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The effectiveness of tepid water sponge on reducing body temperature in children with hyperthermia: A meta-analysis

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ABSTRACT

Background: Hypothermia occurs when the body temperature rises above normal due to external factors, namely exposure to high temperatures or heat sources. This meta-analysis was conducted to assess the effectiveness of warm water spongee compresses in reducing children body temperature by synthesizing previous studies so that they can provide clinical information on clinical practice, guideline development and further research. This studyy aims to assess the effectivenesss of warm water sponge compresses to reduce fever in hyperthermic children Methods: This main article was obtained from online databases (Elsevier, Google Scholar, Science Direct, and PubMed) with a period of 2012-2022. Population: children. Intervention: warm water sponge. Comparison: usual care. Result: body temperature. For searching primary articles used the keywords (Warm water sponge) OR (Warm therapy) AND (Body temperature) AND (children) AND Mean SD. Articles were screened using the PRISMA fflow diagram. Primary article analysis with the Review Manager 5.3 application. Results: The data that has been processed shows that Children with hyperthermia who received the tepid water sponge therapy experienced a decrease in temperature 1.35 units lower compared to children who were only given usual care therapy, (SMD = -1.31; 95% CI = -1.61 to -1.09; p< 0.001). Conclusion: Warm water sponge compresses can be used as initial therapy to reduce body temperature in hyperthermic children Recommendation: Warm water sponge compresses can be recommended as an effective initial treatment to reduce body temperature in hyperthermic children.

Keywords: Water tepidd sponge; hyperthermia; children

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INTRODUCTION

Fever is a one of common symptoms that a complaint of one patient. Plaster and Tepid sponge compress. Tepid sponge compress and plaster compress are one of the actions that cann be taken to decrease temperature. In Indonesia, the incidence of fever cannot be explained directly, but several diseases that have fever symptoms such as DHF (Dengue Hemorrhagic Fever) are 34.33 percent, with an incidence of death (DHF CFR) of 0.90 percent (Ministry of Health RI, 2022). This denguee virus belongs to the group of arthropod-borne viruses (arboviruses) which has ffour virus serotypess, namely DEN-11, DEN-2, DEN-3, and DEN-4. Serotype DEN-3 is the most dominant type in Indonesia, which influences the incidence of severe fever which spreads widely. The following are the six regions with the highest distribution of cases in Indonesia as of week 39, namely West Java with 27,657 cases, Central Java with 8,760 cases, East Java with 8,356 cases, DKI Jakarta with 5,632 cases, North Sumatra with 5,302 cases and East Kalimantan with 3,531 case. In general, the number of deaths reported in 2022 up to the 39th week is 853 deaths with a distribution of cases in West Java with 249 deaths, Central Java with 185 deaths, East Java with 108 deaths, North Sumatra with 29 deaths, East Kalimantan had 26 deaths and South Sumatra with 21 deaths.

Solas in 2020 states that hyperthermia is caused by an increase in body temperature that exceeds normal limits that occurs due to external factors such as exposure to high temperatures or heat sources. It can also refer to an increase in body temperature due to an underlying medical condition or disease. Hyperthermia occurs due to various factors, namely, exposure to high temperatures, extreme physical activity, certain medications, and certain conditions such as heat stroke, infection, and hyperthyroidism (Ebi et al., 2021). Sweating, dehydration, fatigue, dizziness, nausea, fast heartbeat and confusion are some of the symptoms of hyperthermia. In more severe cases, hyperthermia can cause seizures, organ failure and even death (Lestari et al, 2019). Symptoms of hyperthermia are characterized by an increase in body temperature above 38°C.

The main topic of discussion in this research is the management of hyperthermia incidents in children and the effectiveness of warm water sponges as a treatment intervention. While previous studies have reported the effectiveness of tepid sponge in reducing hyperthermia, there is still a need for a comprehensive analysis to consolidate the existing evidence and determine the overall effectiveness of this intervention. This meta-analysis aims to bridge the gap and to add information regarding the effectiveness of compressing using a warm sponge to reduce body temperature in children with hyperthermia Despite the existing studies on tepid water sponge, several unknowns remain. This includes overall effectiveness: Although individual studies have reported positive effects, the overall effectiveness of using warm sponge compresses to reduce body temperature in children with hyperthermia is not well established. A comprehensive meta-analysis can provide a more definitive evaluation by synthesizing the available evidence.

Conducting a meta-analysis of effectiveness of water sponge compresses to reduce body temperature in children with hyperthermia is important, especially to increase statistical power.: Meta-analysis combines the results of multiple studies on the same topic to provide a more robust and reliable estimate of the treatment effect. By pooling data from several studies, the sample size increases, which enhances statistical power. This allows for more precise estimates of the treatment effect and reduces the impact of random variations or biases in individual studies.

Enhanced Generalizability is another reason this research is important Meta-analysis integrates findings from various studies conducted in different settings, populations, and conditions. This broader perspective helps to determine the generalizability of the treatment effect across different contexts. It can also identify factors that may influence the effectiveness of the treatment, such as age, severity of hyperthermia, or underlying health conditions. Likewise, resolving inconsistencies: sometimes, individual studies may produce conflicting or inconclusive results due to variations in methodology, sample sizes, or other factors. Meta-analysis can help identify and resolve these inconsistencies by providing a comprehensive overview of the available evidence. It allows researchers to examine the overall trend and effect size across studies, potentially clarifying any discrepancies.

Increased precision and accuracy, because the meta-analysis uses statistical techniques to estimate the overall treatment effect more precisely. Combining multiple studies makes it possible to detect more minor treatment effects that may have been missed in individual studies due to limited sample sizes or insufficient statistical power. This enhanced precision improves the reliability and accuracy of the findings. Also, identification of Sources of Heterogeneity: Meta-analysis allows for the exploration of potential sources of heterogeneity or variability among study results. Researchers can conduct subgroup analyses to examine whether certain characteristics (e.g., study design, participant characteristics, intervention protocols) influence the treatment effect. This information can help identify important factors that may affect the effectiveness of the tepid water sponge treatment in children with hyperthermia.

Therefore, this research was conducted to estimate the effectiveness of the water-tepid sponge effect in reducing hyperthermia in children based on primary studies that have been conducted previously.

LITERATURE REVIEW

Hyperthermia is a condition where the body temperature increases above the body's normal range. Hyperthermia is a condition where an individual experiences or is at risk of experiencing an increase in body temperature of >37.80 C (100 o F) orally or 38.80 C (101 o F) per rectally which is persistent due to external factors (Bin et al., 2022). Hyperthermia is a condition of increased body temperature (rectal temperature > 38.80 C (100.4 F)) which is related to the body's inability

to eliminate heat or reduce heat production. Hyperthermia is a condition in which there is an increase in body temperature due to the body's inability to increase heat output or reduce heat production (Mahmood et al., 2020).

Hyperthermia causes increased reabsorption of Na+ and H2O so that membrane permeability increases. Increased membrane permeability causes fluid from intravascular to move to extravascular, resulting in plasma leakage. Plasma leakage will result in a reduction in plasma volume resulting in hypotension and possibly resulting in hypovolemic shock (Burhans et al., 2022).

Hyperthermia is a health condition characterized by a series of signs and symptoms, which are divided into major and minor. The major signs and symptoms of hyperthermia are body temperature that increases above normal, namely more than 37.5°C. Meanwhile, minor symptoms include several more specific conditions. First, reddish skin, which could be an early indication of an increase in body temperature. Second, spasms, which are muscle reactions to very high body temperatures, where the muscles contract uncontrollably (Yang et al., 2020). Third, tachycardia, a condition in which the heart rate is faster than normal, which is often the body's response to an increase in temperature. Fourth, tachypnea, which refers to breathing that becomes rapid and shallow as the body's attempt to overcome excess heat. Lastly, the skin feels warm, this condition occurs due to vasodilation of blood vessels which is the body's mechanism for releasing heat (Broman et al., 2021).

RESEARCH METHOD

Research Design

This is a systematic review and meta-analysis that data collected from some databased published since 2017 until 2022. The difference between systematic review and meta-analysis is in the quantitative data analysis section. Systematic review is a study design that aims to systematically review and synthesize (combine) the results qualitatively from a number previous primary research that solves the problem same research. Meanwhile, Meta-analysis is designing epidemiological studies aims to study systematic and synthesizing (combine) quantitative estimation results from a number of previous studies that answered the problem the same research and can be combined (combinable).

Data collection

Elsevier, Science Direct, GoogleScholar, Springer Link, and PubMed are just a few of the internet databases from which the primary research study for this study was sourced. The keywords "*Warm Sponge*" OR "*Warm Compress*" OR "*Warm Therapy*" AND "*Hyperthermia*" OR "*Fever*" AND "*Children*" were helpful in finding publications for this study. The PRISMA flowchart was used to filter the number of articles that were obtained.

Step of Meta-Analysis

The five steps of the Meta-analysis are as follows:

1) Make research questions with PICO format (Population, Intervention, Comparison, Outcome). As for population: children; intervention: tepid water sponge; comparison: usual care; outcome: body temperature.
2) Search main study from e-database and non e-databse
3) Screening and cricital assessment for primary study (table. 1)
4) Present data extraction and synthesize an effect estimates using Review Manager (RevMan) 5.3
5) Perform data extraction and synthesize effect estimates using Review Manager (Rev-Man) 5.3.
6) Interpret the data and conclusions

Inclusion Criteria

The effectiveness of water sponge compress to lower body temperature in children met the inclusion requirements for this study, along with full-text and in English. The publication used a randomized controlled trial study design, articles from 2014 to 2022 were included, and the research on body temperature's findings contained a Mean and SD. The research subjects were kids.

Exclusion Criteria

Exclusion criteria were non-full texttarticles, not in English, observational, case-control, quasi-experimental studies, protocol studies, and pilot studies that article published before 2013.

Instruments

This systematic Review and Meta Analysis by PRISMA flow diagram guidelines, and the quality of the articles was assessed using Critical Appraisal from the Center for Evidence Based Medicine (CEBM, 2014)

Statistical Analysis

The collected research articles will be chosen in accordance with the inclusion criteria. The process of conducting research utilizing secondary data involves synthesizing the findings of earlier studies and processing the data using Review Manager (RevMan 5.3).

The odds ratio with 95% CI is calculated from the adjusted Mean and SD. The Forest Plot was used to describe effect sizes and the Funnel Plot to describe publication bias. This analysis was carried out by looking for the heterogeneity consistency value (I2) from the results of previous research that had been synthesized

RESULTS AND DISCUSSION

The study's main research articles were searched using Elsevier, Science Direct, Google Scholar, Elsevier, and PubMed. The process of screening articles with inclusion criteria using a PRISM flow (Figure 1). The First search process for articles found 973 articles that were filtered and obtained 684 articles, 87 of these articles discussed Edge Water Sponges and body temperature, and the other 8 articles discussed the effectiveness of warm water sponges on decreasing body temperature.

The main research articles were obtained from 2 continents, namely the Asian Region (China, Indonesia, Turkey), and the European Region (Germany) (Figure 2). The quality assessment of research articles was carried out quantitatively, where research articles were selected with a randomized controlled trial study design based on the Center for Evidence-Based Management (CEBM) in 2014. The results of the research quality assessment based on CEBM can be seen in Table 1.

Table 2 provides a summary of the eight articles on the topic of how using water sponge compresses can lower body temperature. Table 3 provides a summary of nine research publications discussing the impact of warm water sponges on hyperthermic children's body temperatures, as well as eight studies discussing the impact of water sponge compresses on lowering body temperatures in hyperthermic children.

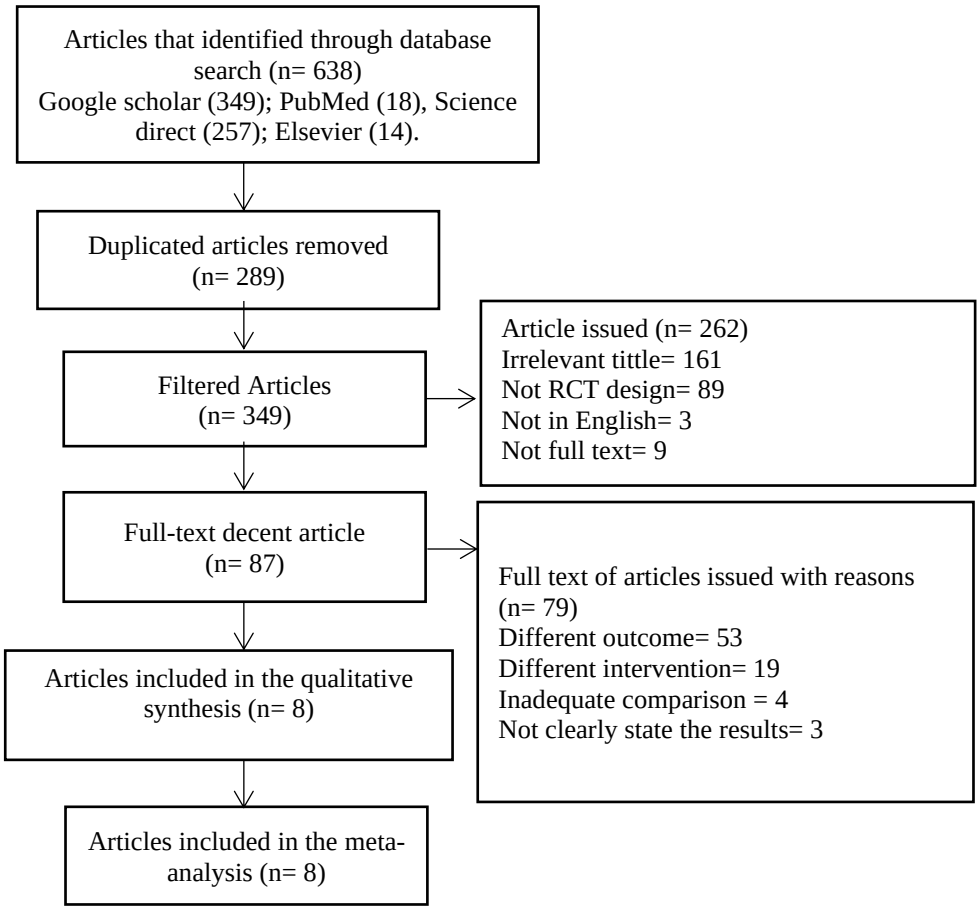

Figure 1 PRISMA flow diagram

Figure 2 Research Distribution Map

Table 1 The effectiveness of a randomized controlled trial study on the impact of tepid water sponges on lowering body temperature in hyperthermic youngsters is evaluated.

Primary Study	Criteria												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
Tasdemir and Efe (2019)	2	2	2	2	2	2	2	2	2	2	2	2	24
Dzulfaijah et al. (2017)	2	2	2	2	2	2	2	2	2	2	2	2	24
Souza et al. (2022)	2	2	2	2	2	2	2	2	2	2	2	2	24
Wang et al. (2022)	2	1	2	2	2	2	2	2	2	2	2	2	23
Vagedes et al. (2022)	2	2	2	2	2	2	2	2	2	2	2	2	24
Luo et al. (2017)	2	2	2	2	2	2	2	2	2	2	2	2	24
Lismayanti et al. (2021)	2	2	2	2	2	2	2	2	2	2	2	2	24
Putri et al. (2020)	2	1	2	2	2	2	2	2	2	2	2	2	23

Description of the question criteria:

1. Does the research explain in detail the issue it focuses on?
2. Does this article use the correct method to answer the research question?
3. Was the sample appropriately measured to reduce bias?
4. Are the subject and research explained in detail?
5. Are the research studied that used is valid and reliable?
6. Is sample measurement based on pre-study considerations?
7. Could a satisfactory response rate be achieved?
8. Can it achieve statistically significant values?
9. Are confidence interval scores included in the main results?
10. Can the research results be used in certain populations?
11. Maybe there are confounding factors that have not been listed?
12. Can local people apply the results of this research?

Description of scoring:

0= No

1= Doubt

2= Yes

Table 2 Description of Primary Studies

Author (Year)	Country	Sample		Study Design	Population	Intervention	Comparison	Outcome
		TWS	UC					
Tasdemir and Efe (2019)	Turkey	60	60	RCT	Late preterm infants	Sponge bathing	Usual care	Heart rate, respiration rate, oxygen saturation, body temperature
Dzulfaijah et al. (2017)	Indonesia	16	16	RCT	Children with hyperthermia	Water sponge technique	Usual care	Body temperature
Souza et al. (2022)	India	10	10	RCT	Febrile children	Wiping technique compression	Usual care	Temperature
Wang et al. (2022)	China	16	13	RCT	Knee osteoarthritis children.	Warm combine block compression	Warm compression	Temperature, functional performance
Vagedes et al. (2022)	Germany	13	13	RCT	Children of the Filderklinik.	Tepid water sponge	Usual care	Warmth.
Luo et al. (2017)	China	48	48	RCT	Febrile children.	Warm combine block compression	Usual care	Heart rate, respiration rate, oxygen saturation, body temperature
Lismayanti et al. (2021)	Indonesia	16	16	RCT	Febrile Critically Ill Adults	Sponge bathing	Usual care	Body Temperature and Hemodynamic Responses
Putri et al. (2020)	Indonesia	15	15	RCT	Fever children.	Tepid water sponge	Warm compress	Body temperature

Table 3 Mean, SD and total sample of Each Primary Studies

Author (Years)	Water Tepid Sponge			Usual Care		
	Mean	SD	n	Mean	SD	n
Tasdemir and Efe (2019)	38.0	0.9	60	38.9	0.6	60
Dzulfaijah et al. (2017)	37.3	0.8	16	38.7	1	16
Souza et al. (2022)	36.4	0.87	10	37.3	0.1	10
Wang et al. (2022)	38.1	0.79	16	39.0	0.56	13
Vagedes et al. (2022)	37.8	0.83	13	38.3	0.6	13
Luo et al. (2017)	37.9	0.5	48	38.6	0.55	48
Lismayanti et al. (2021)	36.3	0.7	16	37.4	0.1	16
Putri et al. (2020)	37.3	0.8	15	38.6	0.5	15

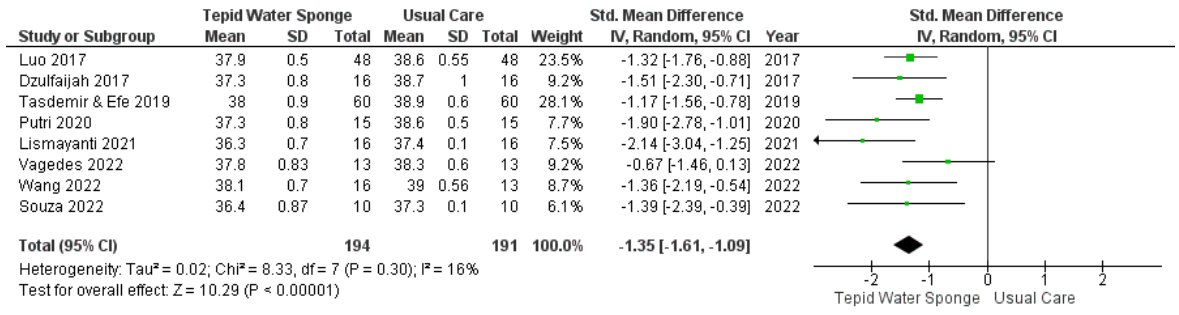

Figure 2 Forest Plot Effect of Tepid Water Sponge on Body Temperature in Children with Hyperthermia

The forest plot shows the effect of water sponge compresses on reducing the temperature in children suffering from hyperthermia and this effect can be declared statistically significant. Hyperthermic children who received tepid water sponge therapy experienced a decrease in temperature 1.35 units lower than children who only received usual care therapy, with (SMD = -1.31; 95% CI = -1.61 to -1.09; $p < 0.001$). Forest plots show low data heterogeneity ($I2 = 16\%$), so the approach used is the fixed effect model (FEM).

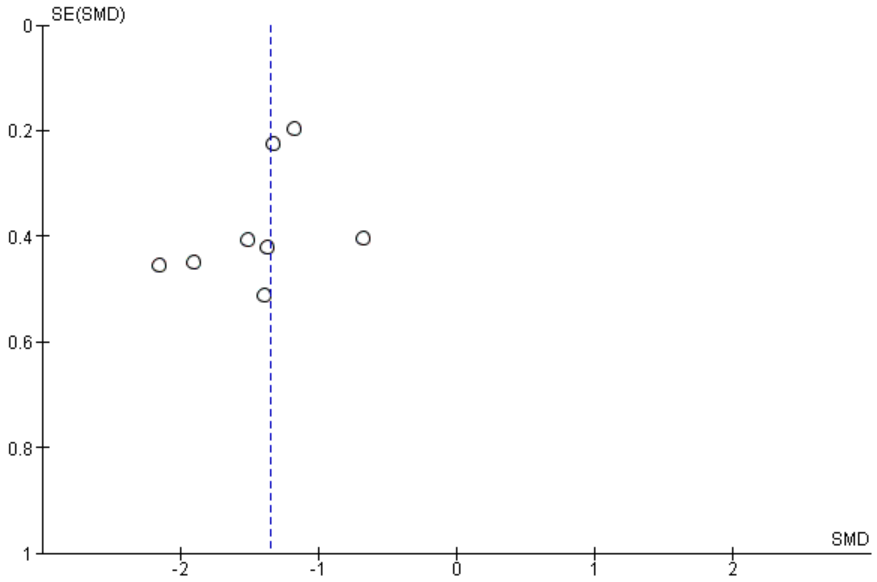

Figure 3 Forest Plot Effect of Tepid Water Sponge on Body Temperature in Children with Hyperthermia

The funnel plot demonstrates that there is publication bias because the distribution of effects lies to the left rather than the right of the vertical line of the mean. This publication bias includes a propensity to overstate the real effect (overestimate), as seen by the distribution of influence being significantly to the left of the average (diamond shape), which is placed to the left of the vertical line of hypothesis 0 in the forest plot.

DISCUSSION

This systematic study and meta-analysis research discuss the effectiveness of tepid water sponges to decreasing body temperature in hyperthermic children. This research is considered important because of the need to provide prompt treatment in cases of hyperthermia, thereby reducing the complications that will occur. The specific points that are important to consider include, the effect size indicates the magnitude of the treatment effect. It quantifies the reduction in body temperature achieved through the use of tepid water sponge. A larger effect size suggests a more substantial reduction in body temperature and indicates a higher effectiveness of the intervention.

Statistical significance is determined by p-values or confidence intervals. If the p-value is less than a predetermined threshold (often 0.05), or if the confidence interval does not include zero, it suggests that the reduction in body temperature achieved by the tepid water sponge is unlikely to occur by chance. Statistical significance supports the effectiveness of the intervention.

By considering these points in the meta-analysis, it is possible to asses the overall effectiveness of water sponge compress to decreasing children body temperature with hyperthermia. The findings will provide valuable insights into the magnitude and consistency of the treatment effect, allowing healthcare professionals to make informed decisions regarding the use of tepid water sponge as a therapeutic intervention.

The sponge should be soaked in water that is neither too hot nor too cold, but rather at a temperature that is slightly cooler than the body's temperature. When applied to the skin, the water in the sponge evaporates and cools the skin, which in turn helps to cool down the body's core temperature (Vagedes et al., 2022). Research from Hendrawati and Elvira (2019) shows that sponges can release heat with convection by moving heat molecules through direct contact with the skin surface.

Research Putri et al. (2021) showed that a water sponge can have the effect of reducing a child's body temperature by compressing it directly on the surface of the skin through which large blood vessels pass which causes circulation and increases capillary pressure. Blood oxygen and carbon dioxide pressure will bind and blood pH will decrease.

Agbolosu et al. (2020) stated that when water on the sponge is applied to the skin, it begins to evaporate due to the body's heat. This evaporation process absorbs heat from the skin and reduces its temperature. As the skin cools down, the blood flowing through the capillaries just beneath the skin's surface also cools, and this in turn helps to reduce the body's

core temperature. The cooling effect of a tepid sponge is most effective when the water is at a temperature that is slightly cooler than the body's temperature, usually around 27°C to 29°C (80.6°F to 84.2°F). This temperature range is effective because it allows for enough evaporation to occur while minimizing the risk of the body losing too much heat. In addition to evaporative cooling, the sponge's physical contact with the skin can also help to reduce body temperature by conducting heat away from the skin and into the sponge.

Dissipation of body heat is caused by the process of vasodilation, this process starts from stimulation of the hypothalamus by receptors. Furthermore, the effector system issues give signals and cause peripheral vasodilation, which in turn, the medulla oblongata vasomotor center located in the brain will regulate changes in the size of blood vessels that cause vasodilation (Mahdiyah et al., 2015).

Warm compresses can actually increase body temperature rather than reduce it. This is because warm temperatures can promote vasodilation, which is the dilation or widening of blood vessels. This can increase blood flow and heat to the affected area, potentially leading to a slight increase in body temperature (Firmansya et al., 2021). However, if a person is experiencing fever, water tepid sponge can help to reduce the sensation of fever by providing a comforting and soothing effect. When a warm compress is applied to the skin, it can help to promote relaxation and decrease muscle tension, which can help to reduce the perception of fever (Alves et al., 2008).

Aijaz et al. (2022) sated that it's important to note that while a warm compress may provide temporary relief for fever symptoms, it is not a substitute for medical treatment or management of the underlying cause of the fever. If a person has a persistent fever, they should seek medical attention to determine the cause and appropriate treatment. The implications of the study on the effectiveness of tepid water sponge on body temperature have practical and research-related implications. First, clinical practice: the findings of the study can inform clinical practice by providing evidence on the effectiveness of tepid water sponge in reducing body temperature in children with hyperthermia. Healthcare professionals can consider incorporating tepid water sponge as a therapeutic intervention in their management plans for hyperthermic children. It may become an essential component of first-line treatment or as an adjunct to other interventions.

Guidelines and protocols: the study can contribute to the development or revision of guidelines and protocols for the management of hyperthermia in children. Regulatory bodies and professional organizations can use the evidence from the meta-analysis to update their recommendations and protocols, ensuring that tepid water sponge is appropriately included as a recommended intervention. Optimization of Treatment: Future research can focus on optimizing the use of tepid water sponge for reducing body temperature. This can include investigating the optimal temperature and duration of the sponge, identifying the most effective technique for application, and exploring the potential benefits of combining tepid water sponge with other interventions. Such research can help refine the implementation of tepid water sponge and enhance its effectiveness.

Long-Term Outcomes: Future research can also explore the long-term outcomes associated with the use of tepid water sponge. This can involve assessing the impact of tepid water sponge on reducing the risk of complications related to hyperthermia, such as seizures or organ dysfunction. Long-term studies can provide insights into the potential benefits and effectiveness of tepid water sponge beyond immediate body temperature reduction.Overall, the study's implications for practice involve the integration of tepid water sponge into clinical management, while future research can further optimize the technique, compare it with other interventions, and explore long-term outcomes. These efforts will enhance our understanding and utilization of tepid water sponge as an effective therapeutic approach for managing hyperthermia in children.

This study has a search bias because researchers only use 4 databases namely PubMed, Google Scholar, SpringerLink, and ScienceDirect thus ignoring other database sources. This study also has a language bias, due to limitations in translating the language of the researcher so that only the article is used published in Indonesian and English ignore articles published in other languages.

CONCLUSION

The results of this study meta-analysis show that the effectiveness of warm water sponges in reducing body temperature in hyperthermic children in 5 countries namely, Germany, China, Turkey, Indonesia and India. The magnitude of the effect indicates a significant reduction in body temperature, indicating the therapeutic potential of the warm water sponge. These findings suggest that warm water sponges may be a valuable adjunct treatment in the management of hyperthermia in children. The novelty of this study lies in its comprehensive synthesis of existing evidence on the effectiveness of tepid water sponge through a meta-analysis approach. By pooling data from multiple studies, the meta-analysis provides a more robust and reliable estimate of the treatment effect, enhancing the understanding of tepid water sponge as a therapeutic intervention.

The recommendation for practice is tepid water sponge should be considered as an effective intervention for reducing body temperature in children with hyperthermia. Healthcare professionals should include tepid water sponge as a first-line or adjunctive treatment in the management plans for hyperthermic children. Guidelines and protocols for the management of hyperthermia in children should be updated to incorporate tepid water sponge as a recommended intervention. Further research should focus on optimizing the implementation of tepid water sponge, including

determining the appropriate temperature and duration of the sponge, as well as the most effective technique for application.

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