A SYSTEMATIC REVIEW OF ECONOMIC EVALUATION STUDIES REGARDING COVID-19

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ABSTRACT

The pandemic brought many uncertainties about both the disease itself and the health system. Due to the high rate of transmission, the Covid-19 pandemic has caused individuals to experience problems in accessing health services not only for Covid-19 but also for other diseases wether chronic or acute. In the stages of struggling with the pandemic, conducting economic evaluation studies on Covid-19 was seen as important, taking into account the uncertainties and access issues encountered, in order to guide decision makers for rational decision-making and to use resources effectively and efficiently. This study aims systematically review the economic evaluation studies for the diagnosis, treatment, and control of Covid-19 disease. PubMed, Scopus, Web of Science and ULAKBİM databases were searched from December 2019 to July 2021 to identify the literature on economic evaluation studies related to Covid-19. As a result of the systematic search, 362 articles were identified as a result of the search made in the relevant databases. After the repetitive entries were removed, title and abstract scanning were performed, and 22 publications that met the inclusion criteria were examined within the scope of the study. It was observed that 68.18% of the studies were published in 2021 and 31.81% in 2020. 81.8% of the published studies have been conducted with cost-effectiveness, 9.09% with cost-benefit, and 4.54% with cost minimization and cost-utility analysis. The majority of the countries where the studies were conducted were in high-income countries, in 2021 and cost-effectiveness analysis. The subject of these studies is mostly related to screening and diagnostic tests for Covid-19 disease. There wasn't any study detected conducted in Turkey on the subject. More research on this particular subject is required in the future.

Anahtar Kelimeler: *Covid-19, Coronavirus, systematic screening, economic evaluation.*

COVID-19 İLE İLGİLİ YAPILAN EKONOMİK DEĞERLENDİRME ÇALIŞMALARINA İLİŞKİN SİSTEMATİK İNCELEME

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ÖZ

Pandemi hem hastalığın kendisi hem de sağlık sistemi hakkında pek çok belirsizliği beraberinde getirmiştir. Covid-19 pandemisi, yüksek bulaşma hızı nedeniyle sadece Covid-19 için değil, kronik veya akut diğer hastalıklar için de bireylerin sağlık hizmetlerine erişimde sorun yaşamasına neden olmuştur. Pandemi ile mücadele aşamalarında, karar vericilerin akılcı karar almalarına rehberlik etmek ve kaynakları etkin ve verimli kullanmak amacıyla, yaşanan belirsizlikler ve erişim sorunları dikkate alınarak Covid-19 ile ilgili ekonomik değerlendirme çalışmalarının yapılması önemli görülmektedir. Bu çalışma, Covid-19 hastalığının tanı, tedavi ve kontrolüne yönelik ekonomik değerlendirme çalışmalarının sistematik olarak gözden geçirilmesini amaçlamaktadır. Covid-19 ile ilgili ekonomik değerlendirme çalışmalarına ilişkin literatürü belirlemek için 2019 Aralık ve 2021 Temmuz arasında PubMed, Scopus, Web of Science ve ULAKBİM veri tabanları taranmıştır. Yapılan sistematik tarama sonucunda İlgili veri tabanlarında yapılan tarama sonucunda 362 makale tespit edilmiştir. Tekrar eden kayıtlar kaldırıldıktan sonra başlık ve özet taraması yapılmış, dahil edilme kriterlerini karşılayan 22 yayın çalışma kapsamında incelenmiştir. Çalışmaların %68,18'inin 2021 yılında %31,81'inin 2020 yılında yayınlandığı görülmüştür. Yayınlanan çalışmaların %81,8'i maliyet etkililik, %9,09 maliyet fayda, %4,54'ü maliyet minimizasyon ve maliyet yararlanım analizidir. Çalışmaların yapıldığı ülkelerinin çoğunluğunun yüksek gelirli ülkelerde, 2021 yılında ve maliyet etkililik analizi olduğu görülmüştür. Bu çalışmaların konusunun çoğunlukla Covid-19 hastalığına yönelik tarama ve tanı testleri ile ilgilidir. Türkiye'den ise konuyla ilgili yapılmış herhangi bir çalışmaya rastlanmamıştır. Konuyla ilgili ilerleyen dönemlerde daha fazla araştırma yapılması gereklidir.

Anahtar Kelimeler: *Covid-19, Koronavirüs, sistematik tarama, ekonomik değerlendirme.*

I. INTRODUCTION

Covid-19 has been defined as a disease caused by a virus type whose agent was determined to be SARS-CoV-2 and was first detected in December 2019 (Ren et al., 2020). It has been announced that the total number of individuals caught in Covid-19, which has been declared a pandemic by WHO in March 2020, is over 530 million globally and the total number of deaths due to the virus is over 6 million as of 2022. According to the statistical reports prepared by considering the virus transmission data around the world, it is known that Türkiye is the 10th country with the highest number of cases (WHO, 2022a). For this reason, it is also important to examine the numbers specific to our country. As of the week of March 19-25, it was announced that the total number of cases in our country was 14,775,634 and the total number of deaths was 97,666 (Ministry of Health, 2022). The quantitative size of the groups affected by the virus has reached to unbelievable proportions, nearly 2 years after the disease began to spread globally and was declared a pandemic, and this brought 'Covid-19' to the top of the countries' agendas.

The source of the virus is still unknown, according to the latest epidemiological guide published by the Ministry of Health (Ministry of Health, 2020). However, it is thought that the evidence-based guideline needed in the management of the epidemic has been successfully created thanks to the studies on reducing the transmission rate of the disease, controlling its spread, detecting, and treating it. In this guideline, the most important and first step considered by the authorities, is the prevention of contamination (Turan and Hamza Çelikyay, 2020). In this step, it is aimed to break the infection chain of the disease, which is known to be transmitted by droplets (Ministry of Health, 2020). It has been stated that the most important point in breaking this chain is to take the source (sick individual) under control, and then to remove the healthy individual from the disease factor, since there is no cure discovered yet for the disease and for its fast-spread (Hayran and Sur, 2021; Turan and Hamza Çelikyay, 2020). Various quarantine and social distance strategies have been developed to achieve that goal. Although the strategy of quarantining the entire population by excluding some occupational groups such as physicians, nurses, health personnel, and security forces was implemented by many countries at first, this practice has left its place to lighter versions over time. Precautions such as isolation of the infected individuals and the individuals they have contacted with during the disease incubation period (2-14 days), the citizens in the risk group being in home quarantine, the closure of places where communities come together like schools, shopping malls, places of worship or limiting their activities, restrictions on domestic and international entry and exit have been taken (Ferguson et al., 2020; Turan and Hamza Çelikyay, 2020). Differently from individual mobility restrictions, vaccination studies to prevent disease transmission were initiated in the early period of the pandemic.

The first fully approved covid-19 vaccine has been developed with the partnership of Pfizer-Biontech and was made available as the first vaccine approved by the FDA in December 2020 (Yavuz, 2020). Apart from this, the vaccines that have been developed and made available for public use in various countries are as follows; Moderna, Sputnik, Sinovac, Astrazeneca-Oxford (Sookaromdee and Wiwanitkit, 2021). In the diagnosis phase of the disease, physicians' findings and radiological findings were used until diagnostic kits were developed, and over time, serological tests such as PCR test and ELISA and diagnostic tests-kits have started to be used (Temel et al., 2021). Individuals diagnosed with Covid positive might be asymptomatic cases as well as showing the symptoms of the disease. It is known that the symptoms of infection in symptomatic patients may vary depending on the person and be mild, moderate, and severe (Ministry of Health, 2020). While patients with mild symptoms can spend this period resting at home, the treatment processes of individuals with severe disease may require healthcare services in hospital intensive care units. It is also known that many drugs such as Remdesivir, Hydroxychloroquine, Ivermectin, Sotrovimab and Molmupiravir are being used in the treatment process of the disease (WHO, 2022b).

The fact that economies of the countries are directly and indirectly affected by various reasons such as the financial burden of the strict measures taken in the fight against the virus (e.g., quarantine at the national level, travel restrictions, mandatory routine testing for early diagnose), the increase in the expenses of the health sector etc. necessitates the economic evaluation of the strategies implemented

within the scope of epidemic management. In addition, while economic evaluation studies on sustainable service delivery in healthcare have always been seen as valuable sources, more studies seem needed on epidemic management which provides continuation of the services provided in times of crisis and successfully manages the crisis/outbreak (Doğan et al., 2019). Thanks to the reports obtained from the economic evaluations to be made, the outputs of the strategies for the country's economy can be observed, and also supply of healthcare resources which are getting harder day by day due to the epidemic can be made in a more evidence-based way (Briggs et al., 1994). Main methods used in economic evaluation studies as follows: Cost-Effectiveness Analysis, Cost Minimization Analysis, Cost-Benefit Analysis and Cost-Utility Analysis (Kobelt, 2013). These methods are based on comparison of the costs of two or more situations with the outcomes (Doğan et al., 2019). Cost-Utility is an economic evaluation method that takes into account not only quantitative but also quality aspects when comparing health interventions. In this method, the parameter that is compared with the costs is the improvement in the health status of the individuals which are measured by the quality-of-life adjusted years (QALY), disability life years (DALY) or healthy years equivalent (HYE) (Doğan et al., 2019; Kobelt, 2013). In the cost-benefit analysis, the costs, and the benefits such as the effects on the quality of life and life span that individuals have or will acquire are compared, but unlike the cost-utility analysis, the benefits obtained from the individuals are converted into monetary units. It is the determination of the net monetary benefit value of the health intervention after the necessary actions are taken on the two parameters, and the one with the highest value is determined as the method to be applied (Doğan et al., 2019; Shiell et al., 2002). Cost-effectiveness analysis is an economic evaluation method that focuses on obtaining maximum outcome with minimum cost. In this analysis, all parameters should remain in their natural form and should be evaluated as such (Shiell et al., 2002; Yalçın Balçık and Şahin, 2013). The cost-effectiveness method emerges as the most frequently used method in economic evaluation studies in healthcare (Doğan et al., 2019). Cost-Minimization method is seen in the literature as an extension of cost-effectiveness analysis (Kobelt, 2013). In this method, the outcomes to be obtained at the end of the intervention would be equal or considered equal (Shiell et al., 2002). The aim is to compare the costs of two or more interventions with equal outcomes to determine the least costly one. It is a relatively less preferred method since intervention situations with the same or nearly identical outcomes are rarely encountered in health services. However, it is a more common economic evaluation method in new intervention development studies to improve outcomes (Kobelt, 2013).

Managing the Covid-19 pandemic by newly developed interventions and strategies, and the undeniable magnitude of its economic effects have made economic evaluation studies in this specific field inevitable. Starting from that point, it is aimed to present a quick review of the studies in the literature on the management of the Covid-19 pandemic, in which the preventive, therapeutic and rehabilitative interventions are evaluated economically.
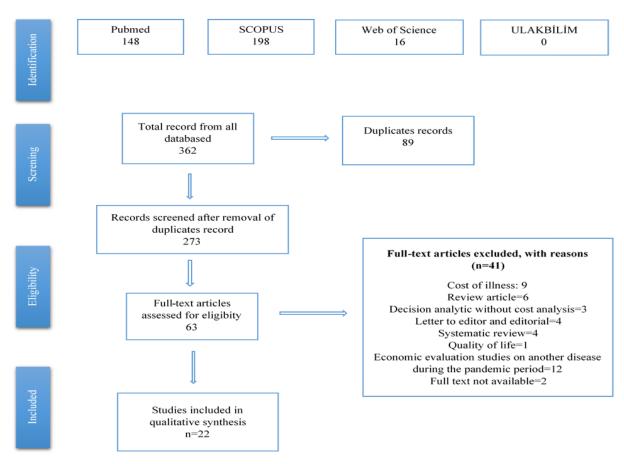
II. METHODOLOGY

Economic evaluation methods are significant tools for rational decision-making in health services and for the effective and efficient use of scarce resources. Due to the high rate of transmission, the Covid-19 pandemic has caused individuals to experience some problems in accessing health services related to a disease other than Covid-19 as well (Aközlü and Öztürk Şahin, 2021; Yıldız and Bulut, 2021). From the first day the Covid-19 disease was detected to nowadays, new diagnosis, treatment and controlling methods have been found, and it is expected that new methods will be developed thanks to the increasing experience and knowledge. It has been considered important and valuable to conduct economic evaluation studies on Covid-19 in order to guide the decision makers and ensure the effective and efficient use of resources. In this context, it is aimed to systematically review the economic evaluation studies for the diagnosis, treatment, and control of Covid-19 disease. To conduct the research, databases of Pubmed, Scopus and Web of Science were chosen as it is suggested for health-related studies in the literature (Tawfik et al., 2019) together with ULAKBİM that is one of the most comprehensive database in Turkish literature.

Table 1. Strategy of Literature Scanning

Keywords	[(covid 19) OR (corona virus 19)] OR (sars cov2)] AND (economic evalution) AND [(cost utility analysis) OR (cost effectivenes analysis) OR (cost benefit analysis) OR (cost minimizition analysis)] [(covid 19) OR (korona virüs 19) OR (sars cov2)] AND (ekonomik değerlendirme) AND [(maliyet yararlanım analizi) OR (maliyet etkililik analizi) OR (maliyet fayda analizi) OR (maliyet minimizasyon analizi)]
Database	Pubmed, Scopus, Web of Science, ULAKBİM
Research Time	01.07.2021-15.07.2021
Language	English, Turkish
Inclusion Criteria	1. Full text available 2. 2019-2021
Exclusion Criteria	1.Cost of illness=9 2.Review article=6 3.Decision analytic without cost analysis=3 4.Letter to editor and editorial=4 5.Systematic review=4 6.Quality of life=1 7.Economic evaluation studies on another disease during the pandemic period 8.Full text not available

Details of the screening strategy for systematic review are given in Table 1. As a result of the search made in the relevant databases, 362 articles were identified, and after the duplicate records were removed, 22 publications were obtained by considering the inclusion criteria and title-abstract-keywords evaluation and were examined within the scope of the study (Figure 1).

Figure 1. PRISMA flow chart for study selection

III. FINDINGS

As a result of the screening process shown in Figure 1, 22 economic evaluation studies related to Covid-19 were examined. Considering the general characteristics of the study (Table 2), it was seen that 68.18% of the studies were published in 2021 and 31.81% in 2020. Distribution of the economic evaluation methods conducted in the studies is found to be as follows: cost-effectiveness (81.8% of the studies), cost-benefit (9.09% of the studies), cost minimization (4.54% of the studies) and cost-utility analysis (4.54% of the studies). Looking at the countries where the studies were held, it was detected that the studies were carried out in 9 different countries, especially the United States (5 of the studies). The majority of economic evaluation studies were related to screening and diagnostic tests (7 of the studies). When the type of intervention in the studies was examined, the majority of the studies were found to be on preventive health services (7 of the studies).

Table 2. General Characteristics of Economic Evaluations Studies on Covid-19

	Number of the studies (N=22)
Publication date	
2020	7
2021	15
Type of study	
Cost-Effectiveness Analysis	18
Cost-Benefit Analysis	2
Cost-Minimization Analysis	1
Cost-Utility Analysis	1
Type of interventions*	
Diagnosis	10
Treatment	5
Preventive	14
Country*	
America	5
United Kingdom	4
Spain	3
China	3
Germany	2
South Africa	2
Low and middle-income countries	1
Canada	1
Israel	1
Taiwan	1
Strategies *	
Screening and diagnostic tests	7
Quarantine	3
Social distancing	2
Isolation	3
Personal Protective equipment	5
Treatment	5
Vaccination	4
* Some of the studies are included to more than one section.	

In total, 81.8% of economic evaluation studies have applied cost-effectiveness analysis in the methodology. The study conducted in Canada, the USA and the United Kingdom was carried out to measure the cost-effectiveness of general vaccination and risk-stratified vaccination models. As a result of the study, if Pfizer, Biontech and Moderna vaccines are applied in the universal vaccination model,

the vaccine both provides cost savings and positively affects health outcomes as long as the rate of anaphylaxis does not exceed 0.8% (Shaker et al., 2021).

In a study conducted in the USA, it was aimed to measure the cost-effectiveness of potential treatments and 'the best supportive care' as mentioned in the publication for patients hospitalized due to Covid-19. As a result, long-term treatments for patients were found to be cost-effective (Sheinson et al., 2021). In the study, which evaluated the cost-effectiveness of social distance, mask, and routine diagnostic tests on a university campus in the USA, it was concluded that comprehensive social distance and mandatory mask-wearing policies were more cost-effective than routine diagnostic tests (Losina et al., 2021). In another study conducted in the USA, a hypothetical Covid-19 vaccine was found to be cost-effective compared to no vaccine at all (Kohli et al., 2021).

A study was conducted to measure the cost-effectiveness of controlling the epidemic strategies in South Africa. A combined epidemic control strategy, consisting of diagnostic testing, contact tracing, isolation of positive cases, collective symptom screening, and quarantine of contacts, is found to be the most cost-effective option (Reddy et al., 2021). Another study conducted in South Africa was led to measure the cost-effectiveness of purchasing the intensive care unit capacities of private hospitals for the treatment of patients. Consequently, it was detected that purchasing the intensive care unit capacity of private hospitals was not a cost-effective option (Cleary et al., 2021).

In a study to measure the cost-effectiveness of infection prevention and control strategies in the endoscopy unit in Germany, the use of high-risk protective equipment and pre-endoscopy virus diagnosis tests to protect healthcare workers were identified cost-effective when the prevalence rate among asymptomatic individuals is 1% or more (Ebigbo et al., 2021). The cost-effectiveness of an increase in the existing intensive care capacity in Germany was calculated, and as a result, the existing capacity was found to be sufficient (Gandjour, 2021).

A study was carried out in the United Kingdom on whether screening tests should be laboratory-based in aged care homes or should be done by establishing a care point in the institution. It was measured that testing in the nursing home was generally more cost-effective than laboratory-based testing (Stevenson et al., 2021). Hypothetical suppression policies in the UK were compared in terms of cost-effectiveness. The cost-effectiveness status of these policies was depending on the hypothesis applied (Zala et al., 2020).

Procurement and distribution of large-scale personal protective equipment is a cost-effective option for low- and middle-income countries to keep the healthcare worker infection rate below 10% and the mortality rate below 1% (Risko et al., 2020). In a study conducted in Israel, three different types of social distancing (isolation of patients and their contacts, quarantine at the national level, and social distancing determined as 2 meters) and two different strategies were determined and compared. As a result of the comparison, it was seen that quarantining the entire population, except for certain occupational groups, is a cost-effective option (Shlomai et al., 2021). Mass vaccination in Taiwan proved to be more cost-effective than no vaccination (Wang and Flessa, 2020).

The purpose of the study conducted in Spain was to compare the cost-effectiveness of the population being vaccinated or non-vaccinated, and it was concluded with the result that the vaccinated population was cost-effective (Marco-Franco et al., 2021). In another study conducted in Spain (González López-Valcárcel and Vallejo-Torres, 2020), it was determined that the TTQ strategy, which is called the testing-tracking-quarantine strategy, is more cost-effective than not taking any precautions or a national quarantine strategy.

Table 3. Features of included economic evaluations studies on COVID-19

	Author	Country	Population	Intervention Type	Type of Economic Evaluation	Purpose	Sensivity Analysis	Conclusion	Strategies *
1	Segui et al. (2021)	Spain	General population	Diagnostic	Cost-benefit analysis	To evaluate the economic impact of mass screening of asymptomatic individuals in the first and second waves of the Covid-19 epidemic.	Not available	The cost-effectiveness of collective screening in asymptomatic cases depends on screening high-risk individuals who are expected to test positive.	Covid-19 screening strategy
2	Shaker et al. (2021)	USA, UK, Canada	General population	Preventive	Cost-effectiveness analysis	To measure the cost-effectiveness of general vaccination and risk-stratified vaccination models.	Available	The universal vaccination model should not exceed 0.8% of the vaccine anaphylaxis rate to be cost effective.	Vaccine (Pfizer, Moderna, Biontech)
3	Sheinson et al. (2021)	USA	Inpatient	Treatment	Cost-effectiveness analysis	To measure the cost-effectiveness of potential treatment relative to best supportive care in patients hospitalized Covid-19.	Available	Long-term treatments for hospitalized patients have been found to be cost-effective.	Treatment (Short term: No supplemental oxygen, supplementation without ventilation, supplemental oxygen with ventilation (Long term: No ventilation during inpatient treatment, ventilation during inpatient treatment)
4	Losina et al. (2021)	USA	University students and academics	Preventive and diagnostic	Cost-effectiveness analysis	To evaluate the cost-effectiveness of routine diagnostic test, social distance and mask applications applied in the university campus.	Available	Comprehensive social distancing and mandatory mask-wearing policies are cost-effective compared to routine diagnostic testing.	Social distancing, mandatory wearing of masks, diagnostic tests
5	Reddy et al. (2021)	South Africa	General population	Preventive and diagnostic	Cost-effectiveness analysis	To make an economic evaluation of epidemic control strategies (diagnostic testing only for individuals who apply to health centers,	Available	The combined outbreak control strategy, consisting of diagnostic testing, contact tracing, isolation of positive cases, mass symptom screening, and	Diagnostic testing, contact tracing, isolation, collective symptom screening, quarantine

					contact tracing at home, isolation centers for cases requiring hospitalization, diagnostic testing for individuals with symptoms, quarantine centers for individuals with negative test results).		quarantine of contacts, was the most cost-effective option in Covid-19 outbreak control.	
6	Ebigbo et al. (2021)	Germany	Health workers	Preventive and diagnostic	Cost-effectiveness analysis	To measure the cost-effectiveness of infection prevention and control strategies of healthcare professionals working in the endoscopy unit.	Available	When the prevalence rate is 1% or more among asymptomatic individuals, the use of high-risk protective equipment and pre-endoscopy virus testing are cost effective.	Diagnostic testing and high-risk protective equipment
7	Risko et el. (2020)	Low and Middle-Income Countries	Health workers	Preventive	Cost-effectiveness analysis	To assess the cost-effectiveness of immediate investment in personal protective equipment for healthcare workers.	Available	Procurement and distribution of large-scale personal protective equipment is a cost-effective option to keep the healthcare worker infection rate below 10% and the mortality rate below 1%.	Mask and protective clothing
8	Cleary et al. (2021)	South Africa	Patient	Treatment	Cost-effectiveness analysis	To measure the cost-effectiveness of purchasing the intensive care unit capacities of private hospitals for the treatment of patients.	Available	It is not cost-effective to buy the intensive care unit capacity of private hospitals.	Intensive care unit capacity
9	Bagepally et al. (2021)	India	General population	Preventive	Cost-utility analysis	To measure the cost-effectiveness of non-pharmacological protective interventions such as hand hygiene, surgical mask, N95	Available	Hand hygiene practices were the most cost-effective option.	Non-pharmacological protective interventions

					mask, hand hygiene and mask.			
10	Gandjour et al. (2021)	Germany	-	Treatment	Cost-effectiveness analysis	To evaluate the cost-benefit of increasing or not increasing the intensive care unit bed capacity.	Available	It is cost-effective to increase the number of intensive care beds, even if the probability of using intensive care beds is minimal.	Providing additional capacity in the Intensive Care Unit
11	Currie et al. (2020)	UK	Patients with suspected Covid-19	Diagnostic	Cost minimizition analysis	To evaluate the cost of standard hospital test applications with the test-making model, which is called the community test model, developed in the study.	Not available	Community testing model saves cost.	Screening and Diagnostic Tests
12	Shlomai et al. (2021)	Israel	General population	Preventive	Cost-effectiveness analysis	To compare theree different types of social distancing (isolation of patients and contacts, quarantine at national level, social distancing set at 2m) and quarantine strategies in terms of cost-effectiveness	Available	It has been determined that the advantageous between the two strategies is the quarantine of the entire population, except for those with basic occupations determined only by government decision. However, it was stated that the strategy could only provide a moderate advantage due to its cost burden.	Social distancing and quarantine
13	Stevenson et al. (2021)	UK	Elders	Diagnostic	Cost-effectiveness analysis	Hypothetically comparing whether Covid-19 screening tests should be done in the laboratory or at the care point established in aged care homes.	Available	In general, point-of-care testing is more cost-effective than lab-based testing.	Screening and Diagnostic Tests
14	Marco-Franco et al. (2021)	Spain	General population	Preventive	Cost-effectiveness analysis	Comparing the cost-effectiveness of the population's vaccination	Available	Vaccination is a cost-effective option. Even if 70% of the population is	Vaccine

						status with its non-vaccination status.		vaccinated with two injections with 70% efficacy, the ICER is determined as 5132 Euros.	
15	Broughel and Kotrous (2021)	USA	General population	Preventive treatment and diagnostic	Cost-benefit analysis	To make a cost-benefit analysis of the strategies implemented to control the first wave of Covid 19.	Not available	As a result of the study, it was determined that the strategies applied during the first wave were effective in slowing the spread of Covid 19 and should be continued.	Quarantine and social distancing
16	Jiang et al. (2020)	China	Patients with Covid-19	Diagnostic	Cost-effectiveness analysis	To assess whether RT-PCR testing twice or three times would be cost-effective to diagnose Covid 19 disease and discharge patients	Available	Three times the RT-PCR test was more cost-effective than two times in quarantined individuals.	Diagnostic Tests
17	Lopez-Valcarcel and Vallejo-Torres (2020)	Spain	Patients with suspected Covid-19	Preventive and diagnostic	Cost-effectiveness analysis	To evaluate the cost-effectiveness of the diagnosis-follow-up-quarantine strategy, called the TTQ strategy	Available	Successful TTQ implementations are no countermeasures and are a cost-effective option compared to a national quarantine strategy.	Screening and diagnostic tests, monitoring and quarantine
18	Kohli et al. (2021)	USA	General population	Preventive	Cost-effectiveness analysis	To investigate the cost-effectiveness of group prioritization in a hypothetical vaccination.	Available	It has been stated that the research has many uncertainties and limitations. However, a hypothetical Covid 19 vaccine was found to be cost-effective compared to no vaccination.	Vaccine
19	Wang et al. (2020)	Taiwan	General population	Preventive	Cost-effectiveness analysis	Vaccination and non-vaccination status of the entire population were compared.	Available	Vaccination of the entire population is cost-effective compared to the absence of vaccination.	Vaccine

20	Jiang et al. (2021)	China	Patients with Covid-19	Treatment	Cost-effectiveness analysis	To compare the cost-effectiveness of using remdesivir and not using it in the treatment of Covid-19.	Available	It has been determined that the use of remdesivir in treatment is more cost-effective. For this reason, it is recommended to add a treatment protocol.	Medication
21	Zhao et al. (2020)	China	General population	Preventive	Cost-effectiveness analysis	The cost-effectiveness of early implementation of movement restriction policies (quarantine, isolation and travel restrictions) and one week, two weeks and 4 weeks late implementation were compared.	Available	Early movement restriction policies were found to be the most cost-effective. It has also been found that these practices reduce the health burden and social costs.	Quarantine, isolation and travel restrictions
22	Zala et al. (2020)	UK	General population	Preventive and diagnostic	Cost-effectiveness analysis	Comparing the cost-effectiveness of hypothetical suppression policies	Available	The cost-effectiveness of suppression policies depends on the assumptions applied.	Quarantine, diagnostic tests and isolation

Performing the RT-PCR test three times in Covid-19 patients in China was found to be more cost-effective than performing the RT-PCR test twice in environments where it is quarantined due to Covid 19 (Jiang et al., 2020). The cost-effectiveness of early implementation of the movement restriction policies (e.g., quarantine, isolation, and travel restrictions) and its one week, two weeks, 4 weeks late implementation were compared in China. The early implementation was seen as the most cost-effective option (Zhao and Feng, 2020). In another study conducted in China, the context of the medication was considered. The cost-effectiveness of using remdesivir and not using it in the treatment of Covid-19 patients was compared. As a result, the usage of remdesivir was found to be cost-effective (Jiang et al., 2021).

4.54% of the economic evaluation studies included in the systematic review have proceeded with the cost-utility analysis. In a study conducted in India by Bagepally et al. (2021), it was aimed to measure the efficiency of non-pharmacological protective interventions such as hand hygiene, surgical mask, N95 mask, hand hygiene and mask. The study concluded that hand hygiene was found to be the most convenient option.

Repeatedly, 4.54% of the economic evaluation studies in the systematic review have utilized from cost minimization analysis in the methodology. In the study conducted in the United Kingdom, the testing model, which is named community testing, was developed for patients with suspected Covid-19, and standard hospital testing practices were compared in terms of cost. The community testing model was found to be the cost-minimized option (Currie et al., 2020).

9.09% of economic evaluation studies are cost-benefit analyses. In a study conducted in Spain, it is cost-effective to perform collective screening in asymptomatic individuals if screening is performed on individuals who are likely to be positive. (López Seguí et al., 2021). In another study which cost-benefit analysis was used conducted in the USA, it was aimed to measure the cost-benefit of the strategies applied to control the first wave of Covid-19. It was seen that the strategies applied during this time period seemed the efficient option (Broughel and Kotrous, 2021).

IV. DISCUSSION

Relevant literature was reviewed by Rezapour et al. (2021) similar to our study by putting a time limit between 2019 November and 2020 July, and the economic evaluation studies of the covid-19 period were systematically scanned and gathered under one title. In the study, scanning was carried out using Medline, PubMed, Cochraine Library, Embase, Web of Science (Core Collection), Scopus and Google Academic databases, and the publication language was limited to English. A total of 26 studies were included in the review during the scanning process. 53% of these studies (14 studies) chose cost-effectiveness analysis as the method, and this was followed by studies using cost-benefit analysis (7 studies) and cost-utility analysis (4 studies). Another study preferred to use the decision tree method. Eighteen of these studies determined the entire population as the universe, 4 of them were studied on patients with covid-19, only 2 on health workers and the other 2 on specific groups. It was determined that some of the included studies worked on more than one subject and the subject distribution was stated as follows: quarantine (10 studies), diagnostic and screening tests (8 studies), social distance (7 studies), isolation (6 studies), personal protective equipment (5 studies), treatment and vaccination (3 studies), and hygiene (1 study). As a result of this study, social distancing in long-term studies and the use of personal protective equipment in short-term studies were found to be more cost-effective than other strategies (herd immunity, quarantine, etc.), besides all studies have found that screening tests are cost-effective.

In another systematic review, 70 studies published between March 2020 and May 2021 were included and examined after scanning the NIH (National Institute of Health) database, NBER (National Bureau of Economic Research) database, EconLit, Google Scholar and Covid Scholar databases (Podolsky et al., 2022). It was observed that the included studies were conducted using cost-effectiveness (45 studies),

cost-benefit (22 studies) and cost-consequence (3 studies) analyses. In this review, where the language of publication was limited to English only, 83% of the studies (58 studies) were conducted on the whole population in general, while the other 12 studies were selected for specific groups such as children, the elderly, health workers, and students. Likely to Rezapour and his friends' study (Rezapour et al., 2021), it has been seen that some of these studies are based on more than one subject. The study subject distributions were stated as follows: non-drug practices (28 studies), diagnostic tests and application policies (15 studies), quarantine and isolation (14 studies), social distance (10 studies), mask (9 studies), treatment (8 studies), investment in health care (6 studies), community screening (5 studies), vaccination policy (5 studies), public information campaigns (5 studies), hand hygiene (4 studies), school closure (4 studies), cleaning (2 studies) study), cancellation of public events (2 studies). As a result of the study, it was taken into account in the economic evaluation studies on Covid-19, and therefore it was suggested to expand the scope of the future studies.

In the scope of our study, Turkish literature was also included together with English literature. The time limit was determined to be between December 2019 and June 2021. In this context, a wider time interval was examined and more comprehensive research was made rather than the systematic review studies in the literature (Rezapour et al., 2021; Podolsky et al., 2022). Unlike the previous studies, the following databases were reviewed: Web of Science, Scopus, Pubmed (Podolsky et al., 2022) and ULAKBİM (Rezapour et al., 2021; Podolsky et al., 2022). Similarly to these studies, the majority of the included studies in this review were conducted with cost-effectiveness analysis and this was followed by cost-benefit. It has been seen that studies were carried out with healthcare workers, (potential) covid-19 patients, the general population, university students and academics. The types of interventions examined in the studies were grouped as diagnostic, preventive and treatment by the researchers. It was determined that studies were more focused on preventive and diagnostic procedures.

V.CONCLUSION

In this study, in which economic evaluation researches related to covid-19 were systematically reviewed, 22 studies were discussed in detail. This study is considered to be significant forwhy it reveals in which contexts economic evaluation methods are used in the fight against covid-19 and in which areas it can be studied. It was seen that the majority of the studies were conducted in high-income countries and carried out in 2021. The subject of these studies is mostly related to the diagnosis and treatment of covid-19 disease. Although the studies included were carried out in various countries worldwide, no studies have been found in Türkiye regarding the economic evaluation of covid-19. Therefore, this research is important in terms of identifying the gap in the literature and guiding the economic evaluation studies to be carried out on covid-19 in the future. The strengths of this study are that it covers a wider time period (December 2019- June 2021) than other studies found in the literature and that Turkish literature is also included to the process, even though it has limitations of being conducted in databases of PubMed, Scopus, Web of Science, ULAKBİM and including the ones in English and Turkish only.

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