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Comparison of plasma triacylglycerol levels in vegetarians and omnivores: A meta-analysis

Zili Zhang M.D.[a], Guanpei Ma Ph.D.[b], Sifan Chen M.D.[a], Zilun Li M.D.[c], Enqin Xia Ph.D.[a], YanShuang Sun M.D.[a], Fang Yang M.D.[a], Lin Zheng B.Sc.[a], Xiang Feng M.D., Ph.D.[a,*]

[a] Department of Nutrition, School of Public Health, Sun Yat-Sen University, Guangzhou, People's Republic of China
[b] Department of Epidemic of Disease and Health Statistics, School of Public Health, Guangzhou Medical University, Guangzhou, People's Republic of China
[c] Divison of Vascular Surgery, First Affiliated Hospital, Sun Yat-Sen University, Guangzhou, People's Republic of China

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ABSTRACT

Objective: To compare the effect of vegetarian diets and omnivorous diets on triacylglycerols (TGs).
Methods: We identified cross-sectional and cohort studies related to TGs (an index of blood lipids) listed on PubMed and ISI Web of Knowledge, bibliographies, and related references and studies suggested by search engines to further increase the range of data collected (all-year time span until May 2011).
Results: Twelve studies with 1300 subjects were included for meta-analysis. Vegetarian diets were effective in lowering plasma TG concentrations (standardized mean difference −1.28 mmol/L, 95% confidence interval −2.14 to −0.42); in eight developed countries, plasma TG levels were insignificantly lower in vegetarians than in omnivores (standardized mean difference −0.31 mmol/L, 95% confidence interval −1.13 to 0.50), but in four developing countries, the phenomenon was obvious (standardized mean difference −4.06 mmol/L, 95% confidence interval −7.43 to −0.70).
Conclusion: Compared with omnivorous diets, vegetarian diets provide health benefits, especially in developing countries. This favorable effect occurs even if vegetarian diets last for at least 6 mo.

Introduction

Dyslipidemia plays an important role in conditions such as heart disease, peripheral vascular disease, and stroke [1–3]. It is increasingly becoming a common public health problem in industrialized and developing countries because of its high prevalence in the general population, which imposes a significant demand on medical care and health services. For instance, in the USA, these diseases account for more than 885 000 deaths and $634.2 billion in related costs annually [4]. Cardiovascular diseases and associated mortality are closely related to increased plasma concentrations of total cholesterol (TC), low-density lipoprotein cholesterol, and triacylglycerol (TG) [1]. It has been estimated that about 0.2% of the general population has familial hypercholesterolemia [5]. However, more than 48% of the adult population in the USA has TC levels above 200 mg/dL. Many famous research institutes have focused studies on this subject, suggesting that non-genetic/dietary factors instead of genetics are involved in hyperlipidemia. The measurement of the blood lipid index is an important tool for elucidating the pathophysiology of these diseases. There is a close correlation between these indices and plasma lipid levels, and measuring these biomarkers is the reference method.

Thus far, the effects of different diets on TG level have been inconsistent. For instance, some data have suggested that a vegetarian diet is associated with lower TG levels than an omnivorous diet [6–13]; other studies have found no such relations [14–17]. The concrete relations of TG concentrations between vegetarian diets and omnivorous diets have been the subject of much study and have caused some controversy during the previous decades. Previous meta-analyses have not included reports in the field. A common feature of these existing studies is that almost all were based on relatively small samples, which might have limited the statistical power to detect a small effect. Because of conflicting results and the limited sample sizes in individual studies, a meta-analysis may be helpful to resolve the controversy regarding the associations of TG concentrations between vegetarian diets and omnivorous diets. In particular, we sought to test the hypothesis that the vegetarians would have lower TG levels than omnivores.

* Corresponding author. Tel.: +86-20-8733-2571; fax: +86-20-8733-0446.
E-mail address: fengx@mail.sysu.edu.cn (X. Feng).

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Table 1
Characteristics of studies included in the meta-analysis and observational studies evaluating the effects of diet on triacylglycerols (millimoles per liter)

Study	Country	Economy*	Design	Average age	Vegetarians			Omnivores			Weight (%)
					Subjects (n)	Mean	SD	Subjects (n)	Mean	SD	
Chen et al. [7]	China	developed	OS	51.22	99	2.48	1.69	99	2.66	2.04	8.8
Li [12]	Australia	developed	OS	44.00	43	1.20	0.66	60	1.27	0.50	8.7
Kritchevsky et al. [15]	UK	developed	OS	37.50	25	3.57	0.36	22	2.51	0.39	8.3
Robinson et al. [17]	UK	developed	OS	38.20	43	1.12	0.26	43	1.10	0.31	8.7
Teixeira Rde et al. [13]	Spain	developed	OS	30.00	67	2.92	2.04	134	4.03	3.28	8.8
Papadaki et al. [16]	Greece	developed	OS	49.50	10	3.85	1.91	10	2.56	1.13	8.1
Famodu et al. [9]	Africa	developing	IC	45.00	28	1.20	0.10	8	1.40	0.10	8.1
De Biase et al. [8]	Brazil	developing	CS	35.76	19	2.43	0.86	22	4.03	3.10	8.5
Krajcovicova et al. [11]	Slovakia	developing	CS	48.00	54	1.21	0.03	59	1.66	0.03	6.0
Alexander et al. [6]	USA	developed	CS	44.00	74	3.94	0.40	45	5.92	0.52	8.5
Hoffmann et al. [10]	Germany	developed	CS	45.00	111	1.84	0.16	138	2.12	0.34	8.8
Fernandes Dourado et al. [14]	Brazil	developing	CS	40.00	29	3.89	2.24	58	3.00	0.92	8.7

CS, cross-sectional observational study; IC, Ilisan cohort; OS, observational study
Data are expressed as mean ± SD. To convert milligrams per deciliter to millimoles per liter, multiply by 0.02586
* A Human Development Index above 0.9 indicated a developed country and a Human Development Index below 0.9 indicated a developing country.

Materials and methods

A systematic search of the literature was carried out by using PubMed, and ISI Web of Knowledge resources (all-year time span until May 2011). We also used bibliographies and related references and studies suggested by the search engines to further increase the range of data collected. The keywords used for the search included *lacto* or *lacto-ova* or *ova* or *vegetarian* or *non meat eaters* or *omnivorous diet* or *omnivores* or *meat eater* or *no vegetarian*, concatenated with *blood lipid levels* or *plasma lipids* or *TG*. The reviewers identified eligible articles by reviewing the abstracts initially. If the abstract was consistent with the inclusion criteria, then the full-text article was obtained. The inclusion criteria were as follows: 1) original studies and articles or abstracts reporting studies on humans and reports published in languages other than English were reviewed if English translations were available; 2) an average age of 30 to 60 y for free-living subjects without gross disturbances of lipid metabolism; 3) trials included adequate control groups; 4) studies included information about the statistical significance of such findings; 5) all subjects who had been on the same diet for at least 6 mo were eligible; and 6) studies reporting group means ± standard deviations for quantitative measurements of the indices including TG and any or all of the following: TC, low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol. We found 12 trials that met our inclusion criteria (Table 1) [6–17].

Several investigators independently extracted the data and reached a consensus on all the items. These search procedures resulted in 563 citations. Abstracts of the remaining citations were examined for a correspondence with the meta-analytic inclusion criteria listed earlier. Discarded citations included reviews of related literature, reports lacking sufficient detail on classification, and reports of other descriptive or intervention studies. Subject group characteristics included location during this process, sample size, sex, age, recruitment procedure, and inclusion and exclusion criteria. Design issues were the type of design, group assignment procedure, and the control of selected confounding variables. The following information was collected from each article: author, year of publication, country of origin, selection, and characteristics of different groups, demographics, and controls. Twelve studies met the inclusion criteria.

The included studies had sufficient information for classification. Each article contained the information on the mean TG levels of a group of subjects while on those diets. The control group with a common baseline diet was followed by vegetarian diets. The intakes of protein, carbohydrate, and dietary cholesterol did not change within a study; any drift in the TG level with time occurred simultaneously in both diet groups and therefore did not affect the differences in the final levels between the two diet groups. The strength of the association between TG levels in the different diets was measured. The mean ± standard deviation (millimoles per liter) with 95% confidence intervals (CIs) and the percentage of weight for all trials were calculated. Multiplication by 0.02586 was done to convert milligrams per deciliter to millimoles per liter. Stratified analyses were also performed by economy. Because of the possible heterogeneity across studies, a statistical test for heterogeneity was performed based on the Q test [18]. If the P value was greater than 0.05 on the Q test, which indicates a lack of heterogeneity among studies, the summary standardized mean difference (SMD) estimate of each study was calculated by the random-effects model using the method of DerSimonian and Laird [18,19]. Sensitivity analyses (Fig. 1) were performed to assess the stability of the results. Funnel plots and the Egger linear regression test (Figs. 2 and 3) were used to determine the potential publication bias [19]. All analyses were done with STATA 10.0 (StataCorp LP, College Station, TX, USA) using two-sided P values.

Results and discussion

We found 563 studies, of which 322 were excluded based on the screening using the general criteria. The remaining 242 abstracts were reviewed, and the full reports were evaluated, of which 23 potentially relevant articles were included. Of the remaining studies, nine additional studies were excluded, leaving 12 trials published for the all-year time span that met the specific inclusion criteria after close examination. Reports were excluded because of an ineligible age, an unavailability of TG levels, a lack of detailed classification, non–English-language studies without English translations, or non-human studies (Fig. 4). The analyzed studies included 1300 subjects, 602 vegetarians and 698 omnivores, and all observational studies (including cross-sectional and cohort studies; Table 1). Two diet types were considered, vegetarian diets and omnivorous diets. The vegetarian diets were classified as lacto-ova vegetarian (included eggs, milk, and dairy products), lactovegetarian (included milk and dairy products), and ova-vegetarian (included eggs and no dairy products or milk). The lacto-ova vegetarian, lactovegetarian, and ova-vegetarian diets showed better lowering of TG levels than the omnivorous or carnivorous diets. The vegetarians excluded meat intake or ate meat no more than six times per year. For the subjects to be classified into these categories, they had to have been practicing their diets for at least 6 mo before the study. An omnivore ate a traditional diet that contained meat and dairy products and

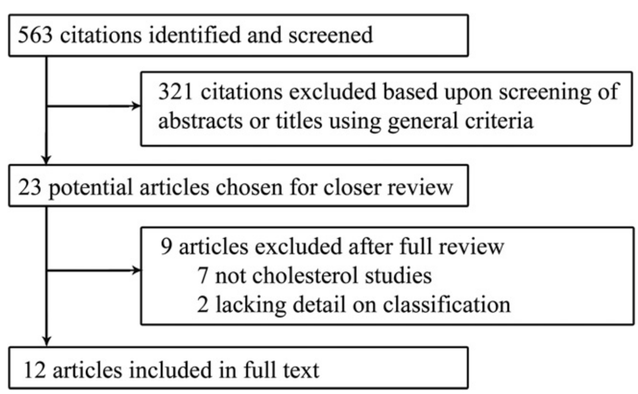

Fig. 1. Sensitivity analyses of 11 studies. Each dotted line represents the 95% confidence interval of one study, and each circle indicates the mean difference.