Egg consumption and coronary atherosclerotic burden

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ABSTRACT

Objective: To verify the association between egg consumption and coronary atherosclerotic burden.
Design: Observational study.
Setting: Cardiac catheterization laboratory.
Participants: Adult patients referred for coronary angiography.
Measurements: Socio-demographic data (age, education level, and occupation), cardiovascular risk factors (smoking, systemic hypertension, dyslipidemia, diabetes, and family history of coronary artery disease), and egg-eating habits were assessed using a research questionnaire. Egg consumption was divided into three categories: less than one egg a week; one egg a week; and more than one egg a week. Coronary atherosclerotic burden was assessed by a blinded interventional cardiologist using the Friesinger Score (FS) obtained from the coronary angiography. This score varies from 0 to 15 and evaluated each of the three main coronary arteries separately. For this analysis, the FS was divided into three categories: 0 −4, 5−9, and 10−15.
Results: The study sample was composed of 382 adult patients; 241 patients (63.3%) were male. The average age was 60.3 ± 10.8 years (range 23−89 years). The egg-eating category was inversely associated with dyslipidemia ($p < 0.05$) but not with the other cardiovascular risk factors. A significant association was found between egg consumption and FS ($p < 0.05$), showing that patients who ate more than one egg a week had a lower coronary atherosclerotic burden. By multivariate analysis, the atherosclerotic burden was independently associated with sex, age, hypertension and egg consumption.
Conclusion: In this observational study of patients undergoing coronary angiography, the consumption of more than one egg per week was associated with a lower coronary atherosclerotic burden.

1. Introduction

Because of the amount of cholesterol contained in eggs, a restricted consumption of eggs has been often recommended to reduce plasma cholesterol levels and the risk of cardiovascular disease. An egg contains more than 200 mg of cholesterol, which is the maximum recommended daily amount for patients with dyslipidemia and cardiovascular risk [1]. However, in addition to cholesterol, eggs contain nutrients such as essential amino acids, folate, riboflavin, selenium, choline, and vitamins B 12, A, D, E and K. Eggs also provide protein of high biological value and a small amount of total fat [2,3]. Compared with other animal foods, eggs contain proportionally less saturated fat [4]. It is conceivable, therefore, that the small adverse effects due to cholesterol could be counterbalanced by the potential beneficial effects of the other nutrients found in eggs [5].

Furthermore, evidence suggests that dietary cholesterol has a limited influence on serum cholesterol and cardiovascular risk [2,6]. Previous studies indicate that the consumption of up to one egg a day is unlikely to have a substantial overall impact on the risk

of coronary artery disease (CAD) or stroke among healthy men and women [6] and that egg consumption was non-detrimental to endothelial function and serum lipids in hyperlipidemic adults [3]. To date, there is no known influence of egg consumption on coronary atherosclerotic burden.

This study aimed to investigate the association between egg consumption and the coronary atherosclerotic burden in patients undergoing coronary angiography for suspected CAD.

2. Methods

2.1. Design

Observational study.

2.2. Subjects and methods

Patients 18 years and older that were undergoing coronary angiography to investigate coronary artery disease at The Center for Cardiovascular Diagnosis and Intervention, São Lucas Hospital (Porto Alegre, Brazil) were invited to participate in the study. Patients who were not capable of answering the study questionnaire were excluded from the study. The data were collected from October 2008 to December 2009. It was calculated that a sample size of 320 patients was required to assess the relationship between eating habits and coronary atherosclerotic burden.

Socio-demographic characteristics and cardiovascular risk factors: The socio-demographic data (age, education and occupation) and cardiovascular risk factors (smoking, hypertension, dyslipidemia, diabetes mellitus and family history of CAD) were collected using a structured questionnaire.

Egg Consumption: The egg consumption data were also collected through direct individual interviews. For analysis, egg consumption was divided into three categories: less than one egg per week, one egg per week and more than one egg per week.

Coronary Atherosclerotic Burden: The coronary atherosclerotic burden was evaluated using the Friesinger Score (FS) [7] obtained by angiography. The FS is determined by separately scoring each of the three main coronary arteries within a range of 0–15. The anterior descending, circumflex and right coronary receive a score of zero to five according to the following categories: 0 — No arteriographic abnormalities; 1 — Parietal irregularities or trivial lesions 1 − 29%; 2 — At least one stenosis of 30−68%; 3 — Diffuse, tubular, or multiple lesions in at least two segments with 30−68% stenosis; 4 — At least one segment with stenosis of 69−99% but without total proximal occlusion; 5 − Total occlusion of a vessel in the proximal portion without any filling of the distal segment. Lesions in the left main stem score for both the anterior descending and the circumflex. All coronary lesions were assessed by an interventional cardiologist blinded to the egg consumption data.

2.3. Statistical analysis

The data analyses were performed using the Statistical Package for Social Sciences (SPSS) version 17.0 (IBM, Chicago, USA). A frequency analysis was carried out for the categorical variables, and mean and standard errors were calculated for the continuous variables. A Pearson's Chi-square test was used for the categorical variables, and a Chi-square Linear-by-Linear Association test was used for the ordinal variables. A model of multiple linear regression was completed using the FS as the dependent variable and the other variables (socio-demographic data, cardiovascular risk factors and egg consumption) as the independent variables. A critical alpha of 0.05 was used for all comparisons.

2.4. Ethical procedures

The research protocol was approved by the Ethics and Research Committees of the Pontifical Catholic University of Rio Grande do Sul (PUCRS), number 08/04211, and all participants signed an informed consent form.

3. Results

The sample consisted of 382 adult patients undergoing coronary angiography; 241 patients (63.3%) were male, and 140 patients (36.7%) were female. Their average age was 60.3 ± 10.8 years, with a minimum of 23 and a maximum of 89 years. Regarding coronary artery disease severity, 112 patients had single-vessel; 70 had double-vessel; and 81 had triple-vessel coronary artery disease.

Men consumed more eggs than women ($p < 0.05$). As indicated in Table 1, there was no significant association between egg consumption and the other socio-demographic variables.

Among the cardiovascular risk factors, a significant difference was found ($p < 0.05$) only for the egg consumption of dyslipidemic patients, who consumed fewer eggs compared with patients without dyslipidemia (Table 1).

As observed in Table 2, a significant association between egg consumption and FS ($p < 0.05$) was found, showing that patients who consumed more than one egg per week had a lower coronary atherosclerotic burden.

In the multivariate analysis, the coronary atherosclerotic burden was independently associated with sex, age, and hypertension and

Table 1
Frequency of sociodemographic and cardiovascular factors in patients undergoing coronary angiography and distribution of egg consumption in accordance with these factors.

	Total sample N (%)	Distribution of consumption of eggs (%)			P*
		Less than one egg per week	One egg per week	More than one egg per week	
Sex					
Female	140 (36.7)	51.4	27.1	21.4	0.020
Male	241 (63.3)	39.8	25.7	34.4	
Marital status					
Married	262 (69.01)	46.2	25.2	28.6	0.771
Widowed	58 (15.3)	37.9	32.8	29.3	
Single	21 (5.5)	38.1	28.6	33.3	
Divorced	38 (10)	42.1	21.1	36.8	
Years of schooling					
<4 years	97 (25.6)	46.4	26.8	26.8	0.960
4–8 years	163 (43)	42.9	26.4	30.7	
>8 years	119 (31.4)	43.7	25.2	31.1	
Systemic arterial hypertension					
No	87 (22.9)	39.1	26.4	34.5	0.481
Yes	293 (77.1)	45.4	26.3	28.3	
Dyslipidemia					
No	182 (48)	39.6	24.2	36.3	0.031
Yes	197 (52)	47.7	28.4	23.9	
Diabetes *mellitus*					
No	275 (72.6)	44.4	25.1	30.5	0.641
Yes	104 (27.4)	42.3	29.8	27.9	
Smoker					
No	174 (45.9)	49.4	24.1	26.4	0.201
Ex-smoker	128 (33.8)	42.2	28.1	29.7	
Yes	77 (20.3)	33.8	28.6	37.7	
Family history of CAD					
No	297 (78.4)	44.4	24.9	30.6	0.571
Yes	82 (21.6)	42.7	30.5	26.8	

P = Pearson chi-square test.

Table 2
Egg consumption and association with coronary atherosclerotic burden evaluated by the Friesinger Score in subjects who undergoing a coronary angiography.

	Total sample N (%)	Distribution of consumption of eggs (%)			P
		Less than one egg per week	One egg per week	More than one egg per week	
Friesinger score					
0—4	96 (25.1)	36.4	29.2	34.4	0.033
5—9	161 (42.1)	43.5	26.1	30.4	
10—15	125 (32.7)	51.2	24.0	24.8	

P = test for linear trend chi-square.

was inversely associated with egg consumption, as shown in Table 3.

Fig. 1 shows the association between egg consumption and FS.

4. Discussion

To the best of our knowledge, this is the first study to verify an association between the dietary consumption of eggs and coronary atherosclerotic burden. Among individuals undergoing coronary angiography for the diagnosis of CAD, it was found that age, sex, hypertension and egg consumption were independent risk factors for the coronary atherosclerotic burden as measured by the Friesinger Score. The consumption of more than one egg per week was associated with a lower coronary atherosclerotic burden.

In addition, we observed a lower consumption of eggs in dyslipidemic patients. This effect may potentially be related to the restriction of egg consumption recommended by many health professionals, who follow the references suggesting this restriction [1].

Although eggs are a source of cholesterol, they are also an excellent source of amino acids and essential fatty acids [2], in addition to providing arginine, a precursor of nitric oxide, which is a vasodilator and plays an important role in endothelial function [8]. In healthy subjects, the ingestion of eggs does not generate any adverse effects on cardiac risk or endothelial function [4].

Eggs are also an important source of vitamins E, B12 and folate. It is known that deficiencies in these vitamins may be associated with increased cardiovascular risk. Eggs are also excellent sources of choline, a nutrient that assists in the maintenance of homocysteine levels [9]. Eggs also contain important minerals required by the human body for health, particularly iodine, zinc, calcium and iron [2]. In addition to nutrients, eggs are a low-cost food that is easy to prepare and may even be an excellent replacement for other foods of animal origin, such as red meat [10].

It has been shown that the consumption of eggs was not significantly associated with serum cholesterol [5,10] or cardiovascular risk [6]. The consumption of 1 or 2 eggs a day, when part of a diet low in saturated fat, does not adversely affect the lipid profile [3,11]. In another study, individuals who consumed four or more eggs per week had lower mean concentrations of cholesterol than those who reported consuming one or fewer eggs per week [2].

Table 3
Multiple linear regression final model (dependent variable = Friesinger Score).

Variable	Beta	SE	Beta (corrected)	P
Constant	−1.41	1.52		0.356
Egg consumption	−0.59	0.26	−0.12	0.025
Dyslipidemia	0.88	0.45	0.11	0.052
Sex	2.13	0.46	0.25	<0.001
Age	0.08	0.02	0.22	<0.001
Hypertension	1.37	0.53	0.14	0.009

P = multiple linear regression; SE = standard error.
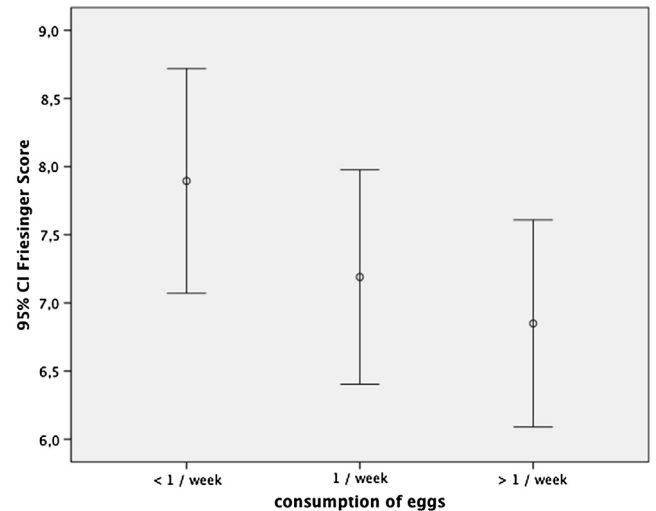
Fig. 1. Association between egg consumption and Friesinger Score.

In one prospective study, no association was found between egg consumption (more than 1 egg per day) and the risk of coronary heart disease or stroke, but in separate analyses by subgroups, an association with increased cardiovascular risk was found in diabetics [6]. In our study, when analyzing the data according to the different subgroups (data not shown), we found no significant difference in the coronary atherosclerotic burden of diabetic patients based on the category of egg consumption.

In a prospective cohort study, the consumption of up to six eggs a week was not associated with stroke, myocardial infarction or total mortality, but the consumption of seven or more eggs per week was associated with a modest but significant increased risk of death, after adjusting the data for confounding factors [12]. Djousse and Gaziano reported an increased risk of heart failure in participants who reported consuming more than one egg per day [13]. Nakamura et al. observed an increased cardiovascular risk in women who consumed more than two eggs per day [14].

In the Mediterranean diet, which is considered to be one of the healthier dietary regimens in the world due to its association with low morbidity and the prevention of chronic diseases, both cardiovascular and neurodegenerative, an average of four eggs are consumed a week, including eggs used in cooking [15]. In a randomized study of different regions of Greece, individuals with metabolic syndrome who had their first acute coronary event were compared to a control group. Individuals who most closely adhered to the Mediterranean diet and who consumed 3-4 eggs per week had a 35% reduction in coronary risk [16].

Recently Voutilainen et al. [17] reported that egg consumption in middle-aged men was not statistically associated either with increased carotid atherosclerosis or increased risk of myocardial infarction. In this study, the average consumption of eggs was 3.4 eggs per week.

Thus, it is important to note that our study cannot be used as a basis for recommending the consumption of eggs indiscriminately to prevent coronary atherosclerotic burden. In the sample group we studied, 101 of the 113 patients who consumed more than one egg per week reported a moderate consumption of eggs 2—4 times per week (data not shown). The association found between egg consumption and FS appears to be linear (Fig. 1). However, we cannot exclude the possibility that consumption of eggs in amounts in excess of that evaluated in this study might be related to a higher atherosclerotic burden, and the association become U-shaped.

This study also found that sex, age and hypertension were independent risk factors for coronary atherosclerotic burden. These

data strengthen the findings in the literature showing that atherosclerosis progresses with age [18] and with elevated blood pressure [19] and that the rate of cardiovascular events and myocardial infarction may be higher in men [20].

However, our study has several limitations. We were not able to examine the effects of cholesterol and saturated fat, lipids, markers of insulin resistance, and other nutrients or relevant biomarkers on the observed association. We do not have nutritional data from the population sample and did not verify the types of egg preparations that were consumed. The type of egg was not ascertained, but we know that most eggs consumed in Brazil are from chickens raised on farms, where they are fed diets based on corn and soybean meal. In relation to the score FS emphasize all angiographic coronary atherosclerotic scores have limitations and none of them has wide clinical acceptance. Angiography only evaluates the coronary lumen and is limited to assessing atherosclerotic plaque extension in the artery wall. The FS is an easily applied and reproducible score, and it is one of the best choices for the angiographic quantification of the coronary atherosclerotic burden.

Finally, by design, our study cannot rule out an epiphenomenon. Regardless, although there is a large body of literature relating cholesterol consumption to atherosclerosis, our findings indicate that additional studies and scientific discussion are necessary before egg consumption is linked to increased coronary atherosclerosis.

5. Conclusion

In conclusion, in patients undergoing coronary angiography, the consumption of 2–4 eggs per week is associated with a lower coronary atherosclerotic burden. Additional studies are warranted to confirm these results and to evaluate the effect of a greater consumption of eggs per day on the atherosclerotic burden. We emphasize that until more research is conducted, egg consumption should not exceed 4 eggs per week, even in healthy patients. We suggest that the consumption of eggs should occur without the use of oil or fat and that the dietary consumption of eggs can be a replacement for meat.

Conflict of interest

None.

List of contributors and their role in the study

Contributor 1. PATRÍCIA CHAGAS participated in the conception of the research and the data collection, the design of the statistical analysis, data interpretation, writing and reviewing the article, and the approval of the final version. No conflict of interest.

Contributor 2. PAULO CARAMORI participated in the conception of the research, the design of the statistical analysis, data interpretation, writing and reviewing the article, and the approval of the final version. No conflict of interest.

Contributor 3. TATIANA PIZZATO GALDINO participated in the data collection, writing and reviewing the article, and the approval of the final version. No conflict of interest.

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Contributor 5. IRENIO GOMES participated in the design of the statistical analysis, data interpretation, writing and reviewing the article, and the approval of the final version. No conflict of interest.

Contributor 6. CARLA HELENA AUGUSTIN SCHWANKE participated in the conception of the research, writing and reviewing the article, and the approval of the final version. No conflict of interest.

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