

## Effect of Exercise on Quality of Sleep in COVID-19 Patients: A Meta-Analysis

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### ABSTRACT

**Background:** Coronavirus occurs because the virus lowers the body immune, which can lead to several things such as decreased sleep quality. Gymnastics is one exercise that can improve sleep quality, gymnastics can also reduce stress levels and anxiety. This study aims to discover the effect of gymnastics on sleep quality in COVID-19 patients.

**Subjects and Method:** It was a systematic review and meta-analysis of primary studies. Article searches were conducted based on PICO model eligibility criteria. Population: COVID-19 patients. Intervention: administration of gymnastic intervention. Comparison: no gymnastics intervention. Outcome: improved sleep quality. Article search was conducted through journal databases including Google Scholar, MEDLINE/PubMed, Science Direct, Hindawi, BMC, Europe PMC, and Springer Link using search keywords: "gymnastic", "sleep quality", "gymnastic effect", "exercise", "exercise effect", "COVID-19", "randomized controlled trial", "gymnastic randomized controlled trial", "sleep quality -randomized controlled trial", AND "sleep quality on covid 19". The inclusion criteria used in this study were full paper articles with a Randomized Controlled Trial (RCT), with Odds Ratio (OR) for the effect size. The screened eligible articles were analyzed using RevMan 5.3.

**Results:** This meta-analysis included 9 articles from China, India, South Korea, South America, North America, and Brazil. Good sleep quality increased with gymnastics in COVID-19 patients (aOR= 1.19; 95% CI= 1.14 to 1.24; p<0.001). There was an overestimate publication bias.

**Conclusion:** The administration of gymnastics interventions to COVID-19 patients has a statistically significant effect on improving sleep quality.

**Keywords:** COVID-19, gymnastics, meta-analysis, sleep quality.

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### BACKGROUND

The novel coronavirus that occurred in 2019 has become a major problem worldwide (Wang et al. 2020). This outbreak caused many cities and even several coun-

tries in the world to be forced into lockdown. Numerous casualties occurred due to the COVID-19 pandemic. COVID-19 is a virus that attacks the human respiratory system. COVID-19 virus is airborne there-

fore it is contagious, especially in weak immune conditions. Numerous cities and countries in the world have decided to lock down because this method is considered effective enough to reduce the spread of COVID-19 (Kharroubi and Saleh 2020).

Some studies say that numerous cases of COVID-19 occur due to decreased immunity due to lack of sleep or lack of sleep quality. This happens a lot to health workers who experience sleep deprivation are vulnerable to COVID-19 (Wang et al., 2020). A study conducted by Sher (2020) elaborates that COVID-19 patients experience high levels of stress and anxiety whereas sleep quality is low. Self-quarantine or lockdown causes changes in habits. These habits are in the form of reduced physical activity, changes in sleep patterns, and increased stress levels (Diniz et al., 2020). Lack of physical activity can cause overweight or obesity, while in a study it is stated that people with obesity have a higher risk of COVID-19 than people who are not overweight (Kurniawati et al., 2021). It can be concluded how important it is to do gymnastics exercises in everyday life.

One of the efforts that can be made to increase public confidence in COVID-19 vaccination is to use the Health Believe Model (HBM). Factors that can influence people's acceptance of COVID-19 vaccination based on HBM theory are high perceived susceptibility to COVID-19 infection and perceived benefit of COVID-19 vaccines (Yuliani et al., 2022). The activities carried out can be in the form of regular activities or gymnastics conducted at a certain time.

This change in sleep habits occurs in almost all societies. There are several factors that cause the change, including age, gender, occupation, and others. Lack of activity will affect the quality of sleep, whether it is good or bad, especially in COVID-19 patients. Gymnastics is one of

the right solutions to reduce anxiety. Another factor causing anxiety about health also occurs due to the place to live. A study explained that people living in urban areas are more at risk of anxiety than those who live in non-urban areas (Fresna et al., 2021). A study states that improving exercise will be an advantage for COVID-19 patients, especially in improving sleep quality (Luciano et al., 2020). A study explains that numerous cases of COVID-19 affect asthma patients and it requires proper prevention - and treatment (Munawaroh et al., 2021), while exercise such as gymnastics is very good for controlling asthma conditions.

Gymnastics is one of the exercises that can be done to improve sleep quality, especially in COVID-19 patients who are self-isolating. Gymnastics can be conducted alone at home without having to meet other people. A study states that monitoring rhythmic exercises in the form of gymnastics will affect the fitness and physical condition of COVID-19 patients (Bobo-arce et al., 2021). With good physical condition and fitness, it will affect the quality of sleep. Fitness against allergies and good immunity are the most important during COVID-19 because there is an increase in emotions/stress, as well as anxiety about various problems such as family, money, and health. Patients should make efforts to improve their fitness by means of physical exercise, which can be in the form of sports, or recommended exercises according to the body's condition (Nyenhuis et al., 2019). This study was conducted to determine the effect of exercise on sleep quality of COVID-19 patients.

## SUBJECTS AND METHOD

### 1. Study Design

It was a systematic review and meta-analysis study conducted with PRISMA flow diagrams. Article search through journal data-

base includes Google Scholar, MEDLINE/ PubMed, Science Direct, Hindawi, BMC, Europe PMC, and Springer Link. The literature search was conducted using search keywords: "gymnastic", "sleep quality", "gymnastic effect", "exercise", "exercise effect", "COVID-19", "randomized controlled trial", "gymnastic randomized controlled trial", "sleep quality randomized controlled trial", AND "sleep quality on COVID-19".

## 2. Steps of Meta-Analysis

- 1) Formulate research questions in PICO (Population, Intervention, Comparison, Outcome).
- 2) Search for primary study research articles databases namely Google Scholar, PubMed, and Science direct.
- 3) Conduct screening and quality assessment of primary articles.
- 4) Extracting and analyzing data into the RevMan 5.3 application
- 5) Interpret results and draw conclusions.

## 3. Inclusion Criteria

The inclusion criteria used in this study were full paper articles with a Randomized Controlled Trial (RCT) design. The subjects in this study were COVID-19 patients.

## 4. Exclusion Criteria

The exclusion criteria of the study included non-Indonesian and English studies, non-gymnastics interventions to improve sleep quality, and articles published before 2000.

## 5. Operational Definition of Variables

**Gymnastics:** is a repetitive and regular movement according to the rhythm performed to improve fitness

**Sleep quality:** a condition where a person experiences sleep with sufficient duration, sleep efficiency, and proper sleep timing and goes through the proper sleep stages.

**COVID-19 patients:** someone infected with the COVID-19 virus.

## 6. Study Instruments

The quality assessment of the study articles was conducted using critical appraisal

checklist tools Randomized Controlled Trial (RCT) published by CEBM University Of Oxford 2014.

## 7. Data Analysis

This study used the Review Manager application (RevMan 5.3) for data analysis. The study used  $I^2$  for quantifying dispersion. The results of data analysis were in the form of effect size values, and the results of the analyzed data were subsequently interpreted in the form of forest plots and funnel plots.

## RESULTS

The process of searching for primary articles was carried out on online databases including Google Scholar, MEDLINE/ PubMed, Science Direct, Hindawi, BMC, Europe PMC, and Springer Link and obtained the results of 9 articles. The total number of articles in the initial search process was 1,458 articles. 324 duplicate articles were deleted. 1,134 article was screened. Then, 63 full-text articles were eligible, and 9 articles were included in the synthesis meta-analysis. These 9 primary study came from 3 continents, namely, 7 articles from Asia and 2 studies from South America.

The article search was conducted using a database based on the PRISMA flow diagram that can be seen in Figure 1. Quality assessment of studies was conducted qualitatively and quantitatively using critical appraisal checklist tools Randomized Controlled Trial (RCT) published by CEBM University of Oxford 2014. In Table 1. each of the 11 questions was answered with an answer choice: Yes with the value of 1 and No with the value of 0. Following a qualitative assessment of the study, a total of 9 articles included in the meta-analysis quantitative synthesis process were analyzed using RevMan 5.3.

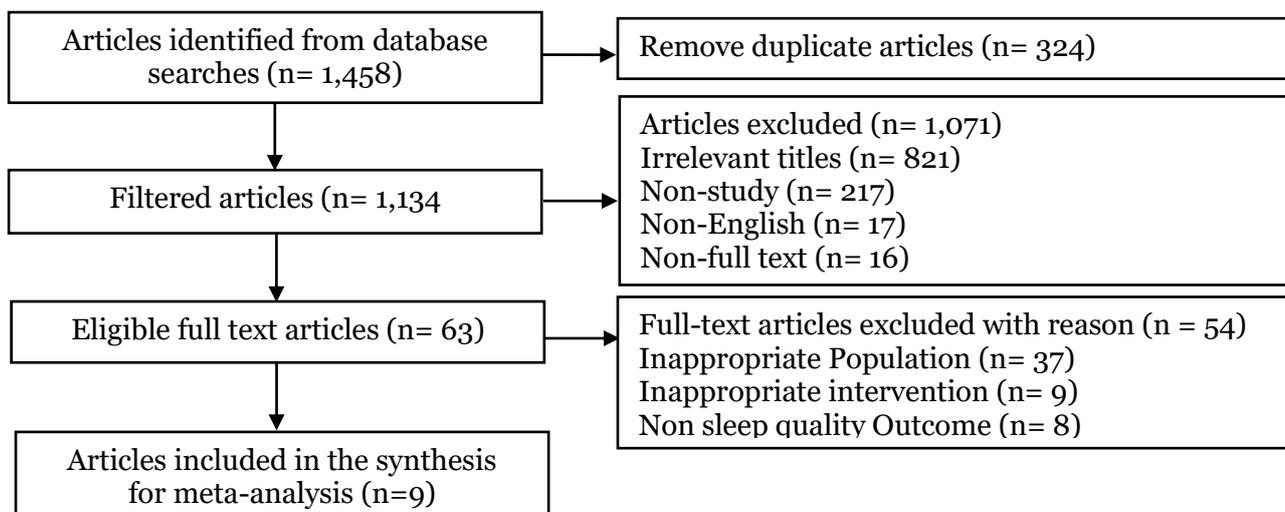


Figure 1. PRISMA flowchart



Figure 2. Map of the distribution of articles included in the meta-analysis

Table 1. Critical appraisal checklist for cross-sectional studies in meta-analyses

Articles	Questions of Checklist												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Park (2014)	1	1	1	1	1	1	1	1	1	1	1	1	12
Wang et al. (2020)	1	1	1	1	1	1	1	1	1	1	1	1	12
Ma et al. (2020)	1	1	1	1	1	1	1	1	1	1	1	1	12
Tan et al. (2021)	1	1	1	1	1	1	1	1	1	0	1	1	11
Mishra et al. (2022)	1	1	1	1	1	1	1	1	1	0	1	1	11
Ghrouz et al. (2021)	1	1	1	1	1	1	1	1	1	1	1	1	12
Hawkins et al. (2019)	1	1	1	1	1	1	1	1	1	1	1	1	12
Neto et al. (2021)	1	1	1	1	1	1	1	1	1	0	1	1	11
Li et al. (2022)	1	1	1	1	1	1	1	1	1	0	1	1	11

**Description of the question criteria:**

- 1 = Does the study address the focused statement/problem clearly?
- 2 = Is the randomized controlled trial study method appropriate to answer the research question?
- 3 = Were there enough subjects in the study to establish that the findings did not happen by chance?
- 4 = Were subjects randomly allocated to experimental and control groups? If not, can this lead to bias?
- 5 = Are inclusion/exclusion criteria used?
- 6 = Were the two groups comparable at the start of the study?
- 7 = Are objective, unbiased outcome criteria used?
- 8 = Are objective and validated measurement methods used in measuring the results? If not, are the result assessed by someone unaware of the group task? (i.e. blinded assessment)/
- 9 = Is effect size practically relevant?
- 10 = How precise are the effect estimates? Is there a confidence interval?
- 11 = Could there be confounding factors that have not been taken into account?
- 12 = Are the results applicable to your research?

**Description of the answer score:**

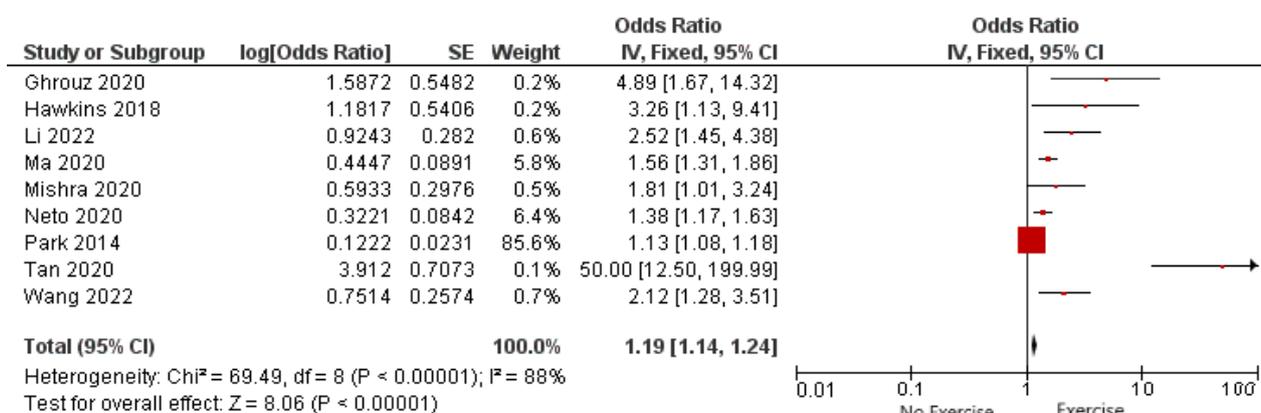
- 0 = No
- 1 = Can't tell
- 2 = Yes

**Table 2. PICO study Summary description of Randomized Controlled Trial effect of gymnastics on sleep quality (N= 89,306)**

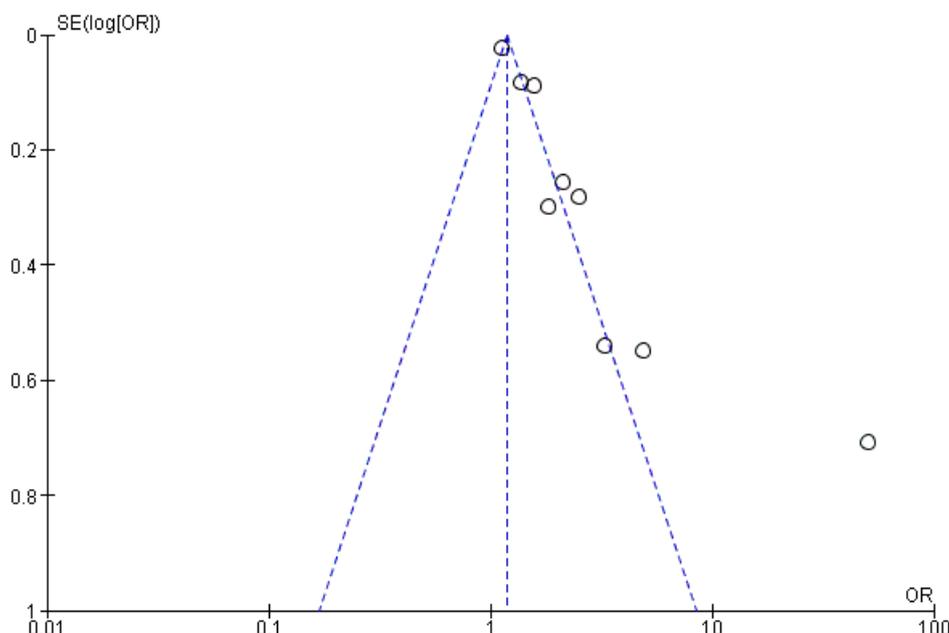
Author (year)	Country	Sample	P	I	C	O
Park (2014)	South Korea	73,238	Adolescents aged 12-18 with COVID-19	Gymnastics	No Gymnastics	Improved Sleep Quality
Wang et al. (2020)	China	3,416	University students aged 20 on average with COVID-19	Gymnastics	No Gymnastics	Improved Sleep Quality
Ma et al. (2020)	China	5,233	University students aged 20-25 with COVID-19	Gymnastics	No Gymnastics	Improved Sleep Quality
Tan et al. (2021)	China	2,443	Mothers aged $\pm$ 20 with COVID-19	Gymnastics	No Gymnastics	Improved Sleep Quality
Mishra et al. (2022)	India	284	University students aged $\pm$ 20 with COVID-19	Gymnastics	No Gymnastics	Sleep quality deteriorated during <i>Lockdown</i>
Ghrouz et al. (2021)	India	662	Students in India with COVID-19	Gymnastics	No Gymnastics	Improved Sleep Quality
Hawkins et al. (2019)	USA	251	Mothers in the USA with COVID-19	Gymnastics	No Gymnastics	Improved Sleep Quality
Neto et al. (2021)	Brazil	1,432	Adolescents aged 10-14 with COVID-19	Gymnastics	No Gymnastics	Improved sleep quality
Li et al. (2022)	China	2,347	Students aged $\pm$ 20 with COVID-19	Gymnastics	No Gymnastics	Improved Sleep quality

**Table 3. Odds Ratio (OR) of Data on the effect of gymnastics on sleep quality**

Author (Year)	OR	CI 95%	
		Lower Limit	Upper Limit
Park (2014)	1.13	1.08	1.18
Wang et al. (2020)	2.12	1.28	3.57
Ma et al. (2020)	1.56	1.31	1.81
Tan et al. (2021)	50.00	25	12.5
Mishra et al. (2022)	1.81	1.01	3.23
Ghrouz et al. (2021)	4.89	1.67	14.35
Hawkins et al. (2019)	3.26	1.13	9.42
Neto et al. (2021)	1.38	1.17	1.63
Li et al. (2022)	2.52	1.45	4.37



**Figure 3. Forest Plot of the effect of gymnastics on sleep quality of COVID-19 patients**



**Figure 4. Funnel Plot of the effect of gymnastics on sleep quality of COVID-19 patients**

The forest plot in Figure 3 Showed that COVID-19 patients who did gymnastics were 1.19 times more likely to obtain better sleep quality compared to COVID-19 patients who did not do gymnastics, and the effect was statistically significant (aOR= 1.19; 95% CI = 1.14 to 1.24;  $p < 0.001$ ). This forest plot shows high heterogeneity of effect estimates across studies ( $I^2 = 88\%$ ;  $p < 0.001$ ). Thus, the calculation of the average effect estimates was conducted using a random effect model approach.

The funnel plot in Figure 4 shows that the distribution of effect estimates was more on the right side than on the left side of the average vertical line, indicating a publication bias. Because the distribution of effect estimates was more on the right side as the diamond shape in the forest plot which is also located to the right of the vertical line of the null hypothesis, the publication bias tends to have an effect beyond the actual effect (overestimate).

## DISCUSSION

There were 9 study articles with a randomized controlled trial study design as a source of meta-analysis of the effect of gymnastics on sleep quality in COVID-19 patients. The results of the forest plot showed that the effect of gymnastics on the sleep quality of COVID-19 patients was 1.19 times better than COVID-19 patients who did not do gymnastics and was statistically significant (aOR= 1.19; 95% CI= 1.14 to 1.24;  $p < 0.001$ ).

This study is in line with a study conducted by Desjardins et al. (2018) which explains that adolescents with regular gymnastics will affect the improving sleep quality. Although it is also explained that adolescents with less gymnastics will also be supported to improve their sleep quality.

A study conducted by Hofman et al. (2022) mentions that doing light exercises

such as gymnastics can affect the improvement of poor sleep quality. This study is in line with the study described here where good gymnastics will affect sleep quality to be better.

However, a study conducted by Koohsari et al. (2023) explained that there was no significant effect of intensified gymnastics on improving sleep quality. This study is not in line with the study described here because it discovered that there was an effect of the gymnastics conducted. In the study, gymnastic interventions were administered toward improving sleep quality in COVID-19 patients, however, the effect that occurred based on the existing data was statistically significant.

A study conducted by Mahfouz et al. (2020) did not mention the significance of the effect of gymnastics on sleep quality, however, the study mentioned that students at Saudi Arabia University with the habit of not doing gymnastics experienced poor sleep quality, and contrarywise, students with active gymnastics experienced better sleep quality.

Even though numerous studies mention the presence or absence of the effect of gymnastics on sleep quality in COVID-19 patients, based on the observations and the study conducted, it can be concluded that there is indeed an effect of the activities conducted on the quality of sleep that occurs, however, the effect that occurs is not significant because there are many affecting factors. These factors can be in the form of the type of gymnastics performed, the quantity and quality of gymnastics performed, and so on.

Gymnastics is one of the exercises that can be conducted to improve the quality of one's sleep, there are various kinds of gymnastics and variations that can be done. Gymnastics can also be performed alone at home or together with others. Doing gym-

nastics can improve fitness and health. In general, it can be concluded that gymnastics can affect sleep quality, however, it depends on the type of gymnastics and how often gymnastics is performed).

#### **AUTHOR CONTRIBUTION**

Septyandi Ramadhan was the principal investigator who selected topics, browsed, and collected study data. Bhisma Murti and Hanung Prasetya analyzed the data and reviewed the study documents.

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#### **CONFLICT OF INTEREST**

There is no conflict of interest in this study.

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