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### Authors

Zeb, Aurang

Sivarajan Froelicher, Erika

Pienaar, Abel

et al.

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# Effectiveness of Community-based Obesity Intervention for Body Weight, Body Mass Index, and Waist Circumference: Meta-analysis

## Abstract

**Background:** Obesity is a significant health problem worldwide and an alarming problem in the developed world including the United States of America and European populations. Subsequently, obesity can lead to different health problems, such as non-communicable diseases. However, it can be prevented through a healthy diet, exercise, and lifestyle modification. The study's purpose was to analyze the published literature on community-based obesity interventions and to present a comprehensive summary of how to reduce the body weight, Body Mass Index (BMI), and Waist Circumference (WC) among overweight and obese individuals in the community through health education and behavior interventions. **Material and Methods:** The meta-analysis was conducted in February–July 2021, searching CINAHL, Cochrane Library, Google Scholar, PubMed, and Science Direct databases. Studies published during the prior 12 years on community-based obesity intervention for weight, BMI, and WC were included in this review. Cochrane Revman software was used for meta-analysis. **Results:** Seventeen studies met the selection criteria for the review. A meta-analysis of the studies on health education and behavioral intervention studies resulted in a statistically significant reduction at 95% confidence intervals in the mean differences of BMI -1.19 (-1.77, -0.62) and WC -1.11 (-1.54, -0.68). **Conclusions:** Community-based obesity interventions through health education and behavior interventions effectively reduce the body weight, BMI, and WC. Implementing community-based health education and behavioral interventions effectively prevents and treats obesity in communities.

**Keywords:** Behavioral modification, body mass index, community-based, health education, obesity

## Introduction

Obesity is the leading cause of chronic and non-communicable diseases, and it has now replaced infectious diseases as the leading cause of ill health.<sup>[1]</sup> The abnormal or excessive fat accumulation in the human body is referred to as obesity or overweight and does present a health risk.<sup>[2]</sup> Obesity is a complex, multi-factorial condition resulting from specific genotypes and environmental interaction.<sup>[3]</sup> Several factors such as, but not limited to, social, behavioral, cultural, physiological, metabolic, and genetic factors all play a role. Obesity affects human health directly or indirectly in association with other problems like diabetes type 2, Coronary Artery Diseases (CADs), osteoarthritis, respiratory problems, and others.<sup>[1]</sup> Moreover, obesity may lead to other adverse health outcomes including hyperlipidemia, stroke, gallbladder problems, and sleep apnea.<sup>[4]</sup> Apart from

chronic and non-communicable diseases, it may also lead to problems related to mental health and impaired quality of life.<sup>[5]</sup> Besides physiological and anatomical consequences in the human body, obesity also has behavioral and psychological implications. Persons who are overweight and obese tend to be stigmatized, leading to psychological challenges including disturbance in body image. Usually, a slim and physically active person is considered attractive as compared to an obese person.<sup>[6]</sup> Furthermore, obesity is a significant health problem globally, and an estimated 37.70% of adults and 17% of children are obese in USA.<sup>[7]</sup> According to WHO, over half of the European population is overweight, and 30% is obese.<sup>[8]</sup> Pakistan is a developing country, and its population also suffers from the heavy burden of obesity. According to Tanzil and Jamali,<sup>[9]</sup> 22% of men and 37% of women living in urban areas of the

Aurang Zeb<sup>1</sup>,  
Erika Sivarajan  
Froelicher<sup>2</sup>,  
Abel Jacobus  
Pienaar<sup>1</sup>,  
Khairunnisa  
Dhamani<sup>1</sup>

<sup>1</sup>Shifa Colleg of Nursing, Shifa Tameer-e-Millat University,

<sup>2</sup>Department of Physiological Nursing, Schools of Nursing, Department of Epidemiology and Biostatistics, Schools of Medicine, University of California San Francisco, San Francisco, CA 94143-0610, USA  
Visiting Professor Shifa College of Nursing, STMU, Pakistan

## Address for correspondence:

Prof. Aurang Zeb,  
STMU Islamabad, Pakistan.  
E-mail: Zaibi83@yahoo.com

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country are obese, whereas Zahid, Claussen, and Hussain<sup>[10]</sup> reported that in rural areas of Pakistan, 26% of women and 18% of men are overweight and 20% of women and 8% of men are obese.

The three most commonly used measures of obesity are the Body Mass Index (BMI), Waist Circumference (WC), and waist-to-hip circumference ratio (WHR). BMI is the ratio of body weight and height. Normal BMI is 18.5–24.90 kg/m<sup>2</sup>. A person is overweight if the BMI is between 25 and 29.90 kg/m<sup>2</sup> and obese if the BMI is  $\geq 30$  kg/m<sup>2</sup>.<sup>[8]</sup> WC is also essential as increased WC is a risk factor. Normal WC for men is  $\geq 101.60$  cm and  $\geq 88.90$  cm in women.<sup>[8]</sup> Factors contributing to obesity include a family history of obesity, the biological makeup of the body, sociocultural beliefs and practices, eating customs and eating habits, level of education, and socio-economic background. The most common theory about obesity is the imbalance between foods consumed and utilized for energy output. A person becomes obese when the food intake exceeds the body's requirements.<sup>[11]</sup>

However, obesity can be prevented and treated in the community through health education and behavior interventions for achieving and maintaining a healthy body weight.<sup>[11]</sup> Community health nurses can play a vital role in preventing and treating obesity in the community through community participation. Awareness among people regarding lifestyle modification, diet, and food management may also play a vital role in the prevention and treatment of obesity. People's motivation for physical activities and exercise helps in burning extra calories. This systematic review and meta-analysis aimed to identify and analyze the available literature and present a comprehensive review of the effectiveness of interventions (health education and behavioral interventions) for reducing body weight, BMI, and WC in overweight and obese individuals in the community. The review's findings can be used as evidence for community-based obesity prevention and weight management programs in Pakistan.

## Material and Methods

This meta-analysis was conducted in February–July 2021. The inclusion criteria for the selection of the studies were original articles with RCTs and quasi-experiments, articles on interventions that include health education and behavioral intervention sessions for obesity prevention and treatment, studies with the outcome measure of body weight and/or BMI and/or WC, and studies conducted in the community. Gao, Griffiths, and Chan conducted an earlier systematic review on children, adolescents, and adults but included studies up to 2007.<sup>[12]</sup> For this reason, studies conducted between 2009 and 2020 were included in the review. Studies with a primary focus on conditions other than obesity and studies on obesity treated in clinics were excluded from the review. A comprehensive literature search was done for selecting the most relevant articles. The

databases used were CINAHL, Google Scholar, PubMed, and Science Direct. Only articles published in English were included. The first Boolean operator 'OR' was used for keywords treatment of obesity, weight reduction, reduction in BMI, obesity prevention, and obesity elimination. The second Boolean operator 'AND' was used to combine these terms with the second search term community-based intervention OR health education and behavior intervention, community-based intervention OR health education and behavioral intervention. The third Boolean operator 'NOT' was used to limit the review to the adult population by excluding the terms children, childhood, infant, adolescents, and teenagers. A total of 4096 articles were retrieved. From PubMed, 1789 were retrieved; Google Scholar, 353; Science Direct, 1 055; and CINAHL, 899. After applying different filters like age >18 years, English language, quasi-experimental or RCTs, nursing and Medline journals, articles published between 2009 and 2020, and studies on the human subject only, the number of retrieved articles was 270. The primary investigator Aurang Zeb (AZ) did the data search, and the relevance was confirmed by a second researcher, Muhammad Haroon (MH).

All the articles shortlisted were imported to Mendeley Reference Management Software to identify duplicate articles, and after removing 125 duplicate articles, 145 were shortlisted for first-level screening. This screening entailed reading the abstracts and titles of the citation, and 60 articles were shortlisted. Second-level screening consisted of reading the complete text of the remaining articles. In the end, 17 studies met the inclusion and exclusion criteria and were included in the review [Figure 1. PRISMA Flow chart]. Studies selected on second-level screening were assessed through full-text review. The Hong *et al.*<sup>[13]</sup> tool was used to assess the quality of RCTs and quasi-experimental studies selected in the review. Of these reviews, 16 were RCTs and one was a quasi-experimental study. The tool assessed RCTs on five required components and quasi-experiments on another five components. Out of a total of 17 studies, seven had all five required components, whereas the remaining 11 had four out of five required components. An Excel sheet was used to record the study description for data extraction, including sample characteristics, the independent variable (health education and behavioral interventions), the dependent variable (body weight, BMI, and WC), results, and statistical methods.

MS Excel 2010 was used for the descriptive analysis of data. The total number of participants, percentage of men and women, the mean age of the participants, marital status, type of intervention (behavior intervention alone or a combination of education and behavioral interventions), and duration of the intervention (<6 months, 6 months to 1 year, 1 year and above) were measured. Means of mean differences in body weight, BMI, and WC between intervention and control groups were calculated. The meta-analysis used the Cochrane Review Manager

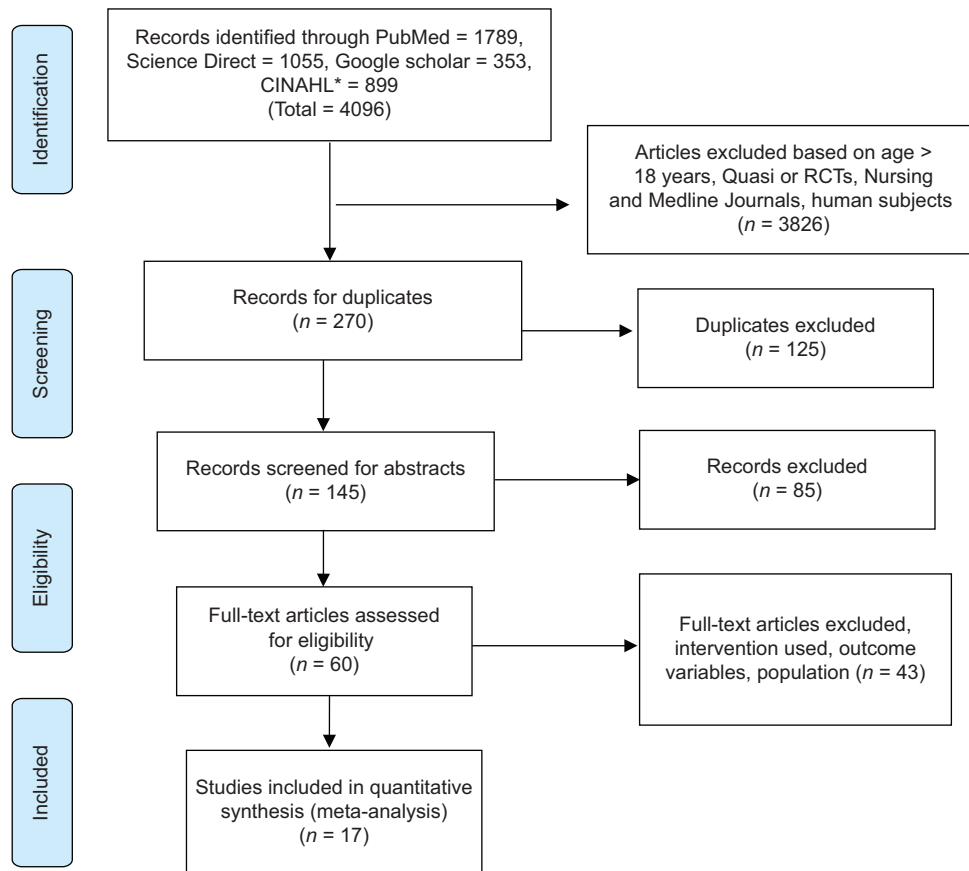


Figure 1: PRISMA Flow Diagram. \*Cumulative Index to Nursing and Allied Health Literature

Software to calculate the 95% Confidence Interval (CI) of the mean, which was used to describe the probability for BMI and WC. CIs were used because they provide the variation around where the actual value of the mean lies. Therefore, the reviewer could state that they are 95% confident that the true population mean is within the given interval range. CI not only gave us the range within which the true population mean lies but also gave us the direction and the strength of the effect, which was essential for clinical decisions. As the CI does not contain NULL, the results can be interpreted as statistically significant between the intervention and control groups. Forest plots for BMI and WC were also generated.

### Ethical consideration

An ethical review was granted by the ethics committee at Shifa Tamee-e-Millat University in March 2021. The ethical certificate was issued on October 14, 2021, with reference number IRB#351-21. The researchers avoided any form of plagiarism, and the data were analyzed with honesty without any fabrication, falsification, or manipulation of data for their benefit.

### Results

All the 17 studies selected for this review are described in Table 1. The descriptive characteristics of the studies are

given in Table 2. The second table also shows the different studies and the durations for intervention; three studies used less than 6 months, eight studies used 6 months to 1 year, and the remaining seven studies used 1 year or more. Three studies in the review used behavioral interventions, while the rest used both health education and behavioral interventions. Studies with both education and behavioral interventions resulted in a significant reduction in BMI and WC when compared to studies with behavioral interventions alone. The analysis revealed that studies conducted for less than 6 months resulted in lower mean differences in body weight, BMI, and WC between control and intervention groups compared to the studies with a duration of 6 months or more.

The Forest plot with the CI for BMI is given in Figure 2. Nine studies were included in the meta-analysis for BMI. The CI of -1.19 (-1.77, -0.62) demonstrates a statistically significant difference between the experimental and control groups, favoring the experimental group. A meta-analysis of 10 studies was performed for WC. The Forest plot demonstrates that the intervention significantly contributed to a loss in WC with CI -1.11 (-1.54, -0.68) as displayed in Figure 3.

The funnel plots for the studies included in the meta-analysis for BMI and WC were constructed to

**Table 1: Studies included in the review**

Study	Study Characteristics	Mean Difference BMI* kg/m <sup>2</sup> **	Mean Difference WC*** inches	Mean Difference Body weight Kg's****
[14]	66 participants were divided into equal control and intervention groups, 80.30% were females, 71.40% have < high education, and 82.40% were married. The study duration was 4 months. Both education and behavioral intervention were used.	-0.99	0.50	-0.73
[15]	A total of 90 participants including 38 in intervention and 52 in control groups, mean age was 49.65, and the study duration was 6 months. Both education and behavioral interventions.	---	---	-4.21
[16]	94 females in the intervention and 91 in a control group with a mean age of 35.40 years, 59.60 have < high schooling, the study duration was 1 year. Both education and behavioral interventions.	-0.60	---	-1.40
[17]	166 participants in the quasi-experimental of 3-month duration have a mean age of 41.50 years, 98% females, 85% married. Both education and behavior interventions.	-0.26	-3.80	-30
[18]	131 participants, equally divided in intervention and control groups with a mean age of 55.24 years and 70.20% have < high school education. The study duration was 6 months using behavioral intervention only	-0.47	-0.97	-3.63
[19]	300 participants were equally divided into intervention and control groups with a mean age of 49 years, 80% of females, 59.50 have < high schooling. The study duration was 6 months. Both education and behavioral interventions.	-3.90	-1.60	-4.20
[20]	495 participants divided into intervention 259 and control 233, all females with a mean age of 39.50 years, 57% have < high school education. The study duration was 6 months. Both education and behavioral interventions were used.	---	---	-0.48
[21]	239 participants with a mean age of 46.80 years, 83.30% of females with 70% have < high schooling. The study duration was 6 months. Both education and behavioral interventions.	---	---	-5.90
[22]	86 female participants in control and intervention groups each, with a mean age of 53.50 years, 52.50% have < high schooling, and the study duration was 6 months. Both education and behavioral interventions.	---	---	-0.96
[23]	333 participants in intervention and control groups each, with mean age of 53.70 years, 78% females. The study duration was 12 months. Both education and behavioral interventions.	---	---	-1.50
[24]	184 participants including 109 in intervention and the rest in control groups, mean age of 52.10 years, 50 have < high schooling, and 95% married. The study duration was 12 months. Both education and behavioral interventions.	-0.15	-0.17	-0.79
[25]	151 in intervention and 150 participants in control, 58% females, the study duration was 12 months. Both education and behavioral as interventions.	---	-4.80	---
[26]	351 participants were equally divided into two groups, the mean age is 50.70 years, 68% females, 49% married. The study duration was 6 months, and behavioral interventions only.	-1.40	-3.30	---
[27]	29 out of 97 in intervention and the rest in control groups, with a mean age of 56 years, 92% females. The study duration was 6 months. Both education and behavioral interventions.	---	---	-1.20
[28]	61 participants were divided into the intervention 29 and control 32, mean age of 49.50 years, 77% females, and the study duration was 8 months. Both education and behavioral interventions were used.	-4.49	-2.20	-1.82
[29]	480 participants were equally divided into intervention and control groups, mean age of 66.80 years, 53% females and 85.60% having < high school education, the study duration was 18 months. Both education and behavioral interventions were used.	---	-3.74	-3.19
[30]	74 participants were equally divided into intervention and control groups, the mean age of 61 years, 50% females, and the study duration was 12 months. Both education and behavioral interventions were used.	-2.60	---	---

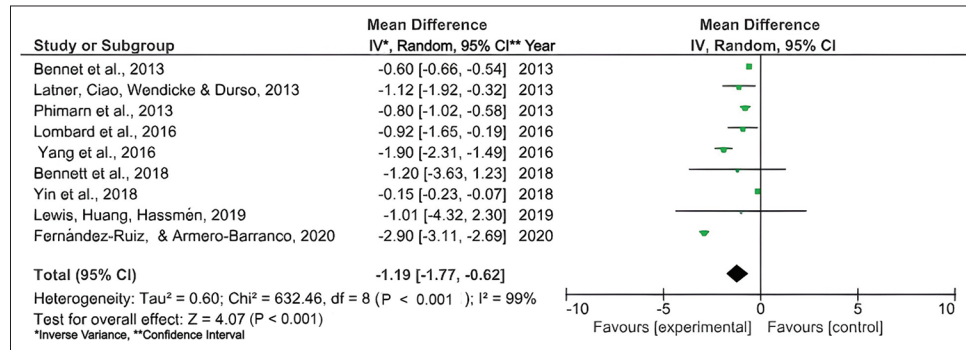
\*Body Mass Index. \*\*\*Kilogram Per Meter Square. \*\*\*Waist Circumference. \*\*\*\*Kilograms

identify publication bias. Both funnel plots are symmetric, in Figures 4 and 5. It is important to draw awareness that demonstrating a low likelihood of publication bias given there was significant heterogeneity among the included

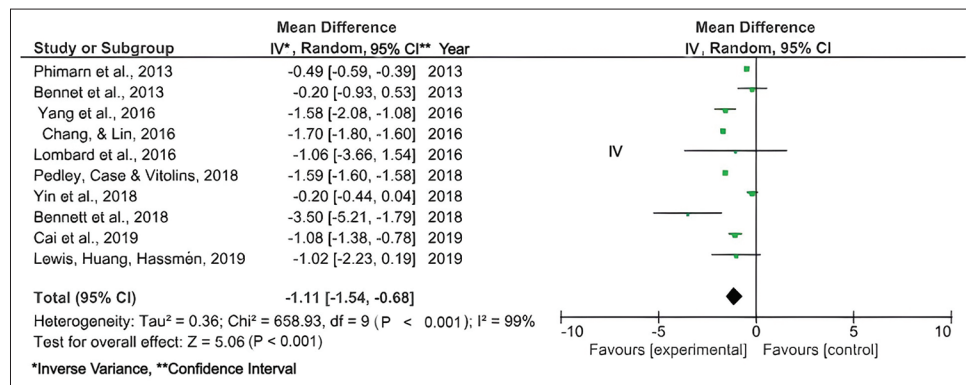
**Table 2: Demographic Characteristics of the Participants in the Studies**

Category	No. of studies	Total participants	Women (n) %	Mean age (In years)	Mean (SD)* difference in weight (kgs)**	Mean (SD) difference in BMI*** (kgs/m <sup>2</sup> )****	Mean (SD) difference In WC***** (inches)
General	17	4135	(3183) 77	51	-2.44 (1.74)	-1.68 (1.49)	-3.71 (2.68)
Duration of the study							
Less than 6 months	3	293	(161) 55.4	45.50	-1.85	-1.91	-1.833
6 months to 1 year	7	1694	(1338) 79.10	50.30	-1.94	-2.56	-2.02
1 year and above	7	1723	(1120) 64.60	53	-2.55	-2.11	-3.55

\*Standard Deviation. \*\*Kilograms. \*\*\*Body Mass Index. \*\*\*\*Kilograms Per Meter Square. \*\*\*\*\*Waist Circumference



**Figure 2: Forest Plot for BMI**



**Figure 3: Forest Plot for WC**

studies, with both having an I<sup>2</sup> of 99%, meaning there was considerable heterogeneity between the included articles.

## Discussion

The current meta-analysis has been done on studies conducted during the last 12 years on obesity interventions including health education and behavioral interventions in the community to evaluate the effect thereof on BMI and WC. The findings of the study are compared with the literature. An earlier review on community-based obesity prevention in an adult population by Gao, Griffiths, and Chan<sup>[12]</sup> included 20 studies. Their review concluded that community-based obesity interventions were effective in reducing weight and BMI. The present review confirmed these findings.

The review's strengths included the topic's importance and the literature available. Furthermore, the supervisory team's contribution and expertise were also strengths. The findings of the current meta-analysis supported the recommendation that obesity can be prevented and treated comparatively inexpensively in the community through health education and behavioral intervention. It is imperative that the government take the necessary action to initiate policies about obesity prevention and treatment services in the community. Media can be used to generate awareness among people about obesity and its associated morbidities and mortalities can reduce the epidemic of obesity.

This review has some limitations. The study included articles from Nursing and Medline Journals and lacked studies from gray literature like conference proceedings,

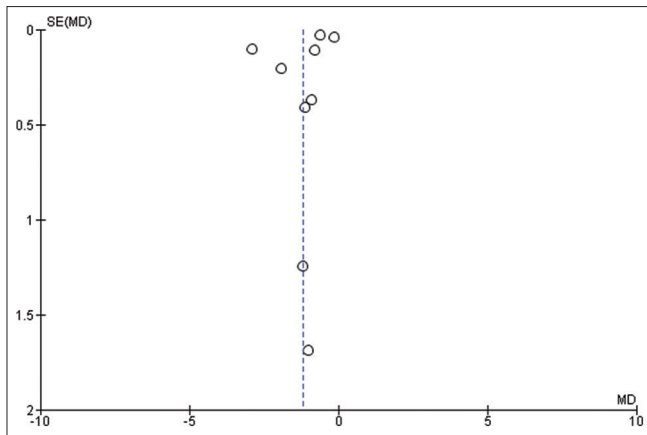


Figure 4: Funnel Plot for studies on BMI\*\*. \*Body Mass Index

doctoral desertions, and agency reports. The review was limited to the English language only. There might be studies done in languages other than English. Also, China, Taiwan, Singapore, and Japanese populations have different skeletal mass and body fat ratios as compared to the Western population.<sup>[31]</sup> Studies published in local languages in these Asian countries may have helped in the current review. Studies included in this review have focused on health education and behavioral interventions only, so further research on other interventions like compliance to exercise and adherence to a healthy diet may be helpful strategies for obesity reduction in the community. The dependent variables measured in this review were limited to weight, BMI, and WC. Further studies can include other variables like waist and hip ratio, blood cholesterol level, and other physiological measures that may even produce valuable results.

## Conclusion

This meta-analysis established that the implementation of health education and behavior interventions significantly reduces BMI (CI-1.19 (-1.77, -0.62)) and WC (CI -1.11 (-1.54, 0.68)). It is recommended that both strategies be implemented in a community-based obesity prevention and weight management program to alleviate obesity in the community. The support of comprehensive community health programs can provide health education about optimum weight, obesity, complications, and treatment.

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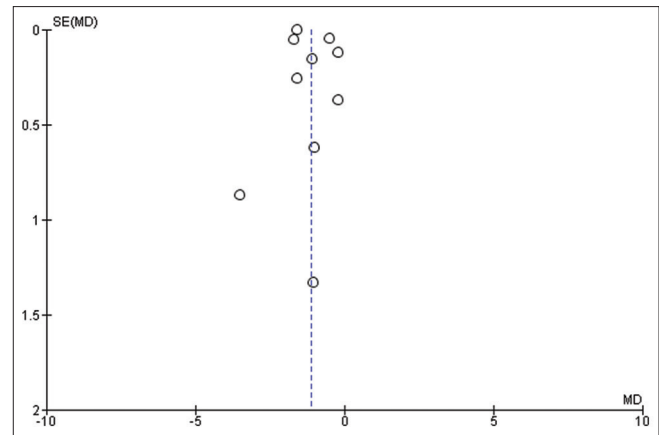


Figure 5: Funnel Plot for studies on WC\*. \*Waist Circumference

## Conflicts of interest

Nothing to declare.

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