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Meta-analysis

Effect of glycemic index and glycemic load on energy intake in children

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ABSTRACT

Objective: Several studies assessed the effect of glycemic index (GI) and glycemic load (GL) on energy intake in children but findings are not consistent in this regard. The aim of this study is to summarize and assess the evidence for the effect of GI and GL on energy intake by conducting a meta-analysis on published randomized clinical trials.
Method: Our search process was conducted in PUBMED, Web of Science, and Google Scholar databases. The following keywords were searched in any part of published articles: "glycemic index" OR "glycaemic index" OR "glycemic load" OR "glycaemic load" OR "energy intake" AND "child" OR "children" OR "adolescent" OR "youth."
Results: We gathered 5099 articles. Non-clinical trial studies that did not intervene by GI or GL or those not assessing energy intake as a dependent variable and those that were conducted on patients over age 18 y were excluded. Each included study was evaluated three times and the exclusion criteria was checked. Eventually, six studies from 1999 to 2012 met the criteria (213 participants ages 4–17.5 y). There is heterogeneity in the study's participants in the present paper. Children with type 2 diabetes, obesity, or normal-weight children were recruited in different studies. Overall effect of consuming low GI (LGI) and low GL (LGL) meals on energy intake was not significant. Subgroup analysis showed that LGI (not LGL) meals decreased subsequent energy intake, whereas heterogeneity was significant in the LGI group of studies. Although a slight asymmetry was shown by Begg's funnel plot, the Egger's asymmetry was not significant. We did not find any evidence of publication bias for studies assessing the effect of low GI or GL meals on energy intake.
Conclusion: Consuming LGI diet (not LGL) has favorable effect on reducing energy intake and obesity, subsequently.

Introduction

Childhood obesity may increase the premature risk for chronic diseases and shorter life span [1]. Globally, the prevalence of obesity among children is around 43 million, of which more than half are from developing countries [1]. Nutritional intervention is one of the most effective approaches to treating and preventing childhood obesity [2]. Carbohydrate intake as a main energy source in the diet of children in developing countries can play an important role in this regard. Dietary pattern analysis among Middle Eastern populations showed that higher amounts of carbohydrates especially refined grain, were consumed [3]. Jenkins et al [4] classified carbohydrate-containing foods based on body glycemic response after their ingestion and called it the glycemic index (GI) [5]. To incorporate the carbohydrate quantity to its quality, it was proposed that the glycemic load (GL) be calculated by multiplying the carbohydrate gram to its GI [6]. The association between dietary GI, GL, and obesity in adults was evaluated in previous cross-sectional [7–11] and cohort studies [12–14]. Many clinical trials have been conducted to assess the effects of dietary GI and GL on adult obesity [15–27]. However, these effects need to be considered in children. There is a body of evidence about the relationship among dietary GI, GL, and childhood obesity. Cross-sectional studies have reported inconsistent results. One cross-sectional study has shown a neutral association between GI, GL, and body fat [27], whereas others have illustrated a positive relationship among GI, GL, and waist circumference, body mass index (BMI), and sum of four skinfolds [5,28]. The inconsistent findings have been repeated in the results of cohort

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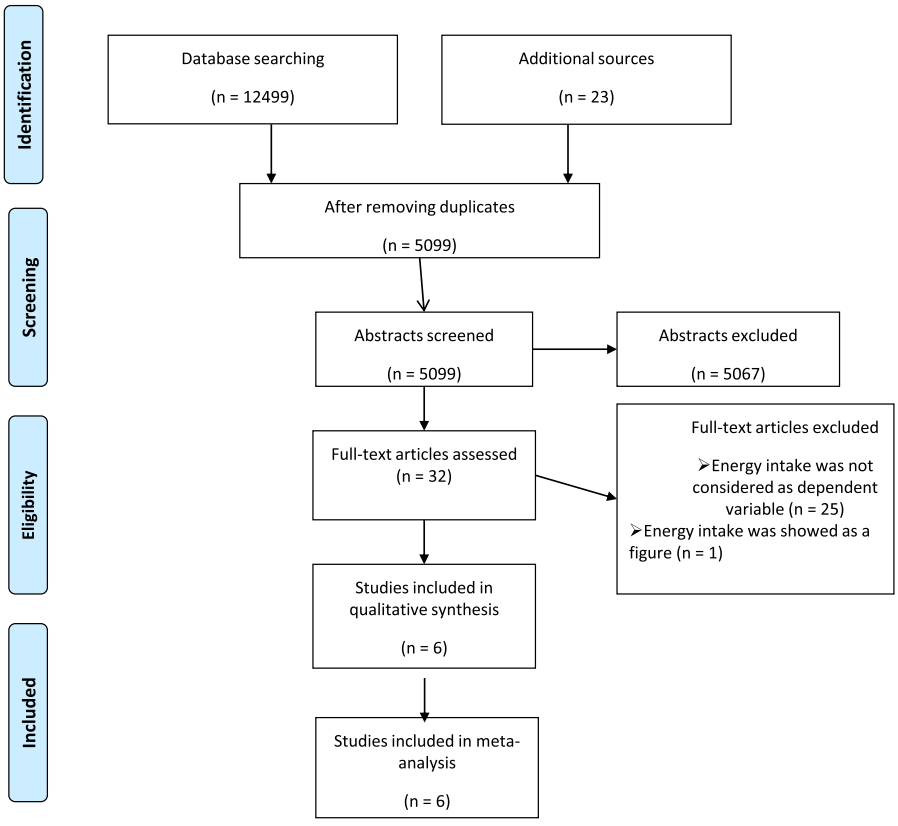

Fig. 1. The process of selecting studies.

studies [29–31]. Published clinical trials should be categorized based on the type of intervention and outcomes: education-based study, whole-diet intervention, and meal intervention. According to previous meta-analyses conducted on participants in different age groups, a low GI (LGI) diet may reduce body mass, total fat mass, and BMI [32]. However, the effects of GI and GL on energy intake reported in some studies have not yet been disclosed. Each 3% to 4% energy imbalance (equivalent to one slice of bread) in adults may lead to 1 kg weight gain per year [33]. Furthermore, energy intake was introduced as a weight gain predictor in epidemiologic studies [33]. Although the association between GI and energy intake was assessed in one observational study [29], the number of observational studies in this regard was not sufficient for conducting a meta-analysis. Therefore, the aim of this study is running a meta-analysis to clinical trials for evaluating the effects of GI and GL on energy intake among children.

Materials and methods

Our search process was conducted in PUBMED, Web of Science, and Google Scholar databases. The following keywords were searched in any part of published articles: "glycemic index" OR "glycaemic index" OR "glycemic load" OR "glycaemic load" OR "energy intake" AND "child" OR "children" OR "adolescent" OR "youth." The process of selecting studies was showed in Figure 1. Finally, 5099 articles were gathered. Non-clinical trial studies that did not intervene by GI or GL or those without assessing energy intake as a dependent variable and those that were conducted on individuals older than age 18 y were excluded. Each included study was evaluated three times to check the exclusion criteria. Eventually, six studies from 1999 to 2012 met these criteria.

Data extraction

A data collection form was used for extracting data. Data extraction was repeated twice. Gathered data were discussed and checked in investigators' periodic sessions. We extracted these information from each study: first author name, year of publication, sample size in each group and total sample size, gender distribution, age range or mean age, study type, properties of intervention and non-intervention diets, study duration, mean and SD of energy intake in each group, any other intervention if it exists, and notes about subjects. We also converted SEs and confidence intervals (CI) to the SD. In studies that did not report SD, SE, or CI, we used *P*-value to calculate effect size. The energy intake values reported in Joule were changed to kilocalorie. All the study durations were converted to day.

Statistical analysis

The mean difference and SD of energy intake between study groups after intervention was used for the meta-analysis. Summary mean estimates with their corresponding SDs were derived by the method of DerSimonian and Laird [34] by using random effects model, which incorporates between-study variability. Subgroup analyses were performed to check for specific source of heterogeneity. Between-subgroup heterogeneity was evaluated using fixed effect model. Statistical heterogeneity between studies was evaluated with Cochran's Q test [35]. Sensitivity analysis was used to explore the extent to which inferences might depend on a particular study or group of studies. Publication bias was assessed by visual inspection of funnel plots [36]. In these funnel plots, the difference in mean energy intake was displayed against the inverse of the square of the SE (a measure of the precision of the studies). Formal statistical assessment of funnel plot asymmetry was done with Egger's regression asymmetry test and adjusted rank correlation test [37]. Reported *P*-values are from the intercept of the regression analysis, which provides a measure of asymmetry. Additionally, Begg's adjusted rank correlation test was used [37]. Statistical analyses were carried out by the use of Stata, version 11.2 (Stata Corp, College Station, TX). *P*-values <0.05 were considered statistically significant.

Results

Finally, six studies were included in this meta-analysis (213 participants ages 4–17.5 y) [38–43]. Table 1 shows the characteristics of the included studies. Two studies compared energy intake following either low GL (LGL) or high glycemic load (HGL)