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Dietary Inflammatory Index and Overweight, Obesity, and Abdominal Obesity: A Meta-Analysis (Postprint)

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Abstract

Background Dietary Inflammatory Index (DII), as a novel indicator for quantitatively assessing dietary inflammatory potential, has been widely applied in research on various chronic diseases; however, no consensus has been reached regarding the correlation between DII and different types of obesity. Objective To systematically evaluate the correlation between DII and overweight, obesity, and abdominal obesity, and to provide a reference for the prevention of different types of obesity. Methods Computerized searches were conducted in CNKI, Wanfang Data Knowledge Service Platform, VIP Database, Chinese Biomedical Literature Database, PubMed, Embase, Cochrane Library, and Web of Science for cross-sectional studies on the correlation between DII and overweight, obesity, and abdominal obesity, with the search timeframe from database inception to January 10, 2023. The Agency for Healthcare Research and Quality (AHRQ) bias risk assessment tool was used to evaluate the included studies. RevMan 5.4.1 was used to perform Meta-analysis, calculating pooled OR and 95%CI to assess the correlation between DII and overweight, obesity, and abdominal obesity. Subgroup analyses were conducted according to differences in gender, study region, survey method, number of DII components, health status of the sample population, diagnostic criteria, and DII grouping type. Results A total of 20 studies from 9 countries were included, comprising 214,808 participants. Meta-analysis results indicated that high DII levels may be a risk factor for overweight [OR=1.12, 95%CI (1.03, 1.22), P=0.005], obesity [OR=1.56, 95%CI (1.34, 1.82), P<0.00001], and abdominal obesity [OR=1.42, 95%CI (1.14, 1.78), P=0.002]. Subgroup analyses based on differences in gender, study region, survey method, number of DII components, health status of the sample population, diagnostic criteria, and DII grouping type from the original studies revealed no significant heterogeneity between groups within subgroups for the correlation between DII and overweight (P>0.05). For the correlation between DII and obesity, the North American population [OR=1.57, 95%CI (1.27, 1.83)] showed a stronger association compared to populations from other regions, and studies using 24-hour recall [OR=1.83, 95%CI (1.39, 2.42)] showed a stronger association compared to those using other survey methods; no significant heterogeneity was observed among other groups. For the correlation between DII and abdominal obesity, the North American population [OR=1.87, 95%CI (1.44, 2.44)] showed a stronger association compared to populations from other regions; no significant heterogeneity was observed among other groups. The funnel plot showed good symmetry, suggesting no significant publication bias. Conclusion

A high DII diet may be a risk factor for overweight, obesity, and abdominal obesity, with this effect being more pronounced in the North American population and males. Increasing the intake of anti-inflammatory dietary components is of great significance for the prevention and treatment of overweight, obesity, and abdominal obesity.

Full Text

The Correlation of Dietary Inflammatory Index with Overweight, Obesity and Abdominal Obesity: A Meta-analysis

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Abstract

Background: The Dietary Inflammatory Index (DII) has been widely applied in chronic disease research as a novel indicator for quantitatively evaluating dietary inflammatory potential, yet the correlation between DII and different types of obesity remains inconclusive. **Objective**: To systematically evaluate the association between DII and overweight, obesity, and abdominal obesity, providing evidence-based references for obesity prevention. **Methods**: Cross-sectional studies examining the relationship between DII and overweight, obesity, and abdominal obesity were systematically searched in CNKI, Wanfang, VIP, CBM, PubMed, Embase, Cochrane Library, and Web of Science from inception to January 10, 2023. The Agency for Healthcare Research and Quality (AHRQ) risk of bias assessment tool was used to evaluate included studies. Meta-analysis was performed using RevMan 5.4.1 to calculate pooled odds ratios (OR) and 95% confidence intervals (CI) assessing the associations. Subgroup analyses were conducted based on gender, geographic region, survey method, number of DII components, health status of sample population, diagnostic criteria, and DII grouping types. **Results**: Twenty studies from nine countries with 214,808 participants were included. Meta-analysis revealed that high DII levels were associated with increased risks of overweight [OR=1.12, 95%CI (1.03, 1.22), P=0.005], obesity [OR=1.56, 95%CI (1.34, 1.82), P<0.00001], and abdominal obesity [OR=1.42, 95%CI (1.14, 1.78), P=0.002]. Subgroup analyses showed no significant between-group heterogeneity for DII-overweight associations (P>0.05). For DII-obesity associations, North American populations [OR=1.57, 95%CI (1.27, 1.83)] showed higher obesity proportions than other regions, and 24-hour recall surveys [OR=1.83, 95%CI (1.39, 2.42)] yielded higher obesity proportions than other methods. For DII-abdominal obesity associations, North American populations [OR=1.87, 95%CI (1.44, 2.44)] demonstrated higher abdominal obesity proportions. Funnel plots showed good symmetry, indicating no significant publication bias. **Conclusion**: High DII diets may represent a risk factor for overweight, obesity, and abdominal obesity, with more pronounced effects in North American populations and males. Increasing anti-inflammatory dietary component intake is important for preventing and managing these conditions.

Keywords: Overweight; Obesity; Abdominal obesity; Dietary inflammatory index; Diet records; Risk factors; Meta-analysis

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Obesity represents a core risk factor for numerous diseases including type 2 diabetes, fatty liver disease, myocardial infarction, and hypertension. Over the past five decades, global obesity prevalence has continued to rise, affecting over 700 million people. The World Obesity Federation and medical associations in the United States and Canada have declared obesity not merely a disease but a source factor for multiple diseases, making it a critical global health burden requiring urgent solutions. Obesity is generally recognized as a systemic chronic low-grade inflammatory state, with pro-inflammatory diets playing a key role in its development. Research demonstrates that Mediterranean dietary patterns effectively reduce risks of obesity, diabetes, and cardiovascular disease, whereas high saturated fat intake from red meat has the opposite effect.

The Dietary Inflammatory Index (DII), first proposed by James at the University of South Carolina and subsequently refined by Hariharan et al., is an indicator for quantitatively assessing the inflammatory potential of diets. Based on 1,943 studies covering dietary data from 11 countries, the DII summarizes associations between dietary components and six inflammatory cytokines including interleukin (IL)-1β, comprising 36 anti-inflammatory and 9 pro-inflammatory components. The calculation formula is: Z-score = (Daily intake of component A - Global average daily intake of component A) / Standard deviation of global average daily intake of component A $\times$ Inflammatory effect index of component A. After converting Z-scores to percentiles, doubling and subtracting "1" creates a "0"-centered symmetrical distribution, which is then multiplied by total inflammatory scores of dietary components to obtain individual DII values. The DII facilitates scientific research at the source of disease, providing new directions for prevention and treatment.

Currently widely applied in large epidemiological studies on various health outcomes, the DII's relationship with obesity remains inconsistent due to differences in study design, geography, and diagnostic criteria. Some studies demonstrate that high DII values significantly promote overweight, obesity, and abdominal obesity, while others find no significant associations. Therefore, this meta-analysis evaluates the relationship between DII and overweight, obesity, and abdominal obesity, with subgroup analyses by gender, diagnostic criteria, and geography to comprehensively discuss heterogeneity sources and provide evidence-based dietary recommendations for obesity prevention.

Methods

1.1 General Information

This study strictly followed PRISMA guidelines and was registered with PROSPERO (registration number: CRD42023393418).

Inclusion criteria: (1) Cross-sectional study design; (2) All human populations; (3) Categorical DII indicators (highest vs. lowest DII categories) assessed via Food Frequency Questionnaire (FFQ), Semi-Quantitative FFQ (SQFFQ), or 24-hour dietary recall; (4) Outcome measures: overweight, obesity, abdominal obesity; (5) Studies using WHO overweight/obesity diagnostic criteria ($25 \text{ kg/m}^2 \leq \text{BMI} < 30 \text{ kg/m}^2$ for overweight, $\text{BMI} \geq 30 \text{ kg/m}^2$ for obesity; male waist circumference ≥ 102 cm, female ≥ 88 cm for abdominal obesity), Chinese Type 2 Diabetes Prevention Guidelines (2013 edition) ($24 \text{ kg/m}^2 \leq \text{BMI} < 28 \text{ kg/m}^2$ for overweight, $\text{BMI} \geq 28 \text{ kg/m}^2$ for obesity; male WC ≥ 90 cm, female WC ≥ 85 cm for abdominal obesity), or WHO pediatric standards (BMI Z-score $> +1$ for overweight, $> +2$ for obesity).

Exclusion criteria: (1) Non-cross-sectional studies (animal experiments, reviews); (2) Studies without reported or extractable effect measures; (3) Duplicate publications; (4) Studies with sample size < 10.

1.2 Literature Search Strategy

Two researchers independently searched PubMed, Embase, Cochrane Library, Web of Science, Wanfang, VIP, CBM, and CNKI for cross-sectional studies on DII and overweight/obesity/abdominal obesity from inception to January 10, 2023. References of included studies were manually traced. Combined subject headings and free-text terms were used. Chinese search terms included: "膳食炎症指数", "膳食促炎指数", "肥胖", "超重", "中心性肥胖", "腹型肥胖". English search terms included: "obesity", "overweight", "Abdominal Obesity", "Central Obesity", "Dietary inflammatory index", "pro-inflammatory diet", "DII". The PubMed search strategy is shown in Table 1 .

1.3 Literature Screening and Data Extraction

Zotero was used to manage retrieved literature. After deduplication, two researchers independently screened abstracts and full texts against inclusion/exclusion criteria, with cross-checking and discussion for discrepancies. Extracted data included: (1) Study characteristics: authors, year, survey method; (2) Baseline participant characteristics: sample size, health status, age, region; (3) Key elements for bias risk assessment; (4) Outcome data: total numbers and overweight/obesity/abdominal obesity cases in high and low DII groups.

1.4 Risk of Bias Assessment

Two researchers independently assessed included studies using the AHRQ risk of bias assessment tool (total score 11 points), with high quality (8-11 points), moderate quality (4-7 points), and low quality (0-3 points).

1.5 Statistical Analysis

RevMan 5.4.1 was used for meta-analysis, with odds ratios (OR) and 95% CIs as effect measures. Heterogeneity was assessed using chi-square test and I^2 statistic (α=0.10), with random-effects models for $I^2 \geq 50\%$ or $P<0.05$, otherwise fixed-effects models. Subgroup analyses were conducted by gender, region, number of DII components, etc. Sensitivity analysis was performed by sequentially removing individual studies. Publication bias was evaluated using funnel plots.

Results

2.1 Literature Search Process

Initial search yielded 1,898 records. After screening, 20 studies were included [9-13,18-32]. The screening flowchart is shown in Figure 1 [Figure 1: see original paper].

2.2 Basic Characteristics of Included Studies

The 20 studies included 214,808 participants from nine countries across five continents: Asia (China, South Korea, Iran) with 10 studies [9-13,26,30-32,34], North America (USA, Mexico) with 6 studies [21,23-25,27,29], and South America (Brazil, Colombia) with 1 study [19]. All studies used the updated Shivappa scoring system [33] and reported categorical DII. AHRQ assessment identified 11 high-quality studies [9-10,12,19,21,23-27,32] and 9 moderate-quality studies [11,13,18,20,22,29-31,34]. Detailed characteristics are in Table 2 .

2.3 DII and Overweight

2.3.1 Meta-analysis of DII-Overweight Association Twelve studies [9-10,13,18-19,21-24,28,30,32] examined DII-overweight relationships. Moderate heterogeneity existed (I^2=59%, P=0.005), so a random-effects model was used. Compared with the lowest DII category, the highest category showed increased overweight proportion [OR=1.12, 95%CI (1.03, 1.22), P=0.005] (Figure 2 [Figure 2: see original paper]).

2.3.2 Subgroup Analysis Subgroup analyses by gender, region, survey method, DII components, health status, diagnostic criteria, and DII grouping types revealed no significant between-group heterogeneity (P>0.05) (Table 3), indicating these factors were not heterogeneity sources.

2.3.3 Sensitivity Analysis Sequential removal of individual studies showed no directional changes, with consistent positive DII-overweight correlations, suggesting stable results. Removing Wang et al. [10] notably reduced heterogeneity (I^2=36%, P=0.11), indicating it may be a major heterogeneity source.

2.4 DII and Obesity

2.4.1 Meta-analysis of DII-Obesity Association Fourteen studies [9-10,12,18-19,21-24,27-30,32] examined DII-obesity relationships. Significant heterogeneity existed (I^2=91%, P<0.00001), requiring a random-effects model. The highest DII category showed increased obesity proportion compared with the lowest [OR=1.56, 95%CI (1.34, 1.82), P<0.00001] (Figure 3 [Figure 3: see original paper]).

2.4.2 Subgroup Analysis Subgroup analyses revealed significant differences by region and survey method (P<0.05) (Table 4). North American populations [OR=1.57, 95%CI (1.27, 1.83)] showed higher obesity proportions than other regions. Studies using 24-hour recall [OR=1.83, 95%CI (1.39, 2.42)] showed higher obesity proportions than other methods. These factors may be primary heterogeneity sources for obesity outcomes.

2.4.3 Sensitivity Analysis Sequential removal of studies showed no directional changes, with consistent positive DII-obesity correlations and minimal heterogeneity changes, indicating stable results.

2.5 DII and Abdominal Obesity

2.5.1 Meta-analysis of DII-Abdominal Obesity Association Nine studies [9,11-12,20,25-27,31-32] examined DII-abdominal obesity relationships. Significant heterogeneity existed (I^2=86%, P<0.00001), requiring a random-effects model. The highest DII category showed increased abdominal obesity proportion [OR=1.42, 95%CI (1.14, 1.78), P=0.002] (Figure 4 [Figure 4: see original paper]).

2.5.2 Subgroup Analysis Subgroup analyses revealed significant regional differences. North American populations [OR=1.87, 95%CI (1.44, 2.44)] showed higher abdominal obesity proportions than other regions (Table 5), suggesting geography may be a primary heterogeneity source.

2.5.3 Sensitivity Analysis Sequential removal of studies showed no directional changes, with consistent DII-abdominal obesity correlations and minimal heterogeneity changes, indicating stable results.

2.7 Publication Bias

Funnel plots for all three outcomes showed good symmetry, with studies largely within 95% CIs, indicating no significant publication bias (Figure 5 [Figure 5: see original paper]).

Discussion

Numerous studies demonstrate that chronic low-grade inflammation is a metabolic response to excess nutrients and energy, playing a crucial role in obesity-related metabolic dysfunction pathogenesis. Beyond energy storage, adipose tissue is a major metabolic and immunologically active organ. High fat intake promotes secretion of inflammatory cytokines including IL-1, IL-6, and TNF-α from adipocytes, inducing oxidative stress and systemic chronic low-grade inflammation. Prolonged exposure to high IL-6 levels increases insulin resistance and metabolic syndrome risk.

As the primary source of nutrients, diet is a major driver of global chronic disease burden, with mechanisms rooted in the pro- and anti-inflammatory properties of individual dietary components. The DII provides a standardized quantitative assessment of dietary inflammatory risk, integrating 45 food parameters (e.g., monounsaturated fatty acids, niacin, curcumin) based on 1,943 global studies. It captures the comprehensive inflammatory effects of multiple dietary components simultaneously, overcoming limitations of single-nutrient analyses. Therefore, investigating DII-obesity associations is crucial for obesity prevention and treatment.

This meta-analysis included 20 studies with 214,808 participants from nine countries, confirming associations between dietary inflammation and different obesity types. Results showed positive correlations between DII scores and overweight [OR=1.12, 95%CI (1.03, 1.22), P=0.005], obesity [OR=1.56, 95%CI (1.34, 1.82), P<0.00001], and abdominal obesity [OR=1.42, 95%CI (1.14, 1.78), P=0.002], with obesity showing the strongest association (56% increased risk). Research indicates pro-inflammatory dietary components can directly affect gut microbiota involved in subcutaneous fat accumulation, inducing obesity.

Geographic subgroup analyses revealed heterogeneity for obesity and abdominal obesity outcomes, with North American populations showing higher proportions than other regions. This may reflect the high-fat, high-protein, high-calorie Western dietary pattern and cultural specificity prevalent in North America. Gender subgroup analyses showed stronger DII-obesity associations in males. Studies demonstrate that hypogonadism increases male obesity, cardiovascular disease, and mortality risk, with testosterone levels declining approximately 30% annually after age 20, representing a key obesity risk factor.

These findings suggest DII can serve as a tool for predicting overweight, obesity, and abdominal obesity risks and assessing health status. Increasing intake of anti-inflammatory components (e.g., curcumin, β-carotene, flavonoids) while reducing pro-inflammatory components (e.g., saturated fat, trans fat, vitamin B12) is important for prevention and management.

Limitations: (1) DII assessment method differences may introduce bias (e.g., self-administered FFQ vs. interviewer-administered, social desirability bias, recall bias between FFQ and 24-hour recall). (2) Using categorical DII raw data rather than adjusted ORs may leave residual confounding from age, income, etc. (3) Lack of racial data in original studies prevented race-based subgroup analysis, potentially contributing to heterogeneity.

In conclusion, this meta-analysis demonstrates that DII is associated with overweight, obesity, and abdominal obesity, with high pro-inflammatory diets representing a risk factor, particularly in North American populations and males. Developing rational anti-inflammatory dietary strategies for high-risk populations under professional guidance is essential. These findings can inform public health policies for disease prevention through specific dietary patterns. Future research should clarify intrinsic links between diet, inflammatory cytokines, and obesity-related diseases to provide insights for prevention and treatment.

Author Contributions: LI Jixin designed and implemented the study; QIU Linjie and REN Yan conducted literature screening and data extraction; WANG Wenru and LI Meijie performed data analysis and visualization; ZHANG Jin supervised the study and reviewed manuscript quality.

Conflict of Interest: None declared.

References: [The reference list would follow here, preserved exactly as in the original]

Note: Figure translations are in progress. See original paper for figures.

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