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Meta-Analysis
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Meta-Analysis: The Effect of HBM-Based Health Education on Obesity Prevention among Students

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ABSTRACT

Background: Students engage in various health-risk behaviors such as lack of physical activity and unhealthy diet. Obesity is a worldwide health problem with increased prevalence every year, both in developed and developing countries. This study aims to analyze and estimate the influence of HBM-based health education on obesity prevention in students.

Subject and Method: Meta-analysis was conducted according to the PRISMA flow diagram and PICO model. The search for articles in this study was through databases including PubMed, Google Scholar, Science Direct and Scopus. With keywords including: "Obesity" AND "Health Belief Model" OR "Health Belief" AND "Students". Full paper articles with RCT studies, research subjects were students, the relationship measure used was SMD, the outcome of the study was knowledge and perceived severity of obesity prevention. The analysis was conducted with RevMan 5.3 program.

Results: There are 12 articles with randomized control trial designs originating from Iran, Iraq, India, Thailand, Australia with 2,261 research samples. Meta-analysis of 8 randomized control trial studies concluded that students who received HBM-based health education had knowledge in preventing obesity by 1.65 times higher than those without HBM education (SMD= 1.65; 95% CI= 0.60 to 2.70; p= 0.002). Meta-analysis of 6 randomized control trial studies concluded that students who received HBM-based health education had a perceived severity in preventing obesity by 1.85 times higher than those without HBM education (SMD= 1.08; 95% CI = 0.52 to 1.64; p= 0.002).

Conclusion: HBM-based health education has a significant effect on increasing knowledge and perceived severity of obesity prevention in students.

Keywords: Students, obesity, health belief model

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BACKGROUND

Public health problems are no longer just infectious diseases, but there are also non-transmitted diseases and have threatened the quality of life of the community. In general, the problem of PTM or non-transmitted diseases is caused by the individual habits, one of the most common PTMs is obesity (Rosalinda & Nugroho 2022).

Lifestyle and behavior that do not

support the consumption of healthy and nutritious food cause individuals to have less control over the food they consume. Lifestyle affects the eating habits of a person or group of people and has certain impacts, especially related to nutrition. The prevalence of overweight is increasing very rapidly throughout the world, developed countries such as Europe, the USA, and Australia have reached dangerous levels. There are more people who are overweight than those who are malnourished worldwide. The combination of overweight and obesity in men is 65% and 56% in women in the UK (Miko & Pratiwi 2017).

Obesity is a condition in which excess fat accumulates under the skin and other body tissues, causing an imbalance between food intake and consumption, resulting in excess calories in the body. Obesity has begun to become a health problem worldwide with a prevalence that is always increasing every year, both in developed and developing countries. Obesity among adolescents is a global health problem, especially in high-income countries where more than 20% of children or adolescents are obese. The prevalence of obesity in adolescents has increased at least 4 times higher since 1985, which is 6.8% worldwide (Rosalinda & Nugroho 2022).

Research in America shows that fast food restaurants around schools will affect the eating patterns and habits of students at the school. Eventually, changes in eating habits and eating patterns will affect the number of students who are overweight and obese. In general, samples with good eating habits have a percentage of 56.2%, and those with poor eating habits are 43.8%. Excessive and high-energy eating patterns in adolescents tend to result in increased body weight composition which has an impact on the risk of obesity (Miko & Pratiwi 2017).

Self-control in adolescents is closely related to behavioral conditions that are formed based on the influence of stressful circumstances both from outside and from within. Self-control is formed from behavior that binds oneself and can be controlled. Self-control is very important for individuals to have, because it can regulate, direct, and control their behavior based on cognitive and psychological processes. Good self-control will produce expected behavior from the individual. Regulating self-control requires trust from the individual, and it is formed by the Health Belief Model theory, because this theory model can be used to guide health promotion and disease prevention programs, by explaining and predicting individual changes in health behavior, consisting of perceived vulnerability, perceived severity, perceived benefit, perceived barrier, perceived threat, self-control, cues to action (Padaallah et al. 2024).

One theory that can describe health actions is the Health Belief Model. The Health Belief Model is a theory of health behavior change and a psychological model used to predict health behavior by focusing on individual perceptions and beliefs about a disease. The structure of the Health Belief Model includes perceived susceptibility which is the perception of the risk of getting a disease, perceived seriousness is the perception of the severity of the disease, perceived benefit, and perceived barrier are the benefits and barriers felt in adopting preventive behavior and cues to action are their signals to act in the form of motivating factors inside and outside the family such as: friends, doctors, health care providers, media and educational resources. The Health Belief Model is used to predict preventive health behavior and to explain the role behavior of people with illness (Berhimpong *et al.* 2020).

This study aims to analyze previous primary studies in assessing the effect of HBM-based health education on obesity prevention in students.

SUBJECT AND METHOD

1. Study Design

Meta-analysis was conducted with PRISMA flow diagram using PubMed, Google Scholar, Science Direct and Scopus databases. The keywords including: "Obesity" AND "Health Belief Model" OR "Health Belief" AND "Students".

2. Steps of Meta-Analysis

Meta-analysis was carried out in 5 steps as follows:

1) Formulate research questions in PICO format (Population, Intervention, Comparison, Outcome).
2) Search for primary study articles from various electronic and non-electronic databases such as PubMed, Science Direct, Google Scholar, Scopus, and so on.
3) Conduct screening to determine inclusion exclusion criteria and conduct critical appraisal
4) Extract primary study outcome data and synthesize effect estimates using RevMan 5.3 application.
5) Interpret results and draw conclusions.

3. Inclusion Criteria

Full paper article with Randomized Control Trial study, research subjects were students, the relationship measure used was Mean SD, research outcomes were knowledge and perceived of the severity of obesity prevention.

4. Exclusion Criteria

Articles published in languages other than English. The study outcomes were not knowledge and perceived severity of obesity prevention, and the articles were published before 2013.

5. Definition of Operational Variable

Obesity is a condition where body weight exceeds normal limits due to the accumulation of excess fat in the body.

HBM is a model used to describe an individual's belief in healthy living behavior, so that the individual will carry out healthy behavior, this healthy behavior can be in the form of preventive behavior or use of health facilities.

Knowledge is something that is present and manifests in a person's soul and mind due to reactions, contact and relationships with the environment and nature around them.

Perceived severity is a belief in the level of danger of a disease or dangerous condition as a result of certain behavior.

6. Research Instrument

Quality assessment in this study used a critical appraisal checklist from the Randomized Control Trial study checklist.

7. Data Analysis

The articles in this study were collected according to the PRISMA diagram flow and analyzed using the Review Manager 5.3 application. The analysis was carried out by calculating the effect size and heterogeneity consistency value (I^2) of the selected research results.

RESULTS

The article search process was carried out through several journal databases including PubMed, Google Scholar, Science Direct and Scopus. The review process of related articles can be seen in the PRISMA flow diagram in Figure 1. Research related to the effect of HBM-based education on knowledge and perception of the severity of obesity prevention in students consists of 12 articles from the initial search process giving results of 1,580 articles, after the process of deleting published articles, 420 articles were obtained with 178 of them fulfilling the requirements for full text review, there were 12 articles that met the

quality assessment were included in quantitative synthesis using meta-analysis. Figure 2 shows research articles originating from 2 continents, namely Asia and Australia.

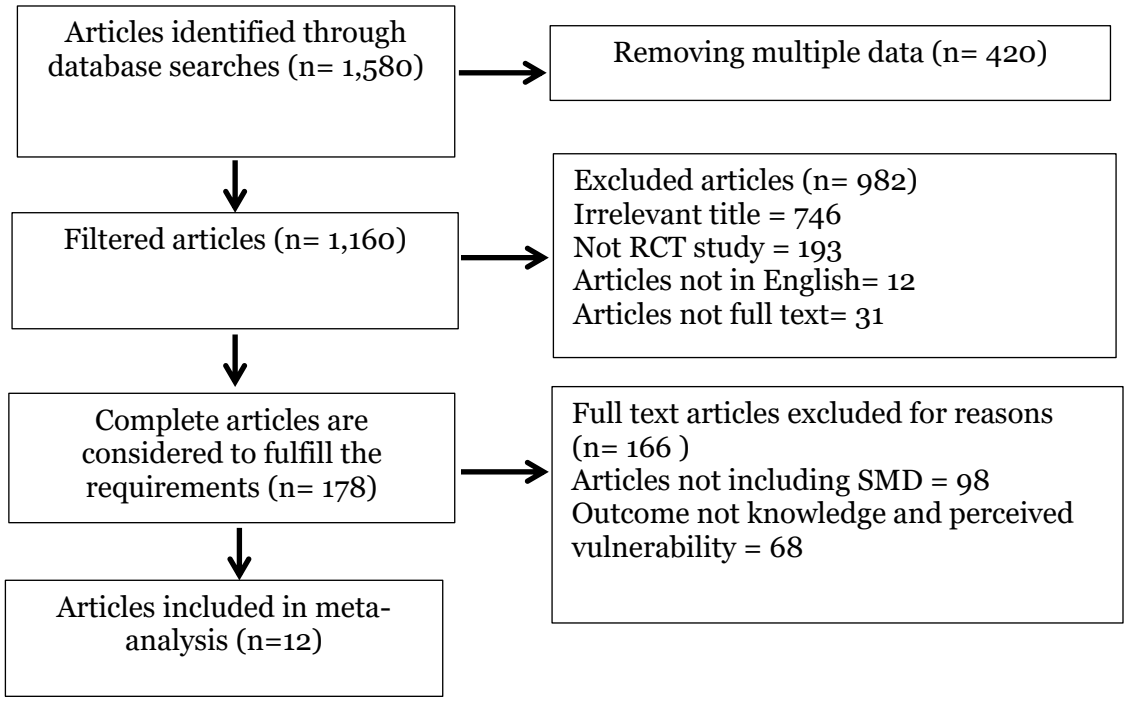

Figure 1. Prisma flow diagram of the effect of HBM-based education on preventing obesity in students

Figure 2. Map of research areas on the effect of HBM-based education on preventing obesity in students

The assessment of research quality was conducted quantitatively, where this study used research quality assessment for randomized control trial research. The

results of the research quality assessment can be seen in Table 1.

Table 1. Results of the quality assessment of a randomized control trial study on the effect of HBM-based education on preventing obesity in students.

Author (Year)	1				2		3		4			5		6	Total
	a	b	c	d	a	b	a	b	a	b	c	a	b		
Nourian et al. (2017)	2	2	2	2	2	2	2	0	0	2	2	2	2	2	24
Rabiei et al. (2017)	2	2	2	2	2	2	2	0	0	0	2	2	2	2	24
Noorbakhsh et al. (2017)	2	2	2	2	2	2	2	0	0	2	2	2	2	2	24
Abdeyazdan et al. (2017)	2	2	2	2	2	2	2	0	0	2	2	2	2	2	24
Khumros et al. (2018)	2	2	2	2	2	2	2	0	2	2	2	2	2	2	26
Rizvi et al. (2022)	2	2	2	2	2	2	2	0	2	2	2	2	2	2	26
Roockley et al. (2014)	2	2	2	2	2	2	2	0	2	2	2	2	2	2	26
Tavakoli et al. (2016)	2	2	2	2	2	2	2	0	1	1	2	2	2	2	24
Shahroodi et al. (2019)	2	2	2	2	2	2	2	0	2	1	2	2	2	2	25
Ahmed et al. (2022)	2	2	2	2	1	1	2	0	2	2	2	2	2	2	24
Khodaveisi et al. (2021)	2	2	2	2	2	2	2	0	1	2	2	2	2	2	25
Amiri et al. (2018)	2	2	2	2	2	2	2	0	2	2	2	2	2	2	26

Answer score descriptions:

0= No
1= Uncertain
2= Yes

Question criteria description

1 **Formulation of research questions in the acronym of PICO**

a = Is the population in the primary study the same as the population in the PICO meta-analysis?

b = Is the operational definition of the intervention, i.e. exposure status, in the primary study the same as the definition intended in the meta-analysis?

c = Is the operational definition of the comparison used in the primary study the same as the scheme planned in the meta-analysis? In RCTs, the comparator can receive either placebo or standard therapy.

d = Is the operational definition of the outcome variable studied in the primary study the same as that planned in the meta-analysis?

2 **Methods for selecting research subjects**

a = Is the sample selected from the population so that the sample is representative of the population?

b = Is the allocation of subjects to the experimental and control groups done by randomization? Random allocation is useful for controlling the influence of all confounding factors, both known and unknown to the researcher.

3 **Methods for measuring exposure (intervention) and outcome variables**

a = Are the intervention and outcome variables measured using the same instrument in all primary studies? If the outcome variables are measured using different instruments, then the effect size used in the meta-analysis should be a standardized version, such as Effect Size (Standardized Mean Difference).

b = If variables are measured on a categorical scale, are the cutoffs or categories used the same across primary studies?

4 **Design related bias**

a = Is double-blinding performed, meaning that the research subjects and the research assistants who helped measure the outcome variables were unaware of the intervention status of the research subjects?

b = Is there no possibility of "Loss-to-Follow-up Bias"?
c = Do the primary study investigators make efforts to prevent or overcome this bias (e.g., selecting highly motivated subjects, subjects who were easy to track, or providing incentives to subjects so that they would not drop out)

5 **Statistical analysis methods**

a = Are outcome data comparable between the experimental and control groups after the intervention? Since the research subjects have been randomly allocated into the experimental and control groups before the intervention, the two groups have been comparable in the distribution of confounding factors before the intervention, so to determine the effect of the intervention, it is sufficient to compare the outcomes of the two groups after the intervention.
b = Are all data analyzed according to randomization results? Randomization performed before the intervention is only effective in controlling the influence of confounding factors if all data are analyzed according to randomization.

6 Conflict of Interest
= Is there a possibility of a conflict of interest with the research sponsor, which could cause bias in concluding the research results?

Table 2. Summary of randomized control trial study articles in meta-analysis with each PICO (N=2,261)

Author (Year)	Country	Sample	P	I	C	O
Nourian et al. (2017)	Iran	90	Adolescent aged 12 - 18 years old	HBM-based healthy lifestyle education	No education given	Knowledge, Perceived Severity
Rabiei et al.(2017)	Iran	126	Student aged 6-10 years old	HBM-based nutrition education	Only given nutritional education	Knowledge, Perceived Severity
Noorbakhsh et al. (2017)	Iran	100	Male adolescent, aged 11-15 years old	HBM-based nutrition and physical activity education	Only given nutritional education	Knowledge
Abdeyazdan et al. (2017)	Iran	64	Elementary student	HBM-based healthy lifestyle education	Only given healthy lifestyle education	Knowledge
Khumros et al. (2018)	Thailand	479	Middle school student, aged 12-15 years old	HBM based education	Traditional school health education	Knowledge
Rizvi et al. (2022)	India	398	Middle school student	HBM based education	Only given health education	Knowledge
Roockley et al. (2014)	Australia	48	Student, aged 6-12 years old	HBM-based Obesity Education and Simulation	Obesity Education	Knowledge
Tavakoli et al. (2016)	Iran	242	College student	HBM based education	Only given health education	Knowledge
Shahroodi et al. (2019)	Iran	180	Elementary student	HBM-based nutrition education	Only given nutritional education	Perceived Severity
Ahmed et al. (2022)	Iraq	80	College student	HBM-based healthy lifestyle education	Only given health education	Perceived Severity
Khodaveisi et al. (2021)	Iran	130	College student	HBM-based health education	Only given health education	Perceived Severity

Author (Year)	Country	Sample	P	I	C	O
Amiri et al. (2018)	Iran	94	Military student	HBM-based health education	No education given	Perceived Severity

Table 3 shows that the effect estimates for each primary study to be included in this meta-analysis study are different. The extracted primary research data were then subjected to quantitative meta-analysis synthesis using RevMan 5.3.

Table 3. SMD of The influence of HBM-based health education on obesity prevention knowledge in students

Author (Year)	Intervention		Control	
	Mean	SD	Mean	SD
Nourian et al. (2017)	11.0	1.45	6.90	1.7
Rabiei et al. (2017)	70.94	13.36	46.81	11.48
Noorbakhsh et al. (2017)	93.2	13.3	42.1	14.4
Abdeyazdan et al. (2017)	23.34	0.94	20.12	1.26
Khumros et al. (2018)	111.17	6.18	81.99	11.54
Rizvi et al. (2022)	6.61	2.42	5.28	2.23
Roockley et al. (2014)	20.50	1.00	26.00	3.61
Tavakoli et al. (2016)	8.3	1.50	7.47	2.12

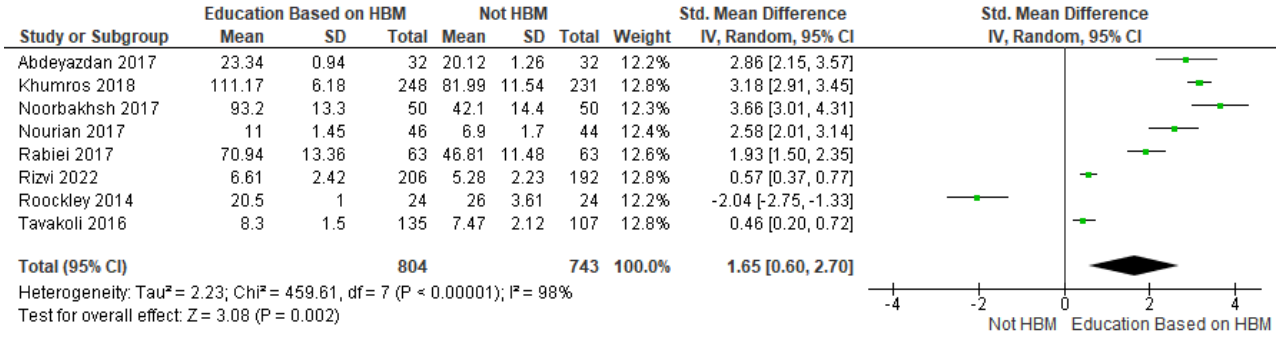

Figure 3. Forest plot of the effect of HBM-based health education on obesity prevention knowledge in students

Forest plot in Figure 3 shows that there is an effect of HBM-based education on knowledge. Students who receive HBM-based education have knowledge to prevent obesity by 1.65 times higher compared to students who do not receive education, and the effect is statistically significant (SMD = 1.65; 95% CI = 0.60 to 2.70; p = 0.002). Forest plot Figure 3. shows heterogeneous effect estimates (I^2= 98%; p < 0.001). Thus, the calculation of the average effect estimate using the random effect model approach.

The funnel plot in Figure 4 shows that the distribution of study effect estimates is more to the right than to the left of the vertical line of the average estimate, thus the funnel plot shows publication bias because the distribution of the effect is more to the right of the vertical line of the average, on the same side as the location of the star shape (diamond) of the average effect estimate, in the forest plot of Figure 4, then the publication bias tends to overestimate the effect on the other side.

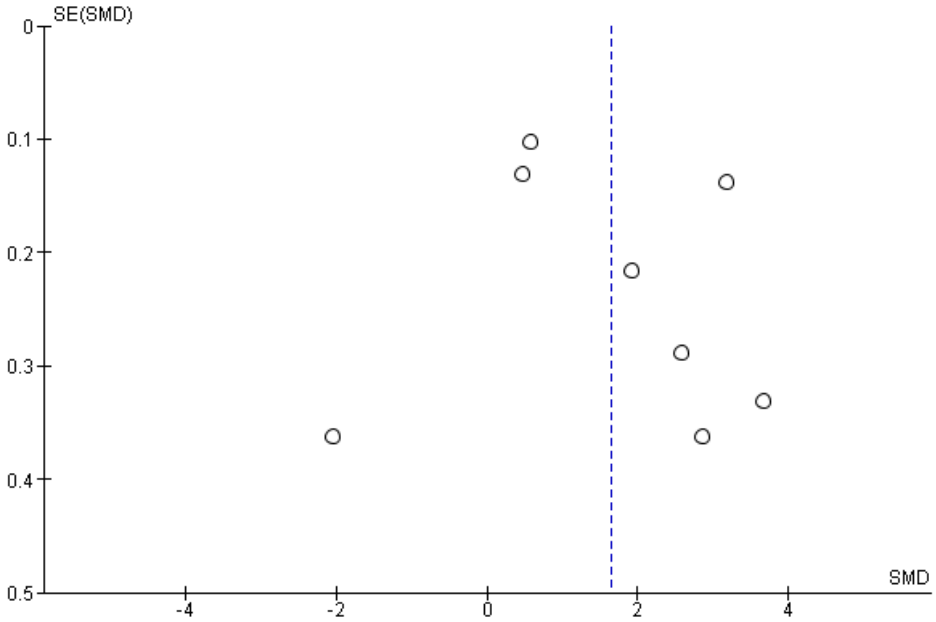

Figure 4. Funnel plot of the effect of HBM-based health education on obesity prevention knowledge in students

Table 4 shows that the effect estimates for each primary study to be included in this meta-analysis study are different. The extracted primary research data were then subjected to quantitative meta-analysis synthesis using RevMan 5.3.

Table 4. SMD of the effect of HBM-based health education on the perceived severity of obesity prevention in students

Author (Year)	Intervention		Control	
	Mean	SD	Mean	SD
Nourian *et al.* (2017)	20.5	2.40	19.6	2.10
Rabiei *et al.* (2017)	48.71	16.15	41.85	15.69
Shahroodi *et al.* (2019)	20.79	0.87	16.33	4.13
Ahmed *et al.* (2022)	3.24	0.63	2.35	0.44
Khodaveisi *et al.* (2021)	22.26	4.33	19.93	5.07
Amiri *et al.* (2018)	16.40	1.92	12.70	1.45

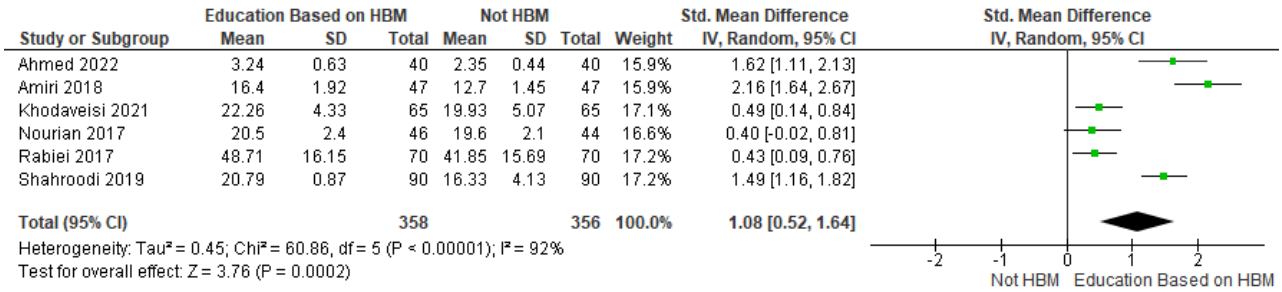

Figure 5. Forest plot of the effect of HBM-based health education on the perceived severity of obesity prevention in students

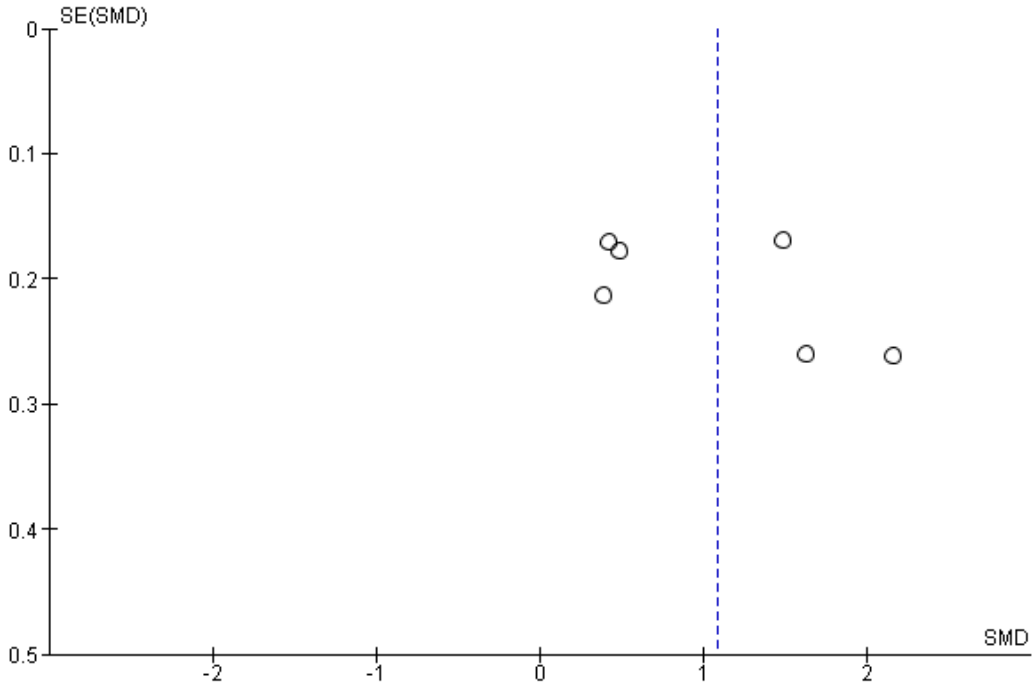

Figure 6. Funnel plot of the effect of HBM-based health education on the perceived severity of obesity prevention in students

Forest plot in Figure 5 shows that there is an effect of HBM-based education on the perception of severity. Students who receive HBM-based education have a perception of severity in preventing obesity by 1.08 times higher than students who do not receive education, and this effect is statistically significant (SMD = 1.08; 95% CI = 0.52 to 1.64; p = 0.002). The forest plot also shows heterogeneous effect estimates (I^2 = 92%; p < 0.001). Thus, the calculation of the average effect estimate using the random effect model approach.

The funnel plot in Figure 6 shows a more or less balanced distribution of effects on the right and left sides of the mean vertical line, thus not indicating publication bias.

DISCUSSIONS

1. The effect of HBM-based education on obesity prevention knowledge in students

A total of 8 randomized control trial studies originating from Iran, Thailand, India, and Australia. The sample size was 1,547. This meta-analysis concluded that there was an effect of HBM-based education on obesity prevention knowledge in students. Students who received HBM-based health education had knowledge in preventing obesity 1.65 times compared to those without HBM education (SMD = 1.65; 95% CI = 0.60 to 2.70; p = 0.002).

This is in line with research by Soliman et al (2018) who stated that there is a significant difference between students' knowledge and practices regarding obesity, healthy food, and exercise after implementing HBM-based education (Mean= 32.05; SD= 8.86).

2. The effect of HBM-based education on the perceived severity of obesity prevention in students

Meta-analysis of 6 randomized control trial studies concluded that students who received HBM-based health education had a perceived severity in preventing obesity by 1.85 times higher than those who did

not receive HBM education (SMD= 1.08; CI 95%= 0.52 to 1.64; p=0.002).

This is in line with the research of Miky et al. (2022), which revealed that there was a very significant difference in the knowledge of obese female middle school students after the implementation of HBM-based education (Mean= 5.84; SD= 0.37, p <0.001). From this study, it can be concluded that the implementation of the health belief model for junior high schools causes a significant increase in aspects of knowledge and lifestyle.

A training program based on the health belief model and social support intervention has the potential to improve the perceived severity of obesity prevention (Mean= 33.66; SD= 4.31). The findings of this study indicate the efficacy of a training program based on the HBM and a social support approach in increasing social support and physical activity in women. In addition, this study evaluated long-term outcomes in a population with different social, economic, and cultural backgrounds (Faqih et al., 2024).

A research by King et al. (2014) found that HBM is useful in exploring students' perceptions and involvement in vigorous physical activity in obesity prevention. One of the models used to identify factors related to health behavior is the Health Belief Model. HBM has been used to predict health behavior in various populations.

AUTHORS CONTRIBUTION

Ayu Novita Wulandari as a researcher who selected the topic, searched for and collected research data. Titik Haryanti and Iik Sartika analyzed the data and reviewed the research documents.

FUNDING AND SPONSORSHIP

This study was self-funded.

CONFLICT OF INTEREST

There was no conflict of interest in this study.

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