International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 10, Issue 05, May 2025,
*https://doi.org/10.23958/ijirms/vol10-i05/2043*

**Review Article**

# Efficacy of Covid-19 Mitigation Strategies on Incidence

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Received: 28 February 2025; Accepted: 07 March 2025; Published: 12 May 2025

## Abstract

This study aims at assessing the efficacy of COVID-19 mitigation strategies on incidence. It examines the efficacy of the test-trace-isolate-quarantine (TTIQ) strategy in the containment of COVID-19 pandemic to determine the role of the environment in the pandemic and to recommend appropriate practices in the management of COVID-19 outbreak in terms of contact tracing, screening, quarantine, and isolation. To achieve these objectives, the study uses the systematic literature review, whereby secondary data is utilised to address the problem. The study findings show that TTIQ is the best practice for application by medical healthcare practitioners to treat COVID-19 cases worldwide. The TTIQ approach positively impacts the efforts to contain the virus due to the structured measures and practices utilized in dealing with the pandemic. However, the specific characteristics of the environment such as the presence of the supporting healthcare practitioners, defined procedures for minimal interactions and the general application of the related best practices affect the outcome of the exercise and the effectiveness of the TTIQ. In the same way, the presence of qualified practitioners is critical in delivering the required guidelines and expected outcomes towards the containment of the virus. Consequently, the efforts to improve environmental characteristics significantly help in achieving the best outcomes in containing the virus by introducing the cases of infection and achieving high-quality care for infected patients. The need to embrace solutions that minimize the physical interactions and improve the efficacy of the strategies of the management of the pandemic necessitated the adoption of the digital solutions; which mainly consisted of the mobile app solutions and the website technologies to support the strategies implemented to the population.

**Keywords:** ***efficacy, contact tracing, screening, quarantine, isolation, test-trace-isolate-quarantine (TTIQ), COVID-19 pandemic, and the environment.***

## Introduction

## Background and Literature

### COVID-19 pandemic

Individuals affected by the pandemic experience different forms of moderate to mild respiratory issues, while others can recover without the application of any special treatment (Yang *et al.*, 2020). However, in some cases, treatment is necessary, particularly among the elderly and people who have pre-existing conditions, such as respiratory diseases and cardiovascular diseases among other related issues (Ciotti *et al.*, 2020; Gu *et al.*, 2020). Whereas some people survive the pandemic, others die due to both the inability of their bodies to survive the attack and the lack of appropriate medical attention (Shi *et al.*, 2020). Indeed, the virus has been declared a global pandemic, given the need for taking urgent measures by different nations to contain the virus and save the lives of citizens. The declaration is also attributed to the negative impacts of the pandemic on trade in different countries (Fauci *et al.*, 2020; Elibol, 2021). In other words, the need to adopt the best measures for the protection and reduction of infection cases has made different countries embrace systems to restrict the movement of people and goods from and out of their respective regions (Alimohamadi *et al.*, 2020).

Generally, COVID-19 is a virus associated with symptoms that range from a small respiratory tract infection that goes away on its own to a serious progressive pneumonia that kills and damages many organs (Wang *et al.*, 2020; Andrews *et al.*, 2021). However, the symptoms vary from one individual to another depending on factors such as age, health status, and the presence of underlying medical conditions. According to Zandi *et al.* (2020), more than 80% of COVID-19 cases have no symptoms while 15% of cases have mild symptoms such as fever, cough, fatigue, and a loss of taste and smell. Moreover, when a serious illness makes intensive care necessary, massive alveolar damage and breathing problems may kill the patient (Cunningham *et al.*, 2020; Yuki *et al.*, 2020).

Consequently, normal day-to-day activities in companies and general trade have been negatively affected following the need to restrict physical interaction in the general movement of people and goods from one place to another.

**Transmission of COVID-19**

The transmission of the virus is mainly attributed to the movement of body liquids from the mouth or nose of an infected person via coughing, breathing, and sneezing, among other related aspects. Also, the virus is often spread through direct and indirect contact (Quer *et al.*, 2021; Savtale *et al.*, 2022). The occurrence of the virus and its mode of transmission affect the traditional operations and interactions of people in different contexts (Parra *et al.*, 2020). For example, sharing certain elements like public vehicles as well as social gatherings are affected because they include the physical interaction of different people in the given setup. Many person-to-person transmissions happen when two people are close to each other and exchange droplets (e.g., when they talk, cough, or sneeze). Furthermore, indirect transmission can happen when a person touches an object or a surface that is contaminated before they touch their faces (Lythgoe and Middleton, 2020; Parra *et al.*, 2020). As a result, the physical interaction of people is restricted because of its potential to contribute towards the spread of the virus. Similarly, the movement of goods from one place to another is also restricted as it contributes to the movement of infection cases (Shi *et al.*, 2020; Ayoubkhani and Pawelek, 2021). Therefore, emphasis is placed on the appropriate measures that reduce the spread of the virus from the nose or mouth of one individual to another by reviewing all possible channels.

**COVID-19 containment measures**

Several containment and mitigation methods have been used to deal with COVID-19 (Marini and Gattinoni, 2020; Rudroff *et al.*, 2020). Notably, elderly people and individuals with existing medical conditions are perceived to have low immunity, thus, they are more vulnerable to the virus attack (Quer *et al.*, 2021). In addition to protecting vulnerable people from infection, there are programs that seek to slow down the arrival of new patients to hospitals. Many strategies for the prevention, management, and containment of COVID-19 pandemic are based on national risk assessments that predict the number of patients who will need admission to hospitals as well as of the beds and ventilators available there (alca-Utku *et al.*, 2020; Gautier and Ravussin, 2020). Some of these strategies include keeping a social distance of one meter apart from one person to another to avoid the risk of getting the virus (Haynes *et al.*, 2020; Lovato *et al.*, 2020). Indeed, social distancing is perceived to have a great impact on reducing the possible movement of the virus from the infected individual's mouth or nose to others (Nehme *et al.*, 2021). Similarly, protection is enhanced through the proper wearing of masks that cover the mouth and the nose (Carfì *et al.*, 2020; Yang *et al.*, 2020). However, the types of masks must meet the expected conditions for preventing the movement of the virus (Yang *et al.*, 2020). Furthermore, recommendations for maintaining hygiene practices are made, such as washing hands frequently and sanitisation using alcohol-based sanitisers to operate with possible infections (Shi *et al.*, 2020). Other implemented measures include vaccination, quarantine, covering mouth and nose when coughing, and avoiding the touching of face with dirty hands (Zarei *et al.*, 2022; Weng *et al.*, 2021; Hao *et al.*, 2020). Interestingly, many of these prevention and treatment approaches are implemented at the same time to achieve a maximum effectiveness in the management of the COVID-19 pandemic.

**Test-trace-isolate-quarantine (TTIQ) measures for COVID-19**

According to Ashcroft *et al.* (2022), COVID-19 pandemic is mainly managed through the TTIQ procedure that stresses the identification of the affected individuals in the effective process of containing the virus. Yet, measuring the outcomes of applying the approaches is influenced by the transmission dynamics and its general level which occurs without symptoms (Conway *et al.*, 2022; Williams *et al.*, 2020). To enhance their effectiveness, the approaches have guided healthcare providers in embracing a standard system for managing the virus and reducing cases of infection approaches during the situation (Oh *et al.*, 2021). However, studies by Ashcroft *et al.* (2022) and Conway *et al.* (2022) criticise the TTIQ approach and argue that isolation and contact tracing steps do not deliver effectiveness alone, where specific cases of the outbreak are traced and quarantined. Therefore, the steps defined in the approach are combined to improve the effectiveness of the management of the pandemic.

According to Williams *et al.* (2021), the TTIQ provides an alternative approach to non-pharmaceutical intervention in reducing transmissions. In addition, other approaches, such as contact tracing and isolation, have encouraged efforts to reduce the spread of the virus by guiding the measurement and decision-making (Samuel *et al.*, 2022). This is manifest in institutions that necessitate the physical interaction of people in their operation. The outcome of the application also guides stakeholders to improve certain strategies such as promoting school closures, adopting community testing, enforcing physical distancing and other related aspects (MacIntyre, 2020). However, unlike the study by Williams *et al.* (2021), Samuel *et al.*'s study (2022) states that contact tracing approaches could have been improved if a digital solution is embraced in the exercise. In other words, technology plays a critical role in automating manual processes and improving accuracy, the thing that results in better outcomes in the achievement of a given task. Consequently, there is a room for improvement in the initial approaches utilised in the containment of the virus.

Contact tracing does not emphasise individual-level variations which could have been an important factor, especially in determining the sovereignty level and controlling the general control of the virus (Mbwogge, 2021; McPherson *et al.*, 2021). The findings of Samuel and Lucivero (2021) indicate that the effective outcome of the TTIQ strategy is based on its ability to improve hygiene and social distancing, among other related best practices, to suppress the transmission of virus. From another perspective, Feng *et al.* (2020) argue that the implementation of the TTIQ has guided the creation of mathematical models of the disease and the probability of detecting and isolating infected cases at the onset. Both McPherson *et al.* (2021) and Mbwogge (2021) agree that medical practitioners and decision-makers have relied on the outcome of TTIQ for delivering timely improvements in the execution of containment strategies. Therefore, the proper implementation of the TTIQ is important because of its impacts on the effectiveness of the decisions made by stakeholders who are involved in the management and containment of COVID-19 pandemic.

**Problem Statement**

According to Fauci *et al.* (2020), the pandemic has happened unexpectedly, and this has created challenges in the general management and mitigation of the virus. As a result, the different approaches involved in its management are hurriedly adopted, given the urgency of the matter (Daniel, 2020; Bauchner and Fontanarosa, 2020). Therefore, there exists a research problem about the need to review different key activities or practices for COVID-19 mitigation, such as contact tracing, quarantine, screening, isolation, and other related activities that have been practised worldwide in the management and control of the virus. These practices should be

reviewed to determine their effectiveness in improving the general outcome in the management of the pandemic.

**Research Aim and Objectives**

The study aims at assessing the efficacy of COVID-19 mitigation strategies on incidence. The goal can be achieved through the following objectives:

i. To establish the efficacy of contact tracing, screening, isolation, and quarantine work in the containment of the COVID-19 virus.
ii. To determine the role of the environment in the efficacy of contact tracing, screening, quarantine, and isolation.
iii. To recommend the best practices in the application of contact tracing, screening, quarantine, and isolation in the management of the virus outbreak.

**Research Questions**

i. How can contact tracing, screening, isolation, and quarantine practices for COVID-19 virus containment be improved for effective application?
ii. What aspects of contact tracing, screening, isolation, and quarantine are affected by the environment in the process of managing the virus?

In terms of the research hypothesis tested in this study, it includes:

**H:** Contact tracing, screening, isolation, and quarantine practices for the COVID-19 virus containment are effective.

**Rationale**

COVID-19 pandemic has become a notable health issue worldwide, especially as it lacks a proven treatment medication (Cao, 2020). For this reason, academics and policymakers have paid a lot of attention to how COVID-19 pandemic has affected the environment, and, hence, how people and nature work together (Mathieu *et al.*, 2021). Moreover, a thorough understanding of how community mitigation techniques affect the environment would help to prevent a public health disaster in the future. The results of the present research are important because they increase knowledge about the efficacy and the importance of the recently implemented COVID-19 management practices. Notably, the virus is still affecting thousands of people worldwide; therefore, it is necessary to review the efficacy of different strategies that are applied. As a result, the guidance of the study will help decision-makers and researchers to improve the current strategies used for the mitigation of the COVID-19 pandemic.

## Methods

**Overview**

The chapter discusses the selected methodology to highlight the different approaches and strategies employed in the collection, analysis, and interpretation of data to arrive at the study results. Some of the key elements discussed in this chapter include the method, strategy data analysis, and ethical considerations. Therefore, the chapter plays a critical role in

**Protocol and Registration**

As mentioned earlier, the present study employs a systematic review to examine the chosen research problem. As Stevanin *et al.* (2018) argue, automatic reviews entail a process of summarising different evidence as related to the research problem to achieve a comprehensive explanation of the study findings. However, the study by Karabulut-Ilgu, Jaramillo Cherrez, and Jahren (2018) shows that the available evidence must be utilised effectively, especially in the stages of selection and synthesis, to ensure that the outcome is reliable, repeatable, and formal for effectiveness. Similarly, the type of evidence for synthesis in addressing the research problem must be relevant to the topic to guarantee its effectiveness. In the present research, the systematic reviews are critical and appropriate for use in establishing the efficacy of COVID-19 mitigation strategies on incidence, as will be argued later.

With the associated characteristics of the narrow scope, systematic reviews are important as they enhance thoroughness, limit any possible bias, and increase the chances of replicating the results. This suggests that systematic reviews can deliver robust outcomes for the study. The main steps adopted in the implementation of the systematic literature review include question framing, searching, and identifying the article for use, appraisal of the study, creating summaries of evidence and interpretation based on specific research questions.

**Eligibility Criteria, Information Sources and Search Strategy**

The accuracy of the articles retrieved for use in the study is enhanced through a combination of different concepts that directly relate to the current research. The seven generic guidelines are employed in the definition process of the assignment, location establishment, choice of search words, the evaluation process, and the method, all of which function as key guidelines to achieve the required decisions. The articles for use in the study are accessed and searched through different databases, such as science direct, EBSCO and Plos One, JSTOR. More importantly, the researcher broadens the scope of the (re)search by utilising multiple databases for effectiveness. Some of the keywords utilised in the search process include the efficacy of COVID-19, mitigation strategies, and TTIQ for COVID-19. In addition, the development of the keywords is established from the research questions and objectives to address the study problem adequately for better results. Besides, the study achieves more focused results by utilising the Boolean operators, particularly AND, NOT and OR, and this has helped in the exclusion and combination of different keywords for better results. It also applies inclusion and exclusion criteria in the study selection to establish the specific articles used in the analysis process.

**Study Selection**

**Inclusion criteria**

The results are developed from peer-reviewed journals. According to Eloranta and Turunen (2015), the utilisation of peer-reviewed journals is important and reliable because their findings are trusted; hence, they help the study to deliver a credible outcome. The study utilises articles published between the years 2020 and 2022 to ensure that outdated sources are not included in the development of the research findings. Moreover, to reduce the need for additional time for the interpretation of the article, the study utilises sources that are published in English for effectiveness.

**Exclusion criteria**

The study does not include articles that use systematic literature reviews because of the associated perceived possibility of bias. As May *et al.* (2016) argue, poor research design and the execution process usually contribute to the possibility of bias while they develop systematic review articles. The study also excludes articles that do not allow full access to their content because of the limitation to evaluate the suitability of the methodology in the development of reliable results. In addition, it excludes articles whose concepts do not relate directly to the research problem as guided by the study questions. The study, therefore, utilises the following PRISMA flowchart to establish proper articles for synthesis (**Figure 1**).

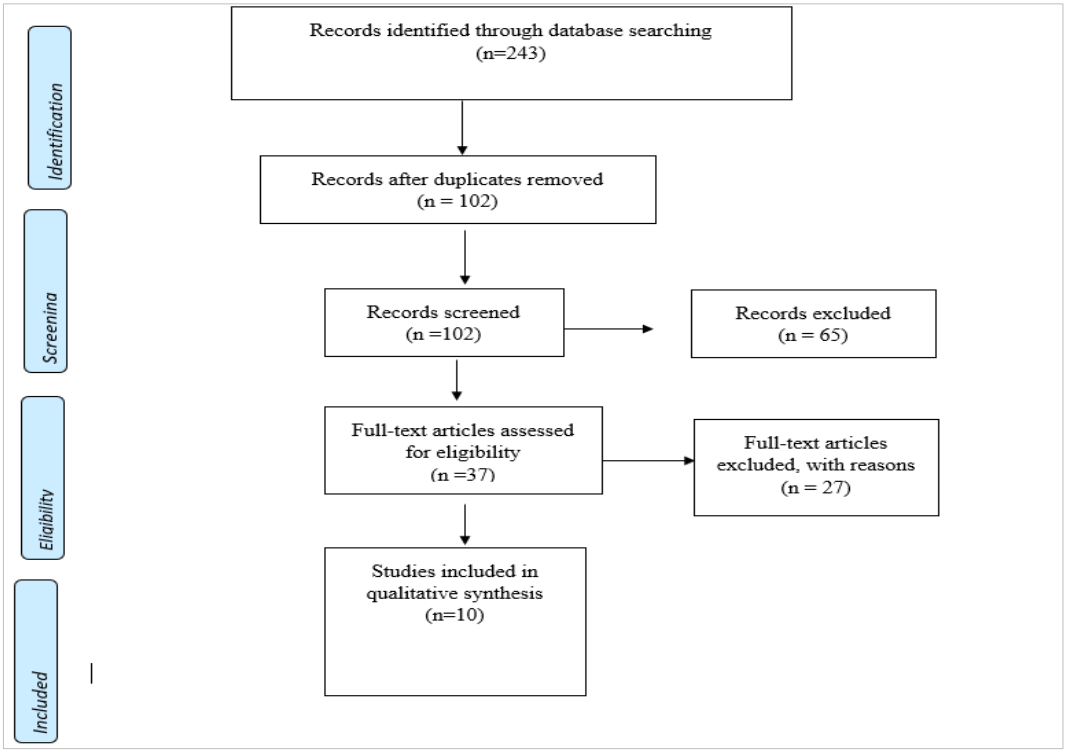


**Figure 1: PRISMA Flowchart**

**Data Items, Risks, Summary and Data Synthesis**

Data synthesis is involved in the process of breaking down the study to extract meaningful information towards the development of the findings of the study. The research by Hasan *et al.* (2021) indicates that synthesis in systematic literature reviews could be done by the integration of different findings as guidelines towards drawing conclusions. The selected articles are analysed with the help of a statistical method. The analysis helps to develop meaningful findings to guide the establishment of the underlying patterns and trends towards drawing the conclusion. In the process, the relationship of the variables is determined, thereby contributing towards answering the research questions of the study.

**Quality Synthesis**

According to Braun and Clarke (2019), quality synthesis activities are vital in the development of systematic reviews. This is because they guide the researcher in making a differentiation between the relevant and irrelevant articles for use within the study. The present research achieves quality synthesis via using a CASP checklist (see Appendix 2). Thus, the approach allows the researcher to evaluate the validity and suitability of the results in different articles that reiterate, and are related to, the current research aim and objectives.

**Ethical Consideration**

According to Remington (2020), the utilisation of secondary data is a practice of ethics in research. Examples of key ethical standards considered in this research include integrity, research procedures, replicability of data, and the level of transparency involved throughout the process. Furthermore, throughout the study, the authors of different selected sources are acknowledged in the content for effectiveness.

## Results

**Study Selection**

A total of 243 studies are returned following the search on the databases. Furthermore, 102 records have been removed because they are duplicates. From the remaining studies, 65 articles are removed because of reasons such as systematic reviews and article published before 2020. Additionally, 27 articles are removed due to many reasons such as limited access to the full content of the article, articles published in non-English languages, and articles not relevant to the research questions and objectives. Overall, 10 articles are identified and used to arrive at the results (see Appendix 1).

**Study Characteristics**

The study by James *et al.* (2021) uses the quantitative method to examine the successful contact tracing systems for patients diagnosed with COVID-19 virus for effective isolation and quarantine. The time for tracing individuals ranges from zero to 6 days. As for the cases traced or detected before 6 days, they have been put into isolation and quarantine. The database used is New Zealand EpiSurv dataset that is centrally managed by Environmental Science and Research. The study includes 101 probable and confirmed cases with COVID-19 symptom onset date. Individuals with recent international travel history are excluded. The follow-up period for individuals is 4 days. In their study, Iqbal and Chaudhuri (2020) use the cross-sectional questionnaire to explore the perceptions of professionals regarding the current management strategy for COVID-19 patients in the UK. The data collection process takes place within 2 weeks. A total of 1007 responses have been obtained, whereby 670 responses are given by doctors and 204 nurses. Panovska-Griffiths *et al.* (2020) also utilise the quantitative method to explore the impacts of test and trace interventions as well as the risk of occurrence of second-wave COVID-19 in the UK.

Moreover, individual contact networks are stratified into school, household, community layers, and workplaces to explore their effectiveness in preventing the occurrence of the second wave of COVID-19 pandemic. Indeed, the statistical technique used by Panovska-Griffiths *et al.* (2020) helps to analyse the collected data and determine the effectiveness of contact tracing and testing. From another perspective, Young *et al.* (2021) use the quantitative method to explore the efficacy of daily testing of people in controlling the spread of the COVID-19 virus. In other words, cluster-randomised, open-label, and controlled trials have been conducted in secondary schools and education colleges across England to control the transmission of the virus. Overall, 5763 intervention group contacts

from the targeted schools have participated in the daily contact testing process, whereby the follow-up period is identified as 10 days. The study by Gilbody *et al.* (2021) uses a pilot randomised controlled trial to explore ways to minimise vulnerabilities to social isolation among COVID-19 patients. Besides, the follow-up is made for the traced patients using the digital apps, where appropriate intervention is administered. Participants aged 65 years are selected, whereby 47 participants are offered the intervention and 49 ones are identified as control participants (Gilbody *et al.*, 2021). Furthermore, Smith *et al.* (2021) use cross-sectional online surveys to investigate the rates of adherence to the UK's trace, test, and isolate system during the COVID-19 pandemic. Overall, 37 representative surveys are conducted in the UK. More specifically, 74,699 responses aged 16 years and above have completed the survey (Smith *et al.*, 2021).

Paris Harper-Hardy *et al.* (2022), they examine the effectiveness of contact tracing programs and practice among COVID-19 patients. Short surveys are distributed to territorial health agencies and senior deputies in the United States. Padidar *et al.* (2021) use an online survey to explore challenges and compliance with social and public health prevention measures during the COVID-19 pandemic in the Kingdom of Eswatini. That is, the population of 542,400 individuals are targeted to fill 28 closed-ended questions administered through a survey. As for Dowthwaite *et al.* (2021), they use a quantitative online survey to explore public adoption and trust in the NHS COVID-19 contact tracing application in the UK. A total of 1001 individuals have filled out the online survey that is analysed through the statistical method. By using quantitative research methods, Perez Vallejos (2021) explore the patients' attitudes and the adoption of NHS COVID-19 digital contact tracing and smartphone apps in the UK. The online survey is thus administered, and statistical analyses are conducted to determine the efficacy of digital tracing apps in preventing the spread of the pandemic.

## Synthesis of the Results

TTIQ is one of the key procedures that are utilised as a guiding framework for medical practitioners in the identification and containment of COVID-19 infection cases. Dowthwaite *et al.* (2021) and Perez Vallejos (2021) argue that over 50% of the participants comply with digital app contact tracing. Also, Iqbal and Chaudhuri (2020) indicate that the approach of the breast is a measure to reduce the infection rate in the world by delivering a structured system for the management of the virus. In particular, 94% of the participants agree that testing all the NHS frontline staff greatly helps in preventing the spread of the virus. This implies that the main aim of contact tracing and testing is to reduce the infection rate and to make direct and indirect impacts to reduce the death rate caused by the pandemic.

According to Panovska-Griffiths *et al.* (2020), 75% of the symptomatic infection could be tested and isolated by means of using contact tracing. Notably, the TTIQ is implemented with the integration of other approaches, such as the emphasis on social distancing with annotation and vaccination among other ones. The study by James *et al.* (2021) establishes that tracing 50% of contacts with 100% isolation and quarantine is indeed effective in preventing the spread of COVID-19 virus. Some aspects of the TTIQ strategy, such as quarantine, are also enhanced through other necessary practices such as total lockdown to significantly reduce the movement of people and goods from one place to another, as argued previously. These aspects and practices are meant to lower the infection rate.

More importantly, the integration of TTIQ with other containment measures and general best practices has helped in enhancing effectiveness in the general efforts to manage the pandemic. Smith *et al.* (2021) note that the intention among people to share close contact is 79.1%, which represents a 95% confidence interval. The approach is significantly useful in the rapid identification of COVID-19 cases. This is because it delivers a suitable platform for the administration of the interventions. To achieve better results, the processes are integrated with contact tracing which guides the administration of testing practices to potential infections. This in turn helps in determining which ones should undergo quarantine practices. Thus, TTIQ contributes to the reduction of the reproduction number by providing a suitable system for collaboration. The latter takes place between the national leadership and healthcare practitioners in the implementation of suitable measures and adoption of the decisions that reduce the impact of the virus.

Therefore, it is possible to argue that TTIQ plays a great role in combatting the COVID-19 virus, both in the UK and the rest of the world. As Paris Harper-Hardy *et al.* (2022) and Young *et al.* (2021) put it, the TTIQ model is effective in curbing the rapid spread of the COVID-19 pandemic globally. However, the same studies identify some weaknesses within the TTIQ which comprises the successful control of the pandemic spread. For instance, the authors state that the TTIQ has its limitations in terms of the testing capacity of the contacts, given that it cannot be implemented across a larger population at once. In line with these findings, Gilbody *et al.* (2021), Padidar *et al.* (2021), and Dowthwaite *et al.* (2021) suggest that the testing capacity for the COVID-19 contacts is limited. That is, it does not meet the targets, thereby making the process insufficient in controlling the pandemic. However, the approach delivers a platform solution to the medical practitioners to help in the timely establishment of people who are infected by the virus while tracking their movement and establishing the possible infections. This contributes to positive outcomes in the efforts to control the general pandemic.

The impact of environmental factors on compliance is also examined in six studies which show a positive influence. Here, the analysis of three studies is contrasted, and the findings of the analysis are summarised in Table 1 below.

**Table 1 The effects of environmental factors on compliance to quarantine and isolation**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Influence | 6 | 66.7 | 66.7 | 66.7 |
| | Lack influence | 3 | 33.3 | 33.3 | 100.0 |
| | Total | 9 | 100.0 | 100.0 | |

The regression analysis regarding the efficacy of COVID-19 mitigation strategies is presented in the table below as follows.

**Table 2 Regression analysis**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.153 | 1 | .631 | 1.553 | .000 |
| | Residual | 30.047 | 6 | .406 | | |
| | Total | 33.200 | 3 | | | |

The regression analysis is used to test the hypothesis H, namely Contact tracing, screening, isolation, and quarantine practices for the COVID-19 virus containment are effective. In this case, Sig. 000 confirms that COVID-19 containment strategies are effective, thereby confirming the hypothesis.

## Discussion

This study assesses the efficacy of COVID-19 mitigation strategies on incidences experienced across different regions worldwide. In the first aspect, the study examines the efficacy of contact tracing, screening, isolation, and quarantine work in the containment of the COVID-19 pandemic (see Table 2). The study results show that COVID-19 containment measures, such as isolation, quarantine, contact tracing and screening, are effective in preventing the spread of the virus (Iqbal and Chaudhuri, 2020; Panovska-Griffiths *et al.*, 2020; James *et al.*, 2021). Interestingly, the findings are consistent with the studies of Fauci *et al.* (2020), Elibol (2021), Haynes *et al.* (2020), and Lovato *et al.* (2020), where they argue that the TTIQ strategy, together with other measures such as lockdown, plays a significant role in containing the spread of the COVID-19 virus among people. Proposed interventions such as lockdowns directly relate to the environmental aspect in influencing the spread of the virus. This aspect is crucial as it addresses the research objective concerning the role of the environment in the efficacy of contact tracing, screening, isolation, and quarantine. Notably, the main environmental factors that shape the tracing, screening and quarantine processes include the physical design of the specific spaces where measures are rolled out, the socio-cultural norms that prevail within the community, etc.

Although the current study provides insignificant focus on the environmental dimensions, Ashcroft *et al.* (2022) and Conway *et al.* (2022) argue that the physical layout of the workplace or community influences the overall efficacy of the containment processes and the efforts to trace contacts and curb the spread of the pandemic. For example, if the community or workplace is overly populated, the implementation of the screening, tracing, quarantine and isolation processes may be difficult due to ineffectiveness and inaccuracy in tracing and tracking contacts infected by the disease. Therefore, the study implies that the physical design of the locality could determine the level of interactions and contacts between people, thus influencing the success of the overall tracing, screening, and tracking of the contacts.

In the fight against the spread of the COVID-19 pandemic, the TTIQ strategy has been limited because it involves more isolation and quarantine logistics that could frustrate the already depleted health departments (Young *et al.*, 2021; Smith *et al.*, 2021; Paris Harper-Hardy *et al.*, 2022). Besides, the implementation of the quarantine and isolation process is challenging. This is manifest in situations where many people come in contact with infected patients; still, the available resources are insufficient to handle the pressure (see Table 2). The pandemic has also led to the contraction of economies worldwide. This has depleted resources directed at controlling the spread through the TTIQ interventions and their limitations as well as demanded for more resources that affect the healthcare environment (Smith *et al.*, 2021; Iqbal and Chaudhuri, 2020). Contrarily, Conway *et al.* (2022) and Williams *et al.* (2020) state that the complexity of public compliance affects the efficacy of COVID-19 prevention measures. The lack of adequate public compliance has increased the difficulties in controlling the spread of the pandemic. In this context, the findings demonstrate that the successful implementation of TTIQ relies on the cooperation of the general public to uphold laid down proposals and measures such as self-isolation and quarantine. Because of these challenges, the study implies that physical designs are an environmental factor that influences the success of the COVID-19 restrictions based on the location of the community or workplace and the level of population and density (**Table 1**). Therefore, the physical design of the environment, where the screening, tracing, quarantine, and isolation of contacts take place, is evaluated to enhance the success of the measures in containing the pandemic. To reiterate the findings by Quer *et al.* (2021), Savtale *et al.* (2022), Gilbody *et al.* (2021), and Padidar *et al.* (2021) argue that while urban localities are complex environments due to the physical design of the location, the rural areas tend to be less populated. This creates an opportunity for health stakeholders to successfully implement the screening, tracing, and tracking processes. Therefore, the efficacy of the contact, tracing, quarantine, and isolation measures for the COVID-19 pandemic is subject to the environment in which they are implemented. The environment within a given health context impacts the success of containment measures due to the interaction of other processes. Environmental factors thus play a significant role in the success of the implementation of screening, tracing, quarantine, and isolation processes.

With the economic impact of the pandemic, the implementation of the TTIQ interventions further worsens the financial status of the people, thus affecting their livelihoods. The study results show that noncompliance to the TTIQ measures, quarantine, and isolation logistics as well as the economic impact of the pandemic affect the success of controlling the spread of the pandemic across the populations and its incidence (Dowthwaite *et al.*, 2021; Perez Vallejos, 2021). This analysis hence addresses the objective of the best practices in the application of TTIQ in the management of the COVID-19 outbreak. As for cultural and social norms within the specific environment, they enhance the success of TTIQ activities (see Table 1). In communities or workplaces that embrace strong interactions and traditions of social connections, the implementation of contact tracing, quarantine and isolation is mostly unsuccessful due to the difficulty in separating the people. Notably, the behaviour, nature, and other related characteristics of social interactions of people within various communities all affect the success of TTIQ. Similar to these findings, Mbwogge (2021), McPherson *et al.* (2021), and Samuel *et al.* (2022) demonstrate that in closely interlinked societies, workplaces and organisations, people often tend to be less compliant with COVID-19 restrictions. This makes healthcare recommendations of contact screening, tracing and quarantine less effective. Indeed, the successful screening, tracing, and quarantine of contacts is witnessed in workplaces and communities that usually embrace individualism and promote personal responsibility. Many countries with authoritarian leadership and strong cultural norms within the Middle East and Asia are successful in operating contact tracing, screening, and isolation due to a favourable environment guided by existing cultural and social practices and norms. In contrary to the current findings, Zarei *et al.* (2022) and Weng *et al.* (2021) point out that the limited testing capacity in many countries is a major challenge, especially in cases where the demand for testing is enormous and exceeds the existing resources such as manpower and testing kits. When people strictly adhere to set measures and restrictions, they are likely to comply with the existing isolation, quarantine and contact tracing interventions during the pandemic.

Furthermore, the effectiveness of the contact tracing, screening, quarantine, and isolation interventions is shaped by the existing cultural and social norms within a given environment. This determines the type of behaviour embraced by people and how they respond to the occurrence of threats such as the pandemic (James *et al.*, 2021; Young *et al.*, 2021). Accordingly, the environmental

factors of social and cultural norms and the physical layout and design of the community or workplace all have direct influences on the success rate of contact tracing, screening, quarantine and isolation process and on the COVID-19 incidence (**Table 1 & 2**). Similarly, Cunningham *et al.* (2020) and Yuki et state that the effectiveness of testing and tracing also affects the fight against the spread of COVID-19 to a certain extent, given that it consumes more time than expected. Despite being time-consuming, TTIQ processes are considered resource intensive, with a high demand for highly-trained medical professionals. As for the identification of contacts and infected people, it is described as stressful and complex, thus harbouring the overall mitigation strategy for the COVID-19 pandemic. In terms of the efficiency of testing and tracing, it requires improved monitoring and resource allocation to yield more positive outcomes. Therefore, the implementation of the TTIQ model is subject to many challenges, especially within the testing and tracing of the people who have come in contact with infected persons, thus affecting the efficiency of interventions to control the spread of the pandemic.

The research hypothesis tested is as follows: Contact tracing, screening, isolation, and quarantine practices for COVID-19 virus containment are effective. The hypothesis is supported by different useful studies and is strongly supported by the data obtained. Therefore, the hypothesis does not need revising or totally changing because it is supported by the data collected.

## Limitations

The findings of this research are based on the synthesis of 10 articles that are accessed from the databases. From this perspective, one can rely on a few articles to make the findings affect the generalisability of the results across different countries. The studies used in the synthesis provide insufficient information about the measures adopted to encourage the use of quarantine, contact tracing, and isolation. There is also a limited focus on the interventions adopted to address the weaknesses associated with contact tracing apps, such as the NHS apps, particularly the privacy and security challenges. These are the potential areas that need to be addressed by future scholars.

## Conclusion

The study aims to assess the efficacy of COVID-19 mitigation strategies on incidence. The first objective seeks to establish the efficacy of contact tracing, screening, isolation, and quarantine work in the containment of the pandemic. The study confirms that the COVID-19 pandemic significantly affects the normal operations of people across different parts of the world. Also, the management of the virus entails both pharmaceutical and non-pharmaceutical approaches for its containment. The study findings argue that the TTIQ offers a leadership framework which helps practitioners in the healthcare industry to manage the virus by embracing the best practices necessary for reducing the spread of the virus from one person another as well as for controlling the virus flow. The method helps in guiding practitioners towards achieving a reduction in the number of cases affected by the virus. Accordingly, the effective application of the approach contributes to the rapid identification of the cases. It also helps practitioners in the application of the desirable interventions to arrive at better outcomes to contain the virus and protect the population. The research states that COVID-19 pandemic is a new condition that has not been previously experienced by health practitioners. Hence, the development of collective efforts to develop the TTIQ framework is crucial in the general management to reduce its transmission from one region to another. However, the TTIQ strategy requires additional pharmaceutical interventions to improve its effectiveness in handling the virus. Consequently, the TTIQ procedure is applied during the peak of the pandemic and has also been applied in the present time whenever the situation happens.

The second objective focuses on determining the role of the environment in the efficacy of contact tracing, screening, quarantine, and isolation. The research findings show that the environment plays a critical role in the effectiveness of TTIQ. Generally, some procedures, such as isolation, are handled at different places that are identified and prepared for the management of the virus. As a result, the specific characteristics of the environment, such as social halls, churches, schools, clinics, and hospitals, significantly affect the effective management and efforts to reduce the spread of the virus from one person to another in a given population setup. To improve the outcome, there is an emphasis on fumigation and other related best practices that are perceived to have a positive impact on reducing the flow of the virus in the given region. Similarly, the presence of medical practitioners in the given isolation sentence is important towards achieving better outcomes. Other elements used by digital solutions, including mobile applications, have also contributed towards the betterment of the general effort to apply TTIQ in the management of COVID-19 pandemic. Consequently, it is important to improve the TTIQ approach because of its relevance in the management of the virus, given the presence of many cases that require attention worldwide.

## Implications of the Study

The study has an implication for the policymakers involved in the management of the COVID-19 pandemic. The outcome can be applied to improve the general outcome and the effectiveness in handling the virus, especially in the application of the recommended intervention of TTIQ. The research unveils the strength associated with the practice and recommends its application in the possibility of reducing the number of infections and the general spread of the virus from one place to another. The information from the study can be applied in different contexts, especially in present and future efforts to contain the virus or in similar situations. However, the study establishes the best practices that can be incorporated into TTIQ and the other related interventions for containing the virus to improve the effectiveness in reducing the number of infection cases. As a result, the findings of the study can be utilised to improve the specific aspects of TTIQ, such as the application of digital solutions in improving contact tracing and other related elements. Similarly, the study confirms the role of environment in the outcome and the efficacy of TTIQ, thus, delivering a link or a guidance to proper strategies to promote environmental well-being, especially in terms of the surrounding characteristics and the creation of a supportive environment when applying the TTIQ practice.

## Recommendations

Future researchers should focus on the improvement of the preparedness of TTIQ in handling future healthcare-related pandemics. The studies should investigate the interventional frameworks to improve their applicability to different cases that may happen in the future. In the process, the outcome of future studies will contribute to the enhancement of the effectiveness of the lessons from the COVID-19 pandemic to related cases that may happen unexpectedly in future. Besides, the stakeholders, including the healthcare operators, the government, and other related parties, should focus on utilising the information from the current research to improve interventions for containing the virus. Consequently, the effective utilisation of knowledge and general application by the

stakeholder is likely to help in reducing present and future cases of COVID-19 virus and other related pandemic cases that may occur in future.

## Declarations

## Ethics approval and consent to participate

Not applicable. This study is based on previously published data and did not involve human participants or animal subjects.

## List of abbreviations

**TTIQ:** Test-trace-isolate-quarantine
**COVID-19**: Coronavirus disease 2019
**PRISMA**: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
**DF**: Degrees of freedom

## Data Availability

All data used in this study are derived from publicly available sources, which are cited in the references.

## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

## Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## Authors' contributions

JA conceptualized the study, conducted the analysis, and wrote the manuscript. SA contributed to the editing and critical review. MA assisted with administrative and institutional coordination. All authors read and approved the final manuscript.

## Acknowledgments

None

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