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Research Article

Non-Pharmacological Weight Management in Schizophrenia: A Network Meta-Analysis

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Keywords: Schizophrenia, Non-pharmacological interventions, Weight management, Lifestyle intervention, Network meta-analysis

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Background

Antipsychotic treatment in schizophrenia is frequently complicated by substantial weight gain and metabolic disturbances. Implementing effective weight-control strategies is crucial for improving physical health outcomes and overall quality of life in this patient population. This network meta-analysis aimed to systematically evaluate and compare the effectiveness of non-pharmacological interventions for weight management in individuals with schizophrenia.

Methods

We conducted comprehensive searches of PubMed, Embase, Cochrane Library, Web of Science, and PsycINFO from January 1, 2000, to August 20, 2024, to identify randomized controlled trials (RCTs) investigating non-pharmacological approaches to weight control in schizophrenia. A network meta-analysis was performed using R software to synthesize the evidence and rank intervention efficacy.

Results

Fourteen RCTs were included, comparing cognitive behavioral therapy (CBT; 5 studies), psychoeducation (4 studies), and lifestyle interventions (5 studies) with usual care. The primary outcome was change in body weight, and the secondary outcome was change in body mass index (BMI). For weight outcomes, lifestyle interventions demonstrated the greatest efficacy (standardized mean difference [SMD] = −3.93, 95% confidence interval [CI] −5.98–−1.90), followed by psychoeducation (SMD = −3.46, 95% CI −5.47–−1.19) and CBT (SMD = −1.95, 95% CI −3.76–−0.32). Surface under the cumulative ranking curve (SUCRA) values indicated that lifestyle interventions had the highest probability of being most effective (SUCRA = 64%), followed by psychoeducation (34%) and CBT (2%). For BMI, only lifestyle interventions showed statistically significant benefits compared to usual care (mean difference −1.47, 95% CI −2.74–−0.17). Heterogeneity was low for weight outcomes (I^2 = 36%) and moderate for BMI outcomes (I^2 = 63.5%).

Conclusion

Among non-pharmacological strategies for weight management in schizophrenia patients, lifestyle interventions incorporating dietary and exercise components appear to be the most effective and should be prioritized in clinical settings. Integrating such interventions into routine care may reduce cardiometabolic risk and improve treatment adherence. Additional high-quality randomized trials are warranted to strengthen the evidence base.

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1. INTRODUCTION

Schizophrenia is a severe mental disorder characterized by substantial impairments in social cognition and emotional regulation.[1] Typically manifesting in late adolescence or early adulthood, the condition affects approximately 0.5–1.2% of the global population.[2] Individuals diagnosed with schizophrenia have mortality rates approximately twice those of the general population, with life expectancy reduced by 10–20 years.[3] While elevated suicide risk contributes to this disparity,[4] accumulating evidence indicates that natural causes—particularly cardiovascular disease—account for the majority of excess mortality.[5,6] Metabolic syndrome, a cluster of conditions including hyperglycemia, dyslipidemia, central adiposity, and hypertension, affects at least one-third of individuals with schizophrenia.[6,7] Each component is an independent risk factor for cardiovascular disease.[8] Recent investigations have also reported associations between inflammatory markers and antipsychotic-induced weight gain.[9] Growing evidence suggests that metabolic syndrome adversely affects both cognitive functioning and quality of life in this population,[10] and is a significant contributor to reduced life expectancy.[11]

Concurrently, research indicates that metabolic complications reduce medication adherence, amplify treatment-related stigma, and substantially diminish quality of life.[12] While pharmacological approaches such as bupropion have demonstrated efficacy for weight management and smoking cessation in other psychiatric populations,[13] the current analysis focuses specifically on non-pharmacological strategies for schizophrenia patients who may be at risk of polypharmacy or additional adverse effects. The established association between cognitive impairment and metabolic dysfunction in schizophrenia[14] underscores the importance of interventions targeting obesity and cardiometabolic risk, which may yield benefits for both cardiovascular outcomes and functional recovery.[15] Consequently, effective weight-management strategies may improve quality of life while supporting treatment engagement and relapse prevention.

Current approaches to address antipsychotic-associated weight gain include non-pharmacological interventions centered on lifestyle modification[16] and pharmacological strategies such as metformin or aripiprazole.[17] The 2021 World Health Organization guidelines specifically recommend lifestyle interventions as first-line management for physical health concerns in adults with severe mental illness, including weight management and cardiovascular risk reduction.[18] Existing literature supports the efficacy of non-pharmacological approaches, including dietary interventions, physical activity programs, psychoeducation, and cognitive behavioral therapy (CBT).[19-22]

Although previous systematic reviews have addressed this topic,[23] a comprehensive comparison of major non-pharmacological interventions using network meta-analysis is lacking. Therefore, this study employs network meta-analysis to compare, directly and indirectly, the efficacy of lifestyle interventions, psychoeducation, and CBT for weight management in schizophrenia, with the aim of identifying the most effective strategy and informing evidence-based clinical decision-making.

2. METHODS

2.1. LITERATURE SEARCH STRATEGY

We conducted a comprehensive literature search across five electronic databases (PubMed, EMBASE, Web of Science, the Cochrane Library, PsycINFO) from January 1, 2000, to August 20, 2024, to identify randomized controlled trials (RCTs) examining non-pharmacological interventions for weight management in schizophrenia patients. Search terms included "schizophrenia," "schizoaffective disorder," "atypical antipsychotics," "mental disorder," "psychiatric patients," "paranoid disorders," "lifestyle intervention," "diet intervention," "exercise intervention," "group lifestyle intervention," "nutrition," "sports," "weight management," "lifestyle modification," "psychosocial education," "cognitive-behavioral therapy," "behavioral intervention." We also manually screened the reference lists of relevant systematic reviews and meta-analyses to identify potentially missed studies.

No language restrictions were applied, maximizing the retrieval of relevant evidence. For non-English publications, titles and abstracts were translated for initial screening. For studies deemed potentially eligible, full-text articles were translated by team members proficient in the relevant language or by professional translation services to assess eligibility and extract data. The complete search strategy for PubMed is illustrated in Figure 1.

2.2. INCLUSION CRITERIA

Eligibility criteria were as follows:

(i) Participants: Adults aged ⩾18 years with a diagnosis of schizophrenia or schizoaffective spectrum disorders according to the International Classification of Diseases-10;

(ii) Intervention: Non-pharmacological interventions targeting weight reduction or prevention of weight gain, including lifestyle interventions, psychoeducation, and CBT. "Lifestyle intervention" included studies in which dietary counseling and physical activity promotion were combined. "Psychoeducation" focused primarily on providing information about health, nutrition, and weight management. "CBT" included interventions employing core CBT techniques (e.g., self-monitoring, cognitive restructuring, and behavioral activation) to target weight-related behaviors;

(iii) Study design: RCTs;

(iv) Outcome measures: Primary outcomes were changes in body weight, body mass index (BMI), and waist circumference; secondary outcomes were changes in glucose, lipid profiles, and other relevant metabolic parameters.

Table 2 summarizes the interventions and outcome definitions.

2.3. EXCLUSION CRITERIA

Studies were excluded if they met any of the following criteria: (i) interventions involving pharmacological weight-loss agents; (ii) unavailable full text; (iii) inappropriate study design, incomplete data, or unavailable outcome data; or (iv) duplicate publications or duplicated data.

#1 Schizophrenia [MeSH terms] OR paranoid disorders [MeSH terms]

#2 Schizophrenia [Title/Abstract] OR Schizophrenias [Title/Abstract] OR Schizophrenic Disorder [Title/Abstract] OR Schizophrenic Disorders [Title/Abstract] OR schizoaffectiveDisorder [Title/Abstract] OR schizoaffective disorders [Title/Abstract] OR psychotic [Title/Abstract] OR psychotic disorders [Title/Abstract] OR schizophrenia spectrum [Title/Abstract] OR mental disorder [Title/Abstract] OR mentally ill [Title/Abstract] OR psychiatric patients [Title/Abstract] OR antipsychotic [Title/Abstract] OR atypical antipsychotics [Title/Abstract] OR paranoid [Title/Abstract]

#3 #1 OR #2

#4 psychoeducation [Title/Abstract] OR psycho education [Title/Abstract] OR health education [Title/Abstract] OR lifestyle Intervention [Title/Abstract] OR lifestyle modification[Title/Abstract] OR diet [Title/Abstract] OR nutrition [Title/Abstract] OR nutritional intervention [Title/Abstract] OR exercise [Title/Abstract] OR physical activity [Title/Abstract] OR sports [Title/Abstract] OR weight reduction programs [Title/Abstract] OR weight management [Title/Abstract] OR Cognitive Behavioral Therapy [Mesh terms] OR Cognitive Behavioral Therapy [Title/Abstract] OR behavioral therapy [Title/Abstract] OR psychotherapy [Title/Abstract] OR cognitive therapy [Title/Abstract] OR CBT [Title/Abstract] OR behavioral intervention [Title/Abstract]

#5 body weight [MeSH Terms]

#6 Body Weight [Title/Abstract] OR Body Weights [Title/Abstract] OR weight loss [Title/Abstract] OR weight gain [Title/Abstract] OR weight change [Title/Abstract] OR body mass index [Title/Abstract] OR BMI [Title/Abstract] OR waist circumference [Title/Abstract] OR waist [Title/Abstract]

#7 #5 OR #6

#8 randomized controlled trial [Publication Type] OR controlled clinical trial [Publication Type] OR randomized [Title/Abstract] OR randomly [Title/Abstract] OR trial[Title]

#9 "2000"[Date-Publication]: "2024/8/20"[Date-Publication]

#10 #3 AND #4 AND #7 AND #8 AND #9

Figure 1. PubMed search strategy

2.4. DATA EXTRACTION

Two investigators (JS and SL) independently extracted relevant data from included studies, including study characteristics (author, publication year, and location), participant demographics (sample size, age, and gender distribution), intervention details (type, duration, frequency), control group characteristics, and outcome measurement methods and results for primary and secondary outcomes.

2.5. RISK-OF-BIAS ASSESSMENT

Methodological quality of included RCTs was assessed using the Cochrane Risk of Bias Tool.[24] We evaluated potential biases in random sequence generation, allocation concealment, blinding, completeness of outcome data, and selective reporting. For each domain, studies were rated as "high risk," "low risk," or "unclear risk" of bias. When methodological details were insufficient, the domain was rated as "unclear risk." Two investigators (JS and SL) performed assessments independently, and disagreements were resolved through consultation with a third investigator (HQ).

2.6. DATA ANALYSIS

Network meta-analysis was performed using R software (version XXX, https://www.r-project.org/) to generate network plots, probability plots, and funnel plots. Risk-of-bias plots were generated in RevMan 5.4. Standardized mean differences (SMDs) with 95% confidence intervals (CIs) were calculated as the effect measure. Heterogeneity within each direct comparison was assessed using the I^2 statistic and Cochran's Q test. A random-effects model was employed for all network meta-analysis comparisons to account for potential clinical and methodological heterogeneity across studies.

The validity of the network meta-analysis relies on the assumptions of transitivity, consistency, and homogeneity. Transitivity was assessed by examining the distribution of potential effect modifiers (e.g., age, baseline BMI, antipsychotic medication type, and study setting) across treatment comparisons; no major imbalances were identified. Consistency (agreement between direct and indirect evidence) was evaluated using the node-splitting method for the only closed loop present in the network (psychoeducation–CBT–usual care). No significant inconsistency was detected (p=0.3917 for weight outcomes and p=0.1943 for BMI outcomes). Homogeneity was assessed using I^2 statistics within direct comparisons, and the use of a random-effects model was intended to account for residual heterogeneity. Overall, these evaluations supported the feasibility of conducting indirect comparisons within the constructed network.

To explore potential sources of heterogeneity and assess the robustness of the findings, we conducted: (i) a sensitivity analysis excluding studies judged to have a "high risk" of bias in any domain of the Cochrane tool; and (ii) an exploratory subgroup analysis comparing intervention durations (short-term: ⩽12 weeks vs. long-term: >12 weeks), where data permitted. Inconsistency was additionally examined using loop-specific approaches when the network contained closed loops. Intervention rankings were summarized using the surface under the cumulative ranking curve (SUCRA) values. Publication bias was evaluated by visual inspection of funnel plot symmetry.

3. RESULTS

3.1. LITERATURE SEARCH RESULTS

Systematic database searches identified 1,580 records. After removing 815 duplicates, 765 titles and abstracts were screened, and 712 irrelevant records were excluded. Following a detailed assessment of 53 full-text articles, 39 were excluded for various reasons (e.g., population mismatch, insufficient data). A total of 14 studies were included

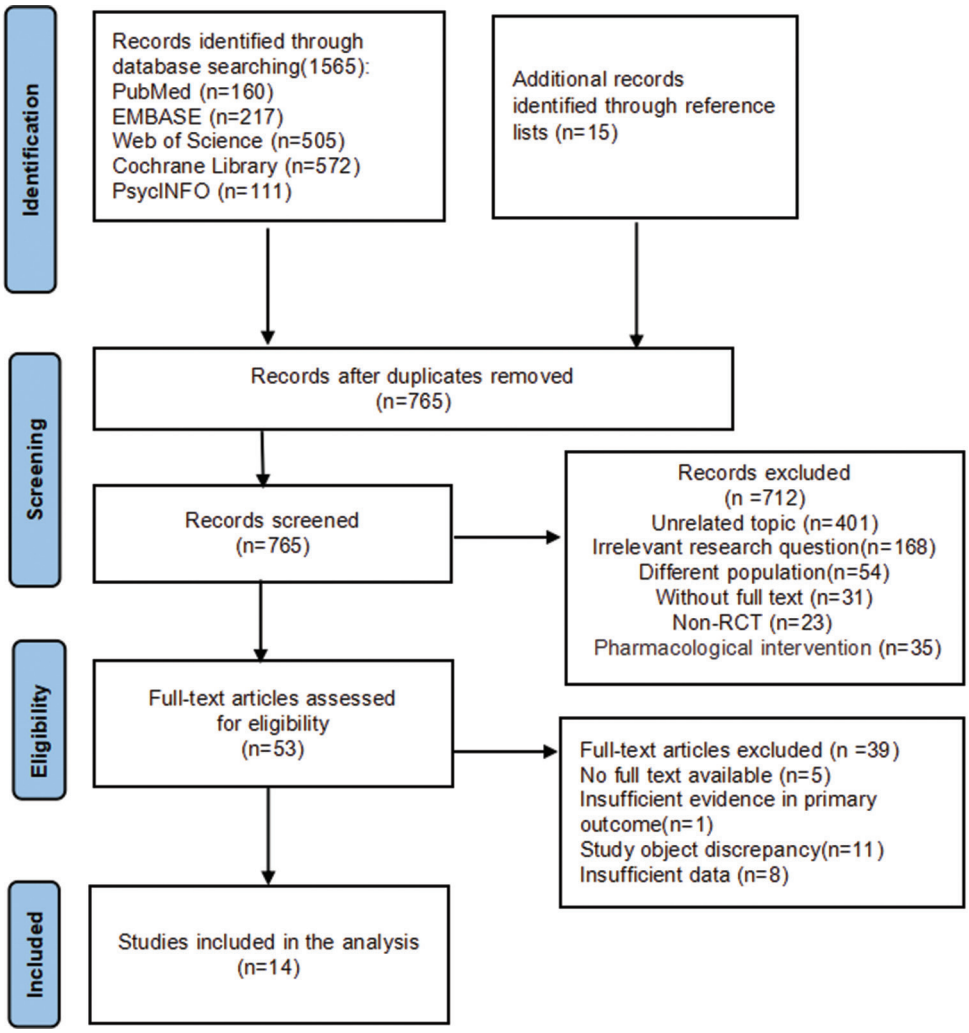

Figure 2. PRISMA flow diagram
Abbreviation: RCT: Randomized controlled trial.

Table 1. Intervention classification and outcome definitions

Intervention category	Core components	Primary outcome	Secondary outcomes
Lifestyle intervention	Dietary counseling+physical activity promotion	Body weight change	Body mass index (BMI), waist circumference
Psychoeducation	Health/nutrition information provision	Body weight change	BMI, metabolic parameters
Cognitive behavioral therapy (CBT)	CBT techniques for behavior change	Body weight change	BMI, psychosocial measures

in the qualitative and quantitative synthesis. The selection process is outlined in Figure 2.

3.2. BASIC CHARACTERISTICS OF INCLUDED STUDIES

Fourteen studies were included. According to Table 2, the studies involved 780 participants, with 403 in the experimental groups and 377 in the control groups. Sex was reported in 13 studies: In the experimental groups, there were 202 males and 193 females, and in the control groups, 204 males and 166 females. One study25 (experimental group = 8; control group = 7) did not report the sex distribution. Participant ages ranged from 18 to 65 years across studies. Intervention duration ranged from 8 to 48 weeks. Three types of non-pharmacological interventions were evaluated: lifestyle interventions, psychoeducation, and CBT. Four studies compared psychoeducation with usual care, five compared lifestyle interventions with usual care, and five compared CBT with usual care. Body weight was the primary outcome in all included studies. In addition, 11 studies reported BMI as a secondary outcome. Study characteristics are summarized in Table 2.

3.3. RISK-OF-BIAS ASSESSMENT

Among the 14 included studies, three studies[25-27] reported the methods used for random sequence generation (e.g., computer randomization, block randomization, and random number tables). One study[26] clearly described allocation concealment. Four studies[26,28-30] used blinding. All studies were rated as "low risk" for selective reporting, and

Table 2. Characteristics of included studies

Study	Country	Samplesize (*n*), EG/CG	Age (years), EG/CG	Sex, EG/CG	Intervention (mode), EG/CG	Treatmentduration (weeks)	Intervention (frequency)	Outcomes
Scocco *et al.*[43]	Italy	9/10	51.7/39.2	M=3; F=6/M=8; F=2	C/A	8	1/2W	①
Weber and Wyne[28]	USA	8/9	18-65	M=3; F=5/M=2; F=7	D/A	16	60 min×1/w	①②
Kwon *et al.*[44]	Korea	33/15	32.0/29.8	M=10; F=23/M=5; F=10	D/A	12	1/w (0–4 w) and 1/2w (5–12 w)	①②
Littrell *et al.*[45]	USA	35/35	33.7/34.5	M=22; F=13/M=21; F=14	C/A	16	60 min×1/w	①②
Iglesias-García *et al.*[25]	Spain	8/7	39.9	NM	C/A	12	60 min×1/w	①②
Brar *et al.*[29]	USA	34/37	40.0/40.5	M=16; F=18/M=13; F=24	D/A	14	2/w (0–6 w) and 1/w (7–14 w)	①
Wu *et al.*[46]	Taiwan	28/25	42.2/39.0	M=11; F=17/M=11; F=14	B/A	24	60 min×3/w	①②
Methapatara and Srisurapanont[26]	Thailand	32/32	43.2/37.6	M=23; F=9/M=18; F=14	D/A	24	NM	①②
Sugawara *et al.*[47]	Japan	93/87	47.6/46.6	M=43; F=50/M=46; F=41	C/A	48	30–40 min×1/4w	①②
Hsu *et al.*[48]	Taiwan	18/15	42.7/45.7	M=13; F=5/M=12; F=3	B/A	8	50 min×2/w	①
Battaglia *et al.*[30]	Italy	10/8	36.0/35.0	M=10; F=0/M=8; F=0	B/A	12	100–120 min×2/w	①②
McKibbin *et al.*[49]	USA	28/29	52.4/55.6	M=19; F=9/M=18; F=11	B/A	24	90 min×1/w	①②
Khazaal *et al.*[50]	Switzerland	31/30	43.0/38.3	M=14; F=17/M=15; F=15	D/A	12	120 min×12/w	①②
Cordes *et al.*[27]	Germany	36/38	38.2/35.8	M=15; F=21/M=27; F=11	B/A	24	90 min×1/2w	①②

Notes: EG: Experimental group; CG: Control group; M: Male; F: Female; A: Treatment as usual; B: Lifestyle interventions; C: Psychoeducation; D: Cognitive behavioral therapy; ①: Weight; ②: Body mass index; NM: No mention.

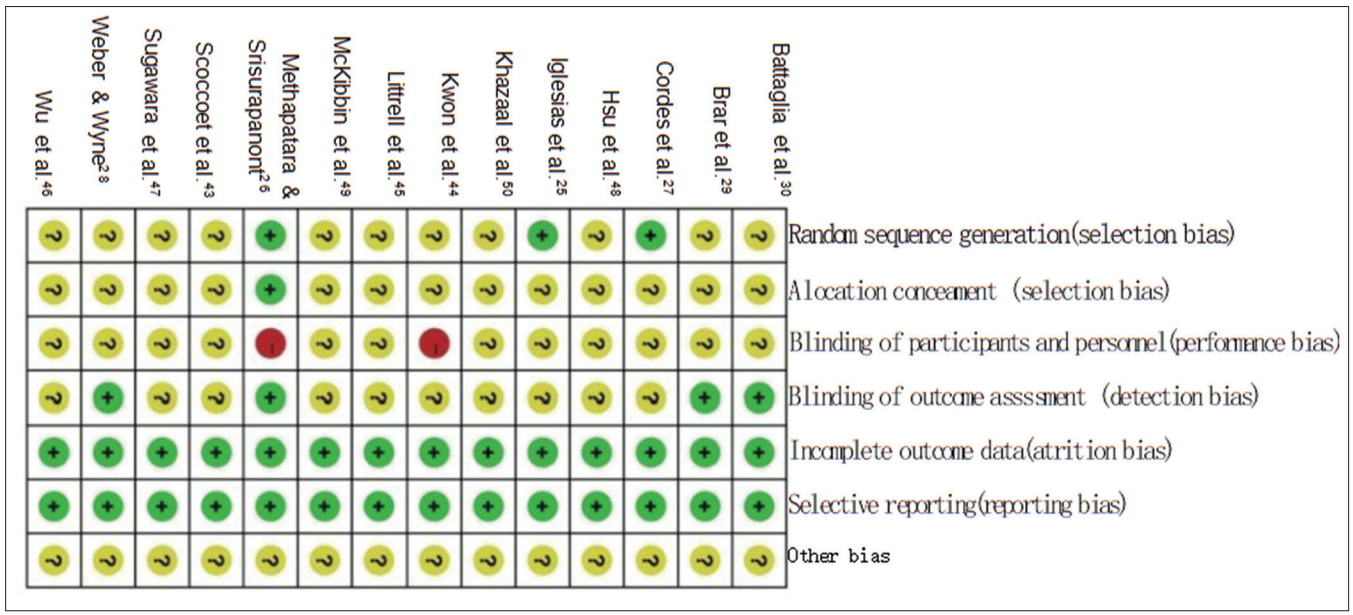

Figure 3. Risk of bias summary

complete outcome data were available for all included studies. The risk-of-bias assessment is presented in Figure 3.

3.4. WEIGHT OUTCOMES

The network meta-analysis for weight outcomes included 14 RCTs evaluating three non-pharmacological interventions (CBT [*n* = 5], psychoeducation [*n* = 4], and lifestyle intervention [*n* = 5]), forming one closed loop (psychoeducation–CBT–usual care). Sensitivity analysis excluding studies rated as high risk of bias did not materially alter the direction or statistical significance of the main findings. Exploratory subgroup analysis by intervention duration suggested that longer interventions (>12 weeks) tended to show larger effect sizes; however, this difference was not statistically significant, likely due to limited sample size. All included studies reported weight outcomes. The evidence

network for weight outcomes, with node sizes representing sample sizes and line thickness representing the number of included studies, is shown in Figure 4.

Compared with usual care, CBT (SMD = −1.95, 95% CI [−3.76–−0.32]; SUCRA = 2%), psychoeducation (SMD = −3.46, 95% CI [−5.47–−1.19]; SUCRA = 34%), and lifestyle interventions (SMD = −3.93, 95% CI [−5.98–−1.90]; SUCRA = 64%) showed statistically significant benefits in reducing body weight (p<0.05), as shown in Figure 5 and Table 3.

Heterogeneity for weight outcomes was low to moderate (I^2 = 36%). No significant loop inconsistency was observed (p=0.3917). Funnel plot analysis revealed slight asymmetry, suggesting possible small-study effects; however, evidence of substantial publication bias was limited (Figure 6).

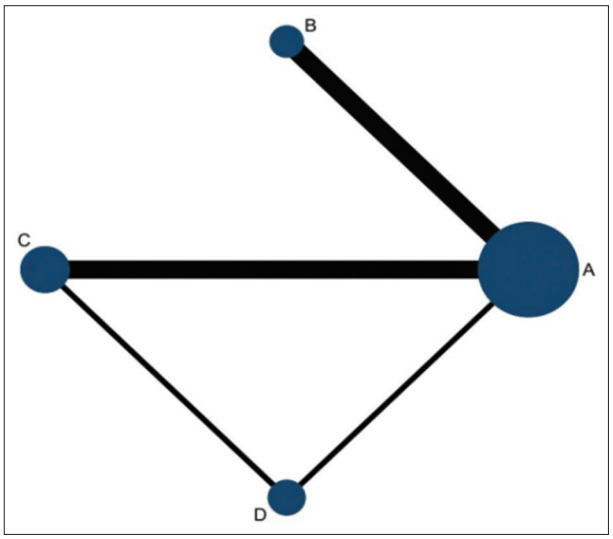

Figure 4. Network plot for body weight outcomes
Notes: A: Usual care; B: Lifestyle; C: Psychoeducation; D: Cognitive behavioral therapy

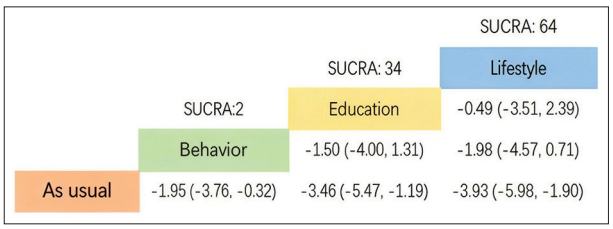

Figure 5. Surface under the cumulative ranking curve for body weight outcomes (14 randomized controlled trials)

3.5. BMI OUTCOMES

The network meta-analysis for BMI included 11 RCTs assessing CBT (n = 3), psychoeducation (n = 3), and lifestyle intervention (n = 4), forming one closed loop (psychoeducation–CBT–usual care). The evidence network for BMI outcomes, with node sizes representing sample sizes and line thickness representing the number of included studies, is shown in Figure 7.

Only lifestyle interventions (SMD = −1.47, 95% CI [−2.74–−0.17]; SUCRA = 68%) were significantly more effective than usual care in reducing BMI (p<0.05). Other non-pharmacological interventions did not differ significantly from usual care, and differences between interventions were also not statistically significant (p>0.05), as shown in Figure 8.

Heterogeneity for BMI outcomes was moderate (I^2 = 63.5%), supporting the use of a random-effects model. No significant loop inconsistency was detected (p=0.1943). The BMI funnel plot was generally symmetry around the null line, although some asymmetry was observed, indicating possible small-study effects or publication bias (Figure 9).

4. DISCUSSION

Patients with schizophrenia often require long-term antipsychotic treatment, and agents such as clozapine and risperidone are associated with weight gain and metabolic disturbances.[31] It is estimated that around 40–60% of patients with schizophrenia are overweight or obese (BMI>24 kg/m^2).[32,33] Excess weight can worsen physical health and may contribute to treatment-related stigma, which can hinder engagement with care.[34] This underscores the importance of non-stigmatizing, patient-centered approaches to weight management that address both physiological and psychosocial dimensions. The complex interplay between mental health and physical comorbidity further highlights the importance of comprehensive care approaches in psychiatric populations.[35] Therefore, effective and evidence-based weight-management strategies are needed to control weight and reduce associated risks. In this study, we utilized network meta-analysis to evaluate the efficacy of different non-pharmacological interventions for weight management in patients with schizophrenia.

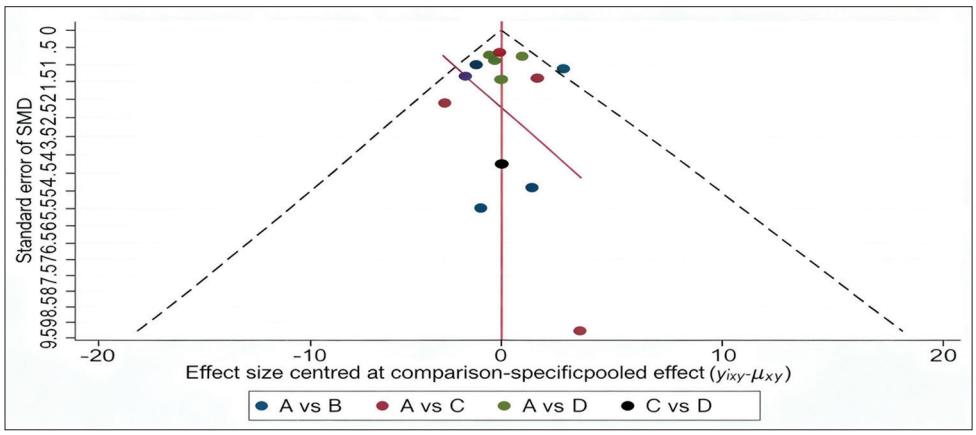

Figure 6. Comparison-adjusted funnel plot for body weight outcomes (14 randomized controlled trials)
Notes: A: Treatment as usual; B: Lifestyle interventions; C: Psychoeducation; D: Cognitive behavioral therapy.

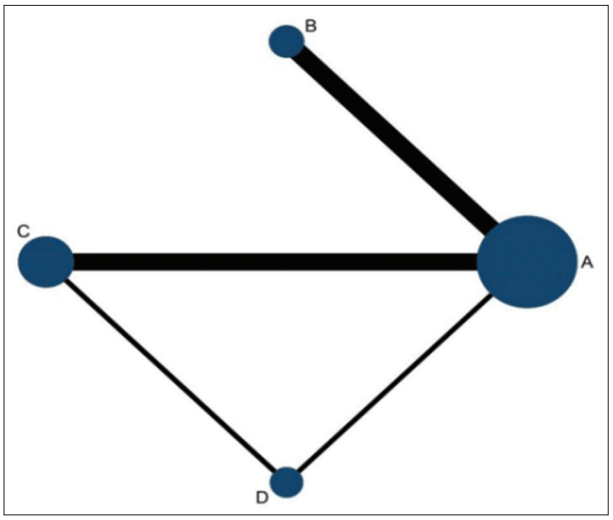

Figure 7. Network plot for body mass index outcomes
Notes: A: Usual care; B: Lifestyle; C: Psychoeducation; D: Cognitive behavioral therapy.

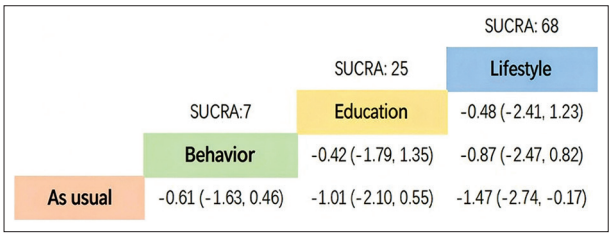

Figure 8. Surface under the cumulative ranking curve for body mass index outcomes (11 randomized controlled trials)

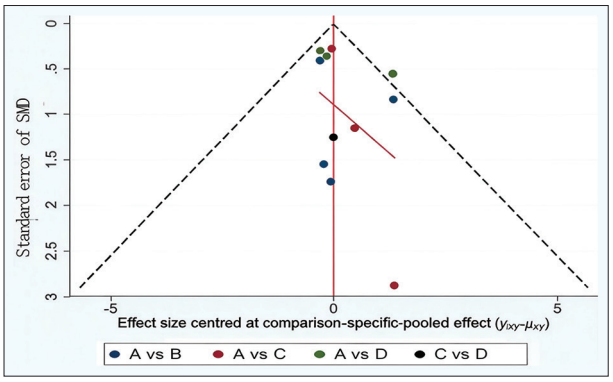

Figure 9. Comparison-adjusted funnel plot for body mass index outcomes (11 randomized controlled trials)
Notes: A: Treatment as usual; B: Lifestyle interventions; C: Psychoeducation; D: Cognitive behavioral therapy.

In the network meta-analysis, lifestyle intervention showed the greatest benefit for weight outcomes. The superior performance of lifestyle interventions may relate to their multi-component nature, addressing both energy intake (dietary change) and expenditure (physical activity), aligning with core principles of weight management. Moreover, these interventions often incorporate behavioral elements that support motivation and adherence, which is clinically relevant given cognitive and motivational challenges in schizophrenia. For BMI outcomes, lifestyle interventions also showed the most significant effect, whereas other non-pharmacological interventions did not differ significantly from usual care.

Table 3. Network meta-analysis results for body weight outcomes

Comparison	SMD (95% CI)	SUCRA (%)	Rank
Lifestyle versus usual care	−3.93 (−5.98, −1.90)	64	1
Psychoeducation versus usual care	−3.46 (−5.47, −1.19)	34	2
CBT versus usual care	−1.95 (−3.76, −0.32)	2	3
Between-intervention comparisons			
Lifestyle versus psychoeducation	−0.49 (−3.51, 2.39)	–	–
Lifestyle versus CBT	−1.98 (−4.57, 0.71)	–	–

Abbreviations: CBT: Cognitive behavioral therapy; CI: Confidence interval; SMD: Standardized mean difference; SUCRA: Surface under the cumulative ranking curve.

A meta-analysis by Fernández-Abascal *et al.*,[36] which included 59 studies of interventions targeting diet and physical activity in non-affective psychosis, reported improvements in BMI and body weight, consistent with our findings. A review by Hjorth *et al.*[37] concluded that lifestyle interventions focusing on diet and exercise can help control weight in patients with schizophrenia. Gurusamy *et al.*[38] similarly proposed that diet- and exercise-based lifestyle interventions are effective for weight management and may improve quality of life. Taken together, these findings support lifestyle interventions as a preferred approach for managing weight in schizophrenia. Lifestyle interventions may reduce energy intake and increase energy expenditure, thereby improving metabolic risk factors associated with weight gain.[39] Compared to pharmacological approaches, lifestyle interventions do not add medication burden and may offer a favorable safety profile.[40] Antipsychotic-induced weight gain may also contribute to additional physical complications, such as meralgia paresthetica,[41] further emphasizing the need for holistic treatment approaches that minimize medication burden while addressing metabolic health.

In addition, a meta-analysis by Firth *et al.*[42] analyzing 20 related studies concluded that exercise interventions did not significantly affect weight in schizophrenia patients, different from our results. This discrepancy may be because their analysis focused on exercise interventions without dietary components. Therefore, in clinical practice, healthcare professionals can prioritize multi-component lifestyle interventions for weight management in schizophrenia patients and develop personalized plans according to patient needs and feasibility, to support overall care and rehabilitation.

The lifestyle interventions included in this study comprised exercise-only programs and programs combining exercise with dietary modification. Exercise-only interventions mainly involved moderate-intensity group aerobic activities (e.g., dance and football). Session duration ranged from 50 to 120 min, typically delivered twice weekly for 8–12 weeks. In combined diet-and-exercise interventions, the physical activity component focused on maintaining appropriate activity levels, such as walking 1.62 km on level ground for about 40 min and supervised stair walking (walking up 231 steps [14 cm each] and down 330 steps [13.5 cm each] for approximately 20 min). The dietary component primarily involved caloric restriction, such as limiting daily intake to 1,300–1,500 kcal/day for women and

1,600–1,800 kcal/day for men. Session duration ranged from 60 to 90 min, and intervention frequency varied from twice weekly to once every two weeks, over a total of 24 weeks. Although current evidence does not clearly indicate which lifestyle program is optimal, existing systematic reviews[36,37] suggest that combining diet and exercise may be more effective.

Our analysis revealed moderate heterogeneity ($I^2 = 63.5\%$) for BMI outcomes, which warrants careful consideration when interpreting the pooled estimates. Several factors may contribute to this variability. Clinically, included populations differed in illness chronicity, types and doses of concomitant antipsychotic medications (with varying metabolic liabilities), and baseline metabolic status. Methodologically, although interventions were categorized as "lifestyle," "psychoeducation," or "CBT," their components, intensity (session frequency and length), duration (8–48 weeks), delivery format (group vs. individual), and provider expertise varied across studies. Furthermore, adherence rates to the interventions, which are often challenging in schizophrenia, were not uniformly reported or likely differed across trials. This heterogeneity suggests that our findings represent an average treatment effect, and effectiveness in real-world settings may be influenced by these contextual factors. Future research should aim to identify patient or intervention characteristics (e.g., higher intensity, longer duration, integrated care models) associated with greater weight-loss benefits.

5. LIMITATIONS

This study has several limitations. Methodological constraints of the included trials, such as infrequent use of allocation concealment (1 study) and blinding (4 studies), may introduce bias. Moderate heterogeneity was observed for BMI outcomes, but its sources were not explored. Our pragmatic categorization of interventions amalgamates programs with varying components, intensity, and duration, particularly within the "lifestyle intervention" node (combining exercise-only and diet-plus-exercise approaches), which may affect the precision of the SUCRA rankings. The analysis included many small studies, which may overestimate effect sizes, and data on secondary metabolic outcomes were insufficient for further analysis. Although lifestyle interventions ranked highest, pairwise comparisons between active interventions were often not statistically significant. Finally, most findings were derived from controlled research settings; generalizability to different cultural or low-resource contexts, long-term sustainability, and cost-effectiveness remain uncertain and warrant future investigation.

6. CONCLUSION

This network meta-analysis demonstrates that lifestyle interventions, particularly those combining dietary and exercise components, are the most effective non-pharmacological strategy for weight management in schizophrenia. Integrating such interventions into routine psychiatric care may not only reduce cardiometabolic risk but also improve treatment engagement and adherence. Future research should focus on long-term effectiveness, cost-effectiveness, and implementation strategies across diverse healthcare settings.

7. RELEVANCE FOR CLINICAL PRACTICE AND IMPLEMENTATION CONSIDERATIONS

This analysis indicates that combined diet-and-exercise lifestyle interventions are likely the most effective non-pharmacological strategy for weight management in schizophrenia. Successful implementation requires consideration of feasibility, patient adherence, and resource availability. In resource-limited settings, lower-intensity programs or alternative interventions such as psychoeducation or CBT may be practical initial options. To address adherence challenges common in schizophrenia, interventions may be integrated into routine care and support engagement strategies (e.g., peer support, digital tools). A stepped-care approach, starting with simpler interventions and escalating intensity as needed, may help optimize outcomes. Ultimately, implementation should be adapted to local contexts and embedded within a holistic care model that addresses both mental and physical health.

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CONFLICT OF INTEREST

All authors declare no conflicts of interest.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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