al., 2020; Zhang et al., 2020), like avoiding crowded places. Students saw their parents and adults in the family join events physically and demonstrate gestures that can spread the disease (Getawa et al., 2022). Two studies (Hatami et al., 2021; Subedi et al., 2020) presented the participants' practice on COVID-19 vaccine and health protocol compliance, and there is only 17% (95% CI: 12, 61). It showed in this subgroup analysis that there is a significant relationship between the students' KAPs. Students' poor knowledge and misconception about the vaccine affected their attitude and practiced towards it. Students who have misconceptions about the vaccine could tend to demonstrate vaccine hesitancy. Students must learn how to translate their knowledge into attitude and then practice. Their execution of the learning should be correct to help them mitigate the pandemic. Educators have the most significant role in helping students manifest and execute the correct knowledge accordingly. When students demonstrate or execute their knowledge correctly, they manifest critical thinking abilities (Nafingah et al., 2020).

Aspects of knowledge, attitude, and practices essential for integrating COVID-19 in Basic Education across the globe

After considering the heterogeneity of the pooled level of basic education students' knowledge, attitude, and practices toward COVID through sensitivity and subgroup analyses, different topics or constructs under KAPs were identified as essential for integrating the disease and pandemic in basic education. Table 7 shows the aspects of KAPs essential for integrating COVID-19 into basic education across the globe.

Table 7. Aspects of KAPs essential for integrating COVID-19 in Basic Education across the globe

Inductive Categories	Sub-categories
Knowledge	General knowledge of COVID-19
	Knowledge on signs and symptoms
	Knowledge on prevention
	Knowledge on Transmission
	Knowledge on Susceptible Population
	Knowledge on COVID-19 Vaccine
Attitude	Health and diet
	Personal hygiene and handwashing
	Health protocol
	Social distancing
	COVID-19 vaccine (nature and perception)
Practice	Health and diet
	Personal hygiene
	Social distancing and wearing of facemask
	COVID-19 vaccine and health protocol

Based on the meta-analysis of the KAP studies on COVID-19 among basic education students across the globe, the aspects of knowledge, attitude, and practices essential for lesson integration in science subjects were identified. These items got pooled level of below 70% in the subgroup analysis.

To enhance students' comprehension of the multifaceted nature of COVID-19 and its practical implications for disease prevention, it may be advantageous to integrate these components into the curriculum. As evident from the table, a notable range of subjects can be encompassed under the realms of Knowledge, Attitude, and Practice (KAP).

At a comprehensive level, 'Knowledge' pertaining to COVID-19 encompasses a collective comprehension of the disease, encompassing its symptoms, preventive measures, modes of transmission, vulnerable demographics, and immunization strategies. By integrating these elements into the foundational education system, students' understanding of the disease is improved, leading to the development of safer communities that possess the knowledge and skills necessary to effectively avoid infection. The 'Attitude' category primarily centers on students' attitudes and behaviors pertaining to health and diet, personal hygiene practices, adherence to health protocols, observance of social distancing measures, and their perspectives regarding the COVID-19 vaccine. Educating students on these dimensions serves as a catalyst for instilling motivation within them to adopt suitable measures, so fostering healthy behaviors that effectively mitigate the transmission of the virus. The 'Practice' section emphasizes the significance of maintaining acquired health behaviors, including dietary habits, personal hygiene practices, mask utilization, social separation, and adherence to COVID-19 and health protocols. The inclusion of practical courses pertaining to these areas is crucial in equipping students with the necessary skills to effectively handle the challenges posed by the pandemic.

The findings provide a crucial comprehension of the key areas that should be prioritized when formulating strategies for the incorporation of COVID-19 education within the current curriculum. Implementing this measure will effectively promote students' understanding and compliance with essential measures, so cultivating an environment that is conducive to the cessation of the ongoing pandemic. Moreover, this strategy is in accordance with the ideas of health promotion since it empowers students to exert control over and enhance their health through their individual actions. Considering the extraordinary circumstances, we are currently facing, there is a growing imperative to undertake reforms in basic education that are attuned to the demands posed by prevailing health concerns. This initiative represents a significant stride in cultivating a cohort that possesses a profound comprehension of health and illness, equipped to effectively address forthcoming pandemics.

Conclusion

In general, basic education students across the globe had good KAPs toward COVID-19. However, six sub-categories under the knowledge category considered aspects of knowledge in COVID-19 for science

lesson integration. These are general knowledge about the disease, signs and symptoms, prevention, transmission, susceptible population, and COVID-19 Vaccine. Under attitude, the sub-categories are health and diet, personal hygiene and handwashing, health protocol, social distancing, and the COVID-19 vaccine (nature and perception). The sub-categories for the practice are health and diet, personal and hygiene, social distancing and wearing of facemasks, and COVID-19 vaccine and health protocol. Hence, these were the identified topics about the pandemic essential for integrating into the basic education curriculum. There needs to be more than just providing accurate and up-to-date information and disseminating them in times of crisis like this to mitigate the problem. Education is still the best method to address the pandemic and other public health issues. Reinforcing research-based educational interventions among the students to enhance their understanding of the pandemic can improve their KAPs toward COVID-19.

Limitations and Future Directions

This study had some limitations, such as the fact that assessments for the KAP level of KAPs were captured from each study, and the operational definitions may differ between the studies. The absence of a similar study causes difficulty in comparing the findings with the others. Based on the results, it is suggested that further research is recommended to assess the KAPs of basic education students in other parts of the world and to provide more evidence-based information on why gaps in KAPs among students exist. The DepEd may use the findings of this meta-analysis to consider interventions applicable to basic education students. DepEd should also check and consider available information on the systematic evaluation of KAPs of the general public so the department can prepare the educational system for the next or unforeseen public health issues.

Conflicts of Interest

The author has no conflicts of interest associated with the material presented in this paper.

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