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Meta-Analysis: Effectiveness of Health Education Based on Health Belief Model in Type 2 Diabetes Mellitus Patients

Atika Afniratri[1)], Didik Tamtomo[2)], Bhisma Murti[1)]

[1)]Master's Program in Public Health, Universitas Sebelas Maret
[2)]Faculty of Medicine, Universitas Sebelas Maret

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ABSTRACT

Background: The effectiveness of health education based on the Health Belief Model in diabetes mellitus patients can improve diabetes mellitus prevention behavior. This study aimed to determine the effect of the application of the Health Belief Model on health education in patients with diabetes mellitus.
Subjects and Method: A systematic review and meta-analysis was performed using the PRISMA guidelines and the PICO model including Population= Type 2 diabetes patients; Intervention = Education based on the Health Belief Model; Comparison= Not using an educational method based on the Health Belief Model; Outcome= Perceived vulnerability, Perceived compliance, Perceived benefits, Perceived obstacles. Articles are collected from PubMed, Science Direct, and Google Schoolar. The keywords used "Health Belief Model" AND "DM" OR "Diabetes Mellitus" AND "Type-2". A total of 8 articles met the inclusion criteria, namely primary full text paper, randomized controlled trial study design, based on the Health Belief Model, and outcomes in the form of perceptions of vulnerability, perceived compliance, perceived benefits, perceived obstacles for the meta-analysis were then assessed using RevMan 5.3.
Results: Meta-analyses from Iran, India and Turkey showed that diabetes patients who were given education had an average perceived susceptibility score 1.37 units higher than those without education (SMD= 1.37; 95% CI= 0.74 to 2.01; p= 0.050). Diabetes patients who received education or education had an average severity perception score of 0.86 units higher than those without education (SMD= 0.86; 95% CI= 0.23 to 1.48; p= 0.007). Diabetes patients who received education on average had a perceived benefit score of 1.02 units higher than those who did not receive education (SMD= 1.02; 95% CI= 0.54 to 1.50; p < 0.001).
Conclusion: Education based on the health belief model is effective for increasing perceptions of vulnerability, perceptions of adherence, and perceptions of benefits in diabetes patients with type 2 diabetes mellitus.

Keywords: health belief model, diabetes mellitus, perceived vulnerability, perceived severity, perceived barriers and perceived benefits.

Correspondence:
Atika Afniratri. Master's Program in Public Health, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta, Central Java 57126, Indonesia. Email: atikahafniratri@gmail.com. Mobile: +6281388-352834.

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BACKGROUND

Diabetes mellitus is a disease of the metabolic system which is characterized by high levels of glucose in the blood, damage to pancreatic beta cells resulting in impaired performance of insulin and both of these (Winta, 2018). Diabetes and its complications often place a heavy burden on the health system and on individuals. Diabetes Mellitus is one of the second biggest health problems which is shown in data from a global study in 2011 (Sadeghi, 2017).

The number of people with Diabetes Mellitus reached 366 million people. Based on data from the International Diabetes Federation (IDF) the global prevalence rate of DM sufferers in 2012 was 8.4% of the world's population. There was an increase to 382 cases in 2013. IDF estimates that in 2035 the number of incidents of DM will increase to 55% (592 million) among DM sufferers aged 40-59 years (IDF, 2013). Indonesia is the 7th country with the highest DM incidence with 8.5 million sufferers after China (98.4 million), India (65.1 million), America (24.4 million), Brazil (11.9 million), Russia (10.9 million), Mexico (8.7 million)), Indonesia (8.5 million), Germany (7.6 million), Egypt (7.5 million) and Japan (7.2 million) (Umboh et al., 2022).

Controlling blood glucose and reducing diabetes complications is one of the main goals of diabetes treatment (ADA, 2017). Treatment adherence is very important for optimal diabetes treatment. Patients who are undergoing treatment are influenced by several factors including therapy management, factors related to individual patients and their close relatives, demographic socioeconomic factors and related diseases (Aigner et al., 2017).

Behavioral theory that is widely used in the health sector, one of which is the Health Belief Model (HBM). Chandra (2022) explained, the Health Belief Model (HBM) is a theory that was developed and is often used in health promotion as education to reduce the number of cases of diabetes mellitus. The Health Belief Model assumes that appropriate health behaviors are formed based on one's own beliefs. In particular, people show good reactivity to health when they feel at risk (Perceived Susceptibility), the risk is very serious (Perceived Severity) and behavior change is beneficial to them (Perceived Benefit) and they can remove barriers to health behavior (Perceived Barriers) (Sadegi, 2017).

The aim of this study was to determine the effectiveness of health education based on the Health Belief Model in patients with type 2 diabetes mellitus.

SUBJECTS AND METHOD

1. Study Design

This study uses a systematic review and meta-analysis method, which is a way of analyzing data derived from primary studies from databases based on PRISMA diagrams. The search for articles in this study used electronic databases such as PubMed, Science Direct, Google Scholar and Proquest. The keywords used in the database search were “Health Belief Model” AND “DM” OR “Diabetes Mellitus” AND “Type-2”.

2. Step of Meta-Analysis

The meta-analysis was carried out in five steps as follows:

1) Formulate research questions in the PICO.
2) Search for primary study articles from various electronic and non-electronic databases.
3) Conduct screening and critical assessment of primary research articles.
4) Perform data extraction and synthesize effect estimates into RevMan 5.3.
5) Interpret and conclude the results

3. Inclusion Criteria

Inclusion criteria in this study were full text paper primary research articles using a cross-sectional study design, analysis was carried out using a multivariate Randomized Controlled Trial (RCT), research subjects of diabetes mellitus patients, interventions in the form of perceived high benefits, perceived high seriousness, perceived vulnerability tall.

4. Exclusion Criteria

Research articles published before 2013 and after 2023, outcomes from studies that do not comply with the PICO criteria or formula in research, articles that do not include human resources, and research articles published other than English.

5. Operational Definition of Variables

Article search was carried out by considering the eligibility criteria determined using the PICO model. P= diabetes mellitus patients; I = Education based on the Health Belief Model; C= Not using an educational method based on the Health Belief Model; O= Perceived vulnerability, Perceived compliance, Perceived benefits, Perceived obstacles.

Perceived vulnerability is a belief in one's self related to self-susceptibility which will have an impact on health so that it will encourage a person to change to a healthier behavior.

Perceived severity is an assessment of diabetes mellitus causing death and loss, as well as an assessment of the resulting consequences.

Perceived benefit is a patient's perception factor about the benefits of preventive measures to prevent or delay the possibility of disease complications due to type 2 diabetes.

The health belief model is a theory that explains preventive behavior and individual responses to a disease, confirming perceived benefits, perceived seriousness, and perceived vulnerability in health behavior decisions.

6. Instruments

This review will be analyzed systematically using a meta-analysis guide, namely Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) and using a critical assessment checklist Critical Appraisal Checklist for RCT study.

7. Data analysis

The data in this study were analyzed using the Review Manager application (RevMan 5.4). Forest plots and funnel plots are used to determine the effect size and heterogeneity of the data. Data processing was carried out based on variations between studies, namely the random effect model.

RESULTS

The process of searching for articles in this meta-analysis is by searching through journal databases, namely PubMed, Science Direct, and Google Scholar with a time span between 2010-2021. The keywords used in the database search included “Health Belief Model” AND “DM” OR “Diabetes Mellitus” AND “Type-2”. The process of searching for articles according to the PRISMA flow diagram can be seen as follows.

Figure 1 showed the initial search process which displays a total of 1,152 articles. After the process of deleting articles that were duplicated in more than one journal, 425 articles were obtained, 181 of which met the requirements for further full text review. Then there were 8 articles that met the requirements for a full text review.

Figure 2 showed an overview of the research areas used in this meta-analysis, namely the Asian Continent. There were 8 articles at the end of the review process that met the quantitative requirements. All articles use a Randomized Controlled Trial study.

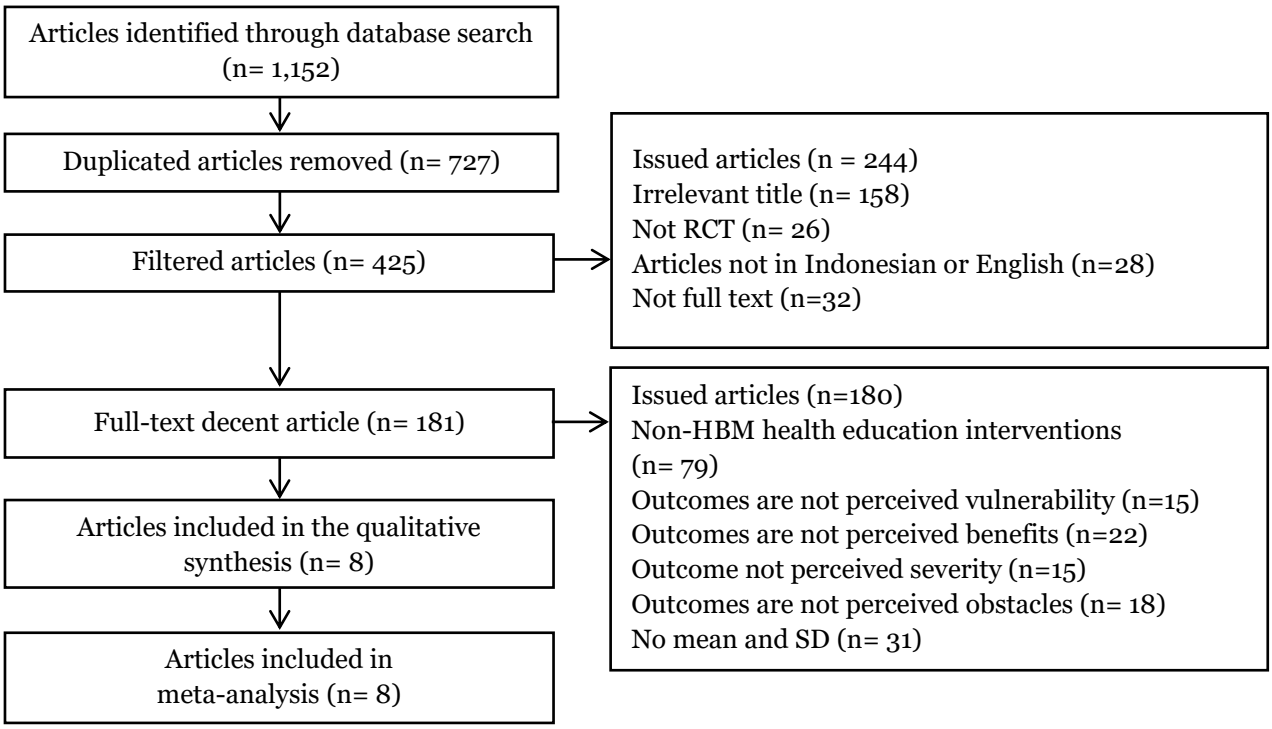

Figure 1. Results of PRISMA Flow Diagrams

Figure 2. Research Distribution Map

Table 1. Critical Appraisal of a Randomized Controlled Trial Study of Health Education Based on the Health Belief Model in Type 2 Diabetes Mellitus Patients

Primary Study	Criteria							
	1	2	3	4	5	6	7	Total
Jalilian et al. (2014)	2	2	2	2	2	2	2	14
Mohammadi et al (2017)	2	2	2	2	2	2	2	14
Sharifirad et al. (2009)	2	2	2	2	2	2	2	14
Bayat et al. (2013)	2	1	2	2	2	2	2	14

Primary Study	Criteria							
	1	2	3	4	5	6	7	Total
Safajou et al. (2021)	2	2	2	2	2	2	2	14
Singh et al. (2021)	2	2	2	2	2	2	2	14
Kashfi et al. (2012)	2	2	2	2	2	2	2	14
Akupunar et al. (2014)	2	2	2	2	2	2	2	14

Description of the question criteria:

1. Is the population in the primary study the same as the population in the PICO meta-analysis??
2. method for selecting research subjects:
   - Descriptive (prevalence) randomized controlled trial study: Was the sample chosen at random?
   - Randomized controlled trial analytic studies: Was the sample chosen randomly or purposively?
3. Methods for measuring comparisons (intervention) and outcome variables:
   - Were exposure/intervention and outcome variables measured by the same instrument (measuring instrument) in all primary studies?
   - If variables are measured on a categorical scale, are the cutoffs or categories used the same across primary studies?
4. Bias of the design:
   - How much is the response rate?
   - Is non-response related to outcomes?
5. Methods to control confounding:
   - Is there any confusion in the results / conclusions of the primary study?
   - Did the primary study investigator use appropriate methods to control for the effects of ambiguity?
6. Method of statistical analysis:
   - In a randomized controlled trial, was a multivariate analysis performed?
   - Multivariate analysis includes multiple linear regression analysis, multiple logistic regression analysis, Cox regression analysis.
7. Is there a conflict of interest with the research sponsor?

Description of scoring:

0= No; 1= Hesitate; 2= Yes

Table 1 describes the results of the quality assessment of the primary studies included in the meta-analysis. Table 2 showed there are 8 articles with a randomized controlled trial study regarding the application of the theory of health belief model regarding health education in patients with type 2 diabetes mellitus using perceptions of susceptibility, barriers, severity, and perceived benefits with a total sample of 1,218. This research was conducted in seven countries including India, Iran and Türkiye.

Table 3 showed the estimated effects of all primary studies included in the meta-analysis of HBM-based health education on perceptions of susceptibility in type 2 diabetes mellitus patients.

Table 2. Description of the primary study of the effectiveness of HBM-based health education in patients with type 2 diabetes mellitus

Author (years)	Country	Sample	P	I	C	O
Jalilian et al. (2014)	Iran	120	Referral patient	HBS-based health education	Without HBM-based health education	Perceived benefit, severity, and susceptibility
Mohammadi et al. (2017)	Iran	240	Type 2 DM patients aged 30 – 65 years	HBM-based health education	Without HBM-based health education	Perceived benefit, severity susceptibility
Sharifirad et al. (2009)	Iran	88	Patients with DM type 2 aged 30-60 years	HBM-based health education	Without HBM-based health education	Perceived benefit, susceptibility, severity
Bayat et al. (2013)	Iran	120	DM patient aged 36 – 55 years	HBM-based health education	Without HBM-based health education	Perceived benefits, susceptibility, severity
Safajou et al. (2021)	Iran	143	Diabetic prone students	HBM-based health education	Without HBM-based health education	Perceived benefits, susceptibility, severity
Singh et al. (2021)	India	200	Patients with type 2 DM aged 40-60 years	HBM-based health education	Without HBM-based health education	Perceived susceptibility
Kashfi et al. (2012)	Iran	100	DM patient	HBM-based health education	Without HBM-based health education	Perceived susceptibility and severity
Akupunar et al. (2014)	Turkey	207	DM patient	HBM-based health education	Without HBM-based health education	Perceived benefits, susceptibility, severity

Table 3. Estimated effects of all primary studies included in the meta-analysis of HBM-based health education on perceptions of susceptibility in type 2 diabetes mellitus patients.

Author (year)	Education			Without educational education		
	Mean	SD	Total	Mean	SD	Total
Jalilian et al. (2014)	16.52	1.77	60	14.68	1.62	68
Mohammadi et al. (2017)	17.78	2.2	60	15.95	1.4	60
Sharifirad et al. (2009)	13.76	1.48	30	12.57	2.17	30
Bayat et al. (2013)	73.71	7.8	50	51.08	9.11	50
Safajou et al. (2021)	24.1	1.6	100	23	1.6	100
Singh et al. (2021)	30.15	3.82	73	28.75	5.37	70
Kashfi et al. (2012)	81	13	44	50	18	44
Akupunar et al. (2014)	23.78	3.65	100	14.78	2.78	100

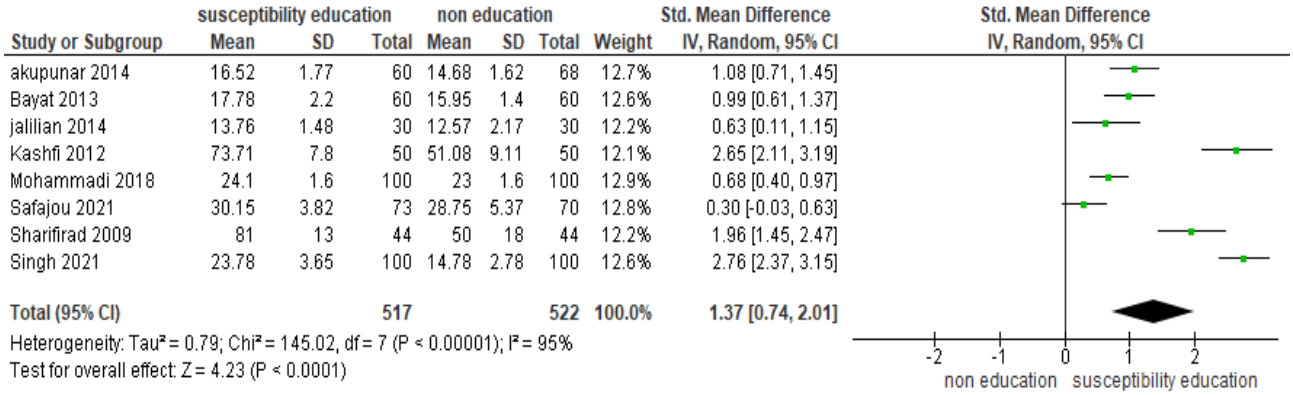

Figure 3. Forest plot of HBM-based health education on perceived susceptibility in patients with type 2 diabetes mellitus

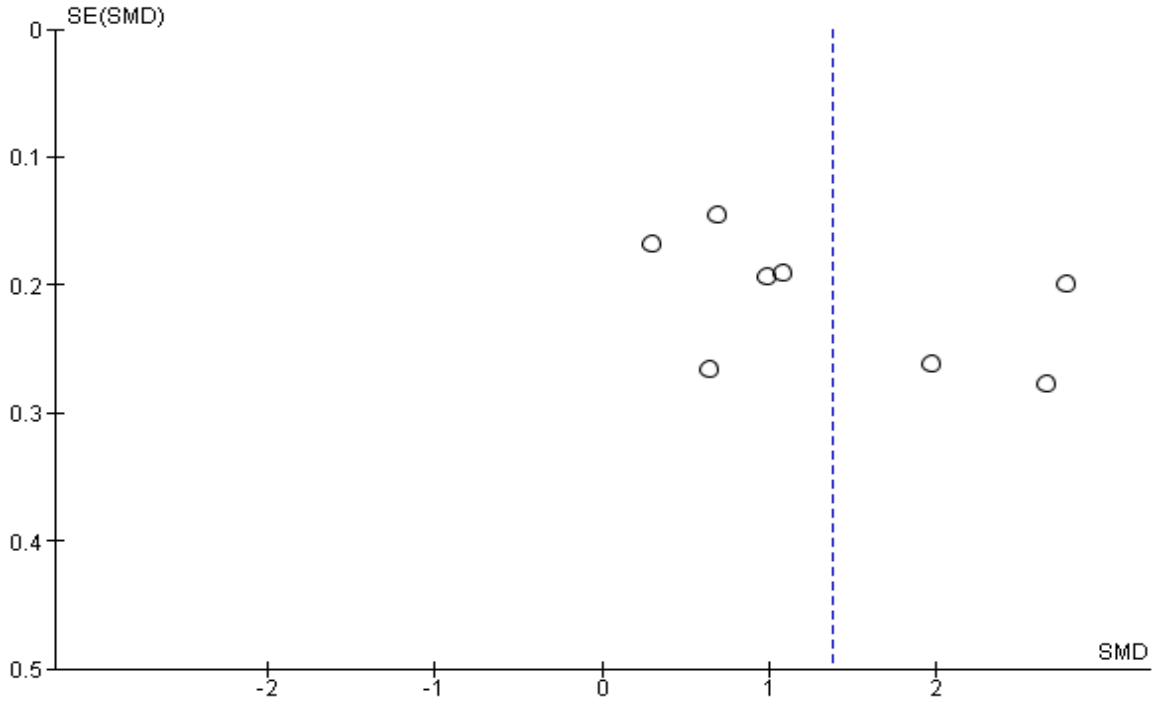

Figure 4. Funnel plot of HBM-based health education on perceived susceptibility in patients with type 2 diabetes mellitus

The forest plot in Figure 3 shows that the provision of educational education can increase the preventive behavior of diabetes patients and the effect is statistically significant. Diabetes patients who were given education on average experienced an increase in preventive diabetes behavior 2.76 higher than those without education (SMD= 1.37; 95% CI= 0.74 to 2.01; p= 0.050). The forest plot shows high heterogeneity of effect estimates between primary studies (I^2= 96%; p< 0.001). Likewise, the calculation of the average effect estimate is carried out using the Random Effect Model approach.

The funnel plot in Figure 4 shows that the distribution of estimates between studies is asymmetric, namely the distribution or distribution of effect estimates to the left of the vertical line of the average effect

estimates is relatively greater than to the right (overestimate). Thus this funnel plot indicates publication bias.

Table 4. Estimated effects of all primary studies included in the meta-analysis of HBM-based health education on perceptions of severity in patients with type 2 diabetes mellitus.

Author (year)	Education			Without educational education		
	Mean	SD	Total	Mean	SD	Total
Akpunar dan Kilic (2014)	12.42	1.14	60	11.85	1.62	68
Bayat et al. (2013)	24.12	0.9	60	21.62	1.4	60
Jalilian et al. (2014)	42.33	3.39	30	40.73	4.88	30
Kashfi et al. (2012)	74.16	3.17	50	56.36	10.13	50
Mohammadi et al. (2017)	19.9	1.26	100	18.8	1.49	100
Safajou et al. (2021)	26.77	3.66	73	25.61	4.17	70
Sharifirad et al. (2009)	56	15	44	60	16	44

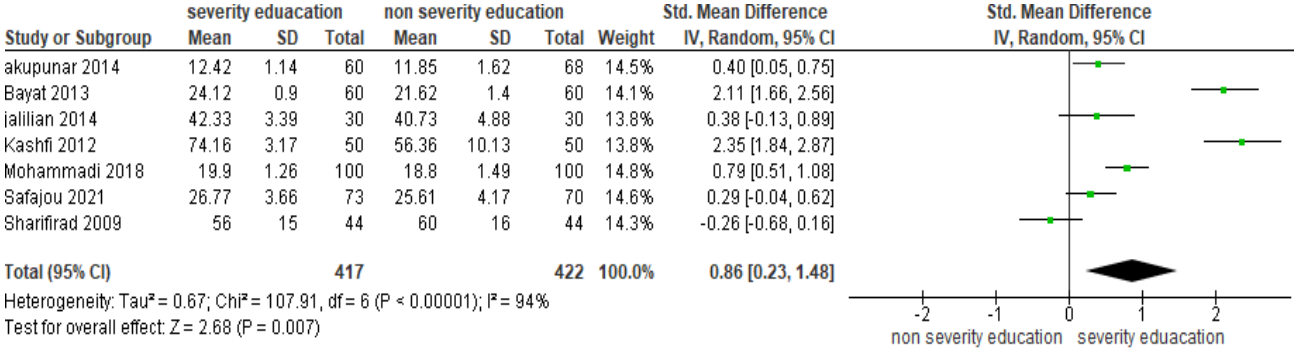

Figure 5. Forest plot of HBM-based health education on perceptions of severity in patients with type 2 diabetes mellitus

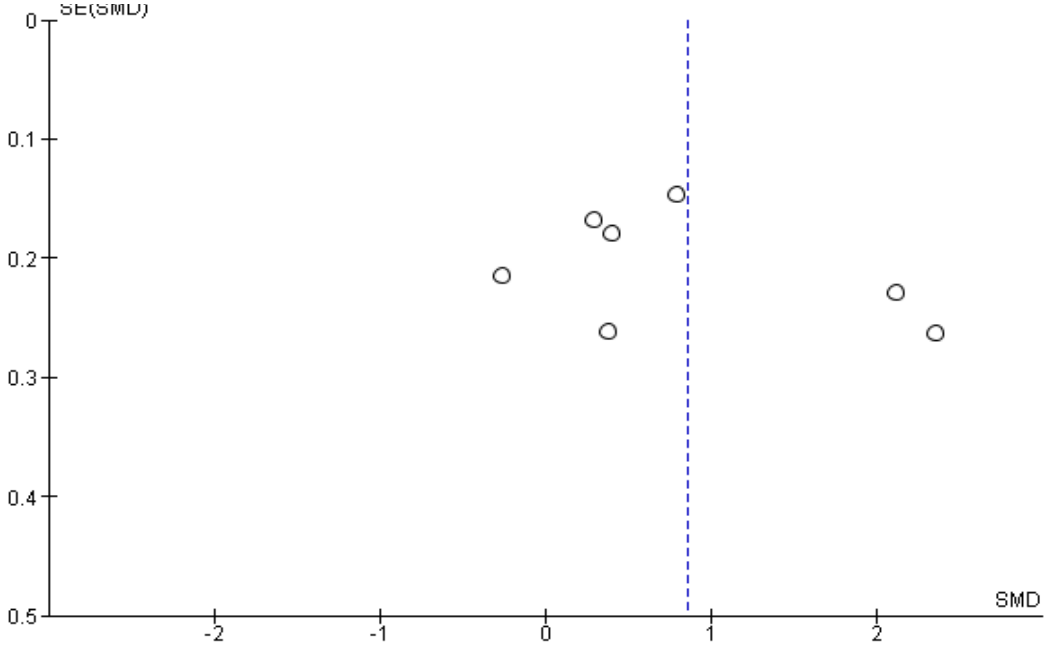

Figure 6. Funnel plot of HBM-based health education on perceived of severity in patients with type 2 diabetes mellitus

The forest plot in figure 5 shows that there is an effect of education on the perceived severity of preventive behavior in patients with type 2 diabetes mellitus. Diabetes patients who received education or education on average had a perceived severity score of 0.86 units higher than those without education with this result being statistically significant (SMD= 0.86; 95% CI= 0.23 to 1.48; p= 0.007). Forest plots show high heterogeneity of effect estimates between primary studies I^2= 94%; p<0.001. Likewise, the calculation of the average effect estimate is carried out using the random effect model approach.

The funnel plot in figure 6 showed the distribution of effect estimates that are mostly located on the left than on the right of the average vertical line. Thus the funnel plot suffers from publication bias.

Table 5. Estimated effects of all primary studies included in the meta-analysis of HBM-based health education on perceived benefit in patients with type 2 DM

Author (year)	Education			Without educational education		
	Mean	SD	Total	Mean	SD	Total
Akpunar dan Kilic (2014)	31.55	2.9	60	29.99	3.08	68
Bayat et al. (2013)	19.18	0.9	60	16.77	1.8	60
Jalilian et al. (2014)	26.21	1.72	30	24.9	2.39	30
Mohammadi et al. (2017)	32	2	100	29.3	2.81	100
Safajou et al. (2021)	32.6	3.17	73	31.11	5.07	70
Sharifirad et al. (2009)	81	14	44	52	16	44

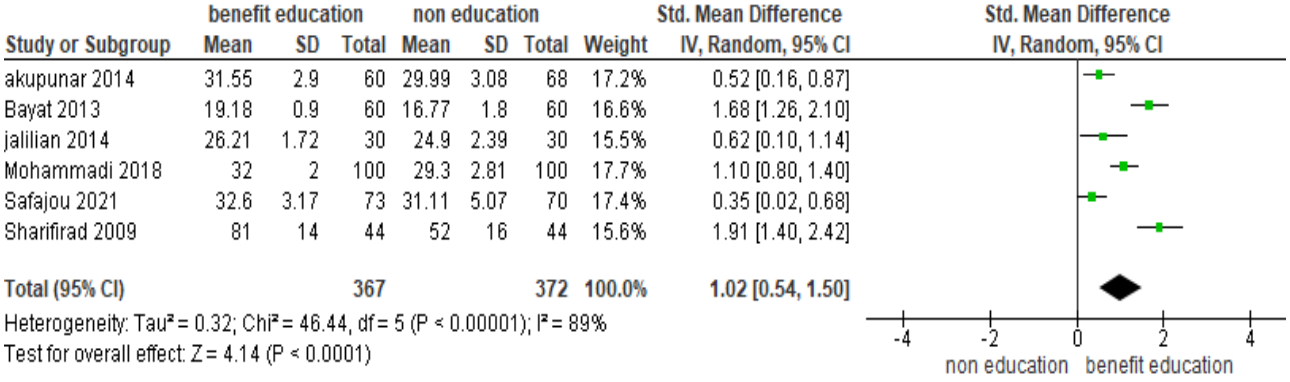

Figure 7. Forest plot of HBM-based health education on perceived benefits in patients with type 2 diabetes mellitus

The forest plot in figure 7 shows that there is an effect of education on the perceived benefits of preventive behavior in type 2 diabetes patients. Diabetes patients who received education on average had a perceived benefit score of 1.02 units higher than those who did not receive education and the effect was significant (SMD= 1.02; CI 95%= 0.54 to 1.50; p< 0.001). The forest plot shows high heterogeneity of effect estimates between primary studies (I^2= 96%; p< 0.001). Likewise, the calculation of the average effect estimate is carried out using the random effect model approach.

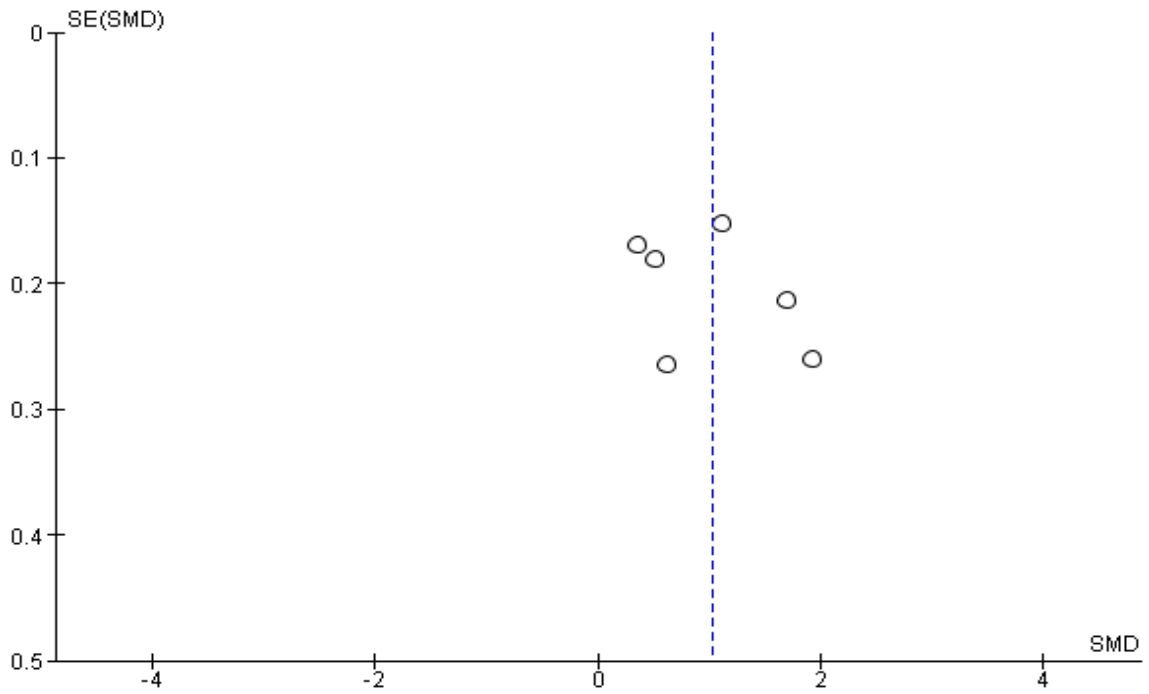

Figure 8. Funnel plot of HBM-based health education on perceived benefits in patients with type 2 diabetes mellitus

The funnel plot in figure 8shows a more or less symmetrical distribution of effect estimates to the right and left of the mean effect estimate line. Thus, the funnel plot does not show bias (underestimate).

DISCUSSION

Systematic review research and meta-analysis in this study themed the application of the theory of health belief model regarding health education in patients with type 2 diabetes mellitus. The interventions in this study were perceived vulnerability, perceived severity, perceived barriers and perceived benefits.

Diabetes mellitus is a disease of the metabolic system characterized by high levels of glucose in the blood, damage to pancreatic beta cells resulting in impaired performance of insulin or both of these. Diabetes and its complications often place a heavy burden on the health system and on individuals. Diabetes Mellitus is one of the second biggest health problems as shown in data from a global study in 2011 (Goorabi, 2017). ADA (2017) argues that, controlling blood glucose and reducing diabetes complications is one of the main goals of diabetes treatment. Treatment adherence is very important for optimal diabetes treatment. Patients who are undergoing treatment are influenced by several factors including therapy management, factors related to individual patients and their close relatives, demographic socioeconomic factors and related diseases (Lagua et al., 2014).

1. Health education on perceived benefits

Someone with a productive age will have the possibility of getting health education to someone who has a lower perceived benefit. Usually because someone knows more about the benefits of health education based on the health belief model in diabetic patients to prevent type 2 diabetes mellitus.

One of the behavioral theories that is widely used in the health sector is the

Health Belief Model (HBM). Becker (1970) explained, the Health Belief Model (HBM) is a theory developed and often used in health promotion as education to reduce the number of cases of diabetes mellitus. The Health Belief Model assumes that appropriate health behaviors are formed based on one's own beliefs.

With chronic disease conditions accompanied by various other external factors will have a widespread negative impact on sufferers. Education based on the Health Belief Model (HBM) has been widely used and has shown its success in improving mental health, stress management and even in other studies, conveying that there is an increase in bio, psycho, social and spiritual aspects in patients with various chronic diseases. In another study conducted to provide Health Belief Model education for 3 months with the amount given every 2 days showed a significant improvement in the value of the HBM scale and the COPD-Self efficacy scale which included measuring indications of the dyspnea scale, ADL and walking for 6 minutes.

The effectiveness of HBM-based educational interventions in overcoming various problems in chronic diseases. Thus, perceived benefits can influence health education based on the health belief model in type 2 diabetes mellitus patients. Diabetes patients who received education on average had a perceived benefit score of 1.02 units higher than those who did not receive education and the effect was significant (SMD= 1.02; 95% CI= 0.54 to 1.50; p<0.001). The forest plot shows high heterogeneity of effect estimates between primary studies I^2= 96%; p<0.001. Likewise, the calculation of the average effect estimate is carried out using the random effect model approach.

2. Health education on perceptions of vulnerability

Akpunar (2014) explained that his research was conducted with the aim of knowing the impact of diabetes training given to type 2 diabetes patients on health beliefs, level of knowledge, and diabetes management. The research sample consisted of 128 patients, 60 experimental persons and 68 controls. A 6-month educational programmed, including a diabetes training booklet and group interviews and telephone communications and consultations was prepared towards the health belief model.

Iran, India and Turkey concluded that the perception of vulnerability in the Health Belief Model had an effect on health education. Patients with diabetes mellitus have a perception of greater vulnerability to implementing health education 1.37 times compared to diabetes patients who do not receive health education. With this result it is statistically significant (SMD= 2.76; 95% CI= 0.74 to 2.01; p=0.050).

3. Health education on perceptions of severity

In the case of type 2 diabetes mellitus, the application of the HBM model was found to be a very effective way to develop a jogging education program for diabetics, to control their blood sugar. In addition to increasing self-efficacy, the Health Behavior Model also plays a role in helping to reduce the perceived inhibition score and increase the self-efficacy score. The results of the study by Singh et al. (2021) found that the scores of the intervention and control groups before the educational intervention were lower in both groups, but after the educational intervention the average score for each HBM construct and self-care behavior showed a significant increase in the intervention group. This suggests that educating diabetes patients by promoting HBM-based self-care behaviors.

Research by Safajou et al. (2021) health education interventions within the HBM framework are a practical approach in educating and promoting good health behaviors related to type 2 diabetes among students. In addition, based on the results of this study and other relevant evidence, this type of education could be included in diabetes-related health promotion programs among students, thereby benefiting from its influence in maintaining and improving students' health behaviors.

This meta-analysis was conducted on 7 primary articles with a random controlled trial study design originating from Iran, India and Turkey concluded that perceived severity in the Health Belief Model had an effect on health education. Patients with diabetes mellitus have a large perception of severity 0.86 times will implement health education compared to diabetes patients who do not receive health education. With this result it is statistically significant (SMD= 0.86; 95% CI= 0.23 to 1.48; p= 0.007). The forest plot shows high heterogeneity of effect estimates between primary studies I^2= 96%; p<0.001.

AUTHOR CONTRIBUTION

Atika Afniratri as the main researcher who chose the topic, conducted a search for data collection in this study.

FUNDING AND SPONSORSHIP

This study is self-funded.

CONFLICT OF INTEREST

There is no conflict of interest in this study.

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