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Review Article

Dietary fat and cholesterol and risk of diabetes in older adults

Ahmad Alqadheb[1]*, Noor Alsalman[2], Alaa Noor Elahi[3], Mohammed Alobaidan[4], Sarah Shams[5], Moeid Alharthi[6], Ghadeer Banjar[7], Reham Alasiri[8], Rzaz Yamani[9], Rana Al-Rasheed[10]

[1]Department of Family Medicine, Security Forces Hospital, Riyadh, KSA
[2]Almaarefa Colleges, Riyadh, KSA
[3]Alamal Complex, Jeddah, KSA
[4]Prince Saud Bin Jalawi Hospital, Alhasa, KSA
[5]East Jeddah Hospital, Jeddah, KSA
[6]King Abdullaziz University, Jeddah, KSA
[7]Primary Health Care Ministry of Health, Jeddah, KSA Makkah,
[8]Primary Health Care Centre, King Abdullah Medical Complex, Jeddah, KSA
[9]Primary Health Care Ministry of Health, Makkah, KSA
[10]King Fahd Medical Research Centre, King Abdul-Aziz University, Jeddah, KSA

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***Correspondence:**
Dr. Ahmad Alqadheb,
E-mail: ahmadalqadheb@gmail.com

ABSTRACT

Type 2 diabetes is a major global public health issue, and the rapid increase in prevalence over the past decades is expected to continue. The present analysis aimed to investigate the relation between egg consumption and type 2 diabetes risk in older adults. We conducted this meta-analysis using a comprehensive search of MEDLINE, PubMed, EMBASE, Cochrane Database of Systematic Reviews, and Cochrane Central Register of Controlled Trials till 01 February 2018 for prospective observational studies that assessed the relationship of the dietary fat and cholesterol and risk of diabetes in older adults. We identified 15 prospective studies that could be included in the meta-analysis. When comparing the highest with the lowest category of egg intake, pooled multivariate RRs of incident diabetes mellitus were 1.25 (95% CI: 1.13, 1.44) using a fixed-effect model and 1.12 (95% CI: 1.01, 1.56) using a random-effect model. There was evidence for heterogeneity (I^2=75.8%, $p<0.001$). Our meta-analysis shows no relation between infrequent egg consumption and diabetes mellitus risk but suggests a modest elevated risk of diabetes mellitus with ≥3 eggs/wk that is restricted to US studies.

Keywords: Dietary fat, Cholesterol, Diabetes, Meta-analysis, Eggs

INTRODUCTION

Type 2 diabetes is a major global public health issue, and the rapid increase in prevalence over the past decades is expected to continue.[1] estimated to affect 350 million people by 2030.[2] Distinguishing modifiable elements, for example, dietary components, that can impact the risk of type 2 diabetes could be essential for lessening the illness burden. Dietary factors, for example, eggs intake can impact the danger of creating type 2 diabetes. Eggs are rich in dietary cholesterol and protein, and prospective examinations have discovered positive relationship of protein and cholesterol consumption with type 2 diabetes hazard.[3,4]

Egg is additionally a rich source of numerous possibly advantageous dietary segments, for example, minerals, vitamins, and carotenoids. Regardless of determined efforts to decrease risk factors between diabetic patients, 65% of people with diabetes mellitus will die of cardiovascular disease.[5] Stroke and coronary artery disease are the primary sources of death and for which elevated LDL cholesterol is a major factor.[6]

Epidemiological evidence for an association between egg consumption and risk of type 2 diabetes is inconsistent. Thus, we conducted this meta-analysis of presently obtainable prospective cohort studies to evaluate the relation of egg consumption and risk of type 2 diabetes.

METHODS

Data sources and searches

We conducted this meta-analysis using a comprehensive search of MEDLINE, PubMed, EMBASE, Cochrane Database of Systematic Reviews, and Cochrane Central Register of Controlled Trials till 01 February 2018 for prospective observational studies that assessed the relationship of the dietary fat and cholesterol and risk of diabetes in older adults. Both semi parametric and parametric methods were used. No language restrictions were imposed. We followed the standard guidelines for conducting and reporting meta-analyses of observational studies.[7]

Selection criteria

Studies were included in this meta-analysis if they satisfied the following criteria: the study design was prospective, the exposure of interest was dietary fat and cholesterol and risk of diabetes, the outcome was diabetes mellitus, and the investigators reported relative risks (RRs) with 95% CI. If study populations were reported more than once, we used the result with the longest follow-up duration. Flow diagram showing the selection criteria of assessed studies.[8]

Data extraction

Two reviewers independently reviewed studies, abstracted data, and resolved disagreements by consensus. Studies were evaluated for quality. A review protocol was followed throughout. We extracted the following data from each study: year of publication, authors, study location, study name, years of follow-up, sample size (number of participants and incident cases), and relative risk (95% confidence interval).

Statistical analysis

The present meta-analysis utilized Stata version 12.0 software for statistical analysis. Mean Difference (MD) were calculated for continuous variables. Pooled odds ratios (OR) were calculated for discrete variables. Heterogeneity amongst the trials was determined by means of the Cochran Q value and quantified using the I^2 inconsistency test with a significance set at the p value <0.10 or I^2 score >50%.[9] For studies that stratified analyses by gender, we considered each gender as an independent study. Whenever it was possible, results were evaluated either considering all the included studies or considering only the randomized trials. Random-effects model were calculated using summary relative risks of egg consumption for patients with diabetes compared with patients without diabetes.[10] Fitted cubic splines with knots at the 5th, 35th, 65th, and 95th percentile of egg distribution (corresponding to 0, 1, 2.7, and 8.6 eggs/wk). Flow diagram showing the selection criteria of assessed studies.[11]

RESULTS

We recognized 1012 citations using the search strategy. Of these, we excluded 462 after examining the title and abstract including removal of duplicates. We retrieved and evaluated 34 articles in more detail, of which 19 articles were excluded, leaving 15 studies that were eligible for inclusion (Figure 1). Major characteristics of included studies have been summarized in Table 1.

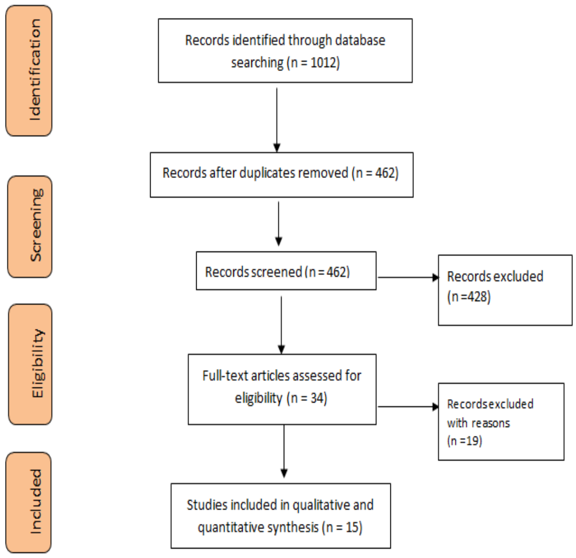

Figure 1: Flow diagram showing the selection criteria of assessed studies.[11]

Seven studies were conducted in the United States, two in Sweden, two in Finland, two in Japan and one each in Spain and France.

When comparing the highest with the lowest category of egg intake, pooled multivariate RRs of incident diabetes mellitus were 1.25 (95% CI: 1.13, 1.44) using a fixed-effect model and 1.12 (95% CI: 1.01, 1.56) using a random-effect model (Table 2). When stratified by geographic location, we observed a 39% higher risk of diabetes mellitus (RR=1.41; 95% CI: 1.32, 1.74) comparing the highest and lowest egg consumption categories when restricted to US studies and using the fixed-effect model. In contrast, there was no statistically significant association of egg consumption with diabetes mellitus in non-US studies (RR=1.05; 95% CI: 0.94, 1.22

using the fixed-effect model, p<0.001 when comparing US with non-US studies). There was evidence for heterogeneity (I^2=75.8%, p<0.001). When stratified by geographic area, there was a 39% higher risk of diabetes mellitus (95% CI: 21%, 60%) comparing highest with lowest egg consumption in US studies (I^2=44.3%, p=0.087) and no elevated risk of diabetes mellitus with egg intake in non-US studies (RR=1.05; 95% CI: 0.94, 1.22 using the fixed-effect model, p<0.001 comparing US with non-US studies). In a dose-response assessment using cubic splines, elevated risk of diabetes mellitus was observed in US studies among people consuming ≥3 eggs/wk but not in non-US studies.

Table 1: Characteristics of included studies.

Study	Year	Country	Age	Participants	Years of follow-up	Categories of egg intake	Adjusted variables
Wallin[12]	2016	Sweden	45–79	39,610	15	<1/wk 1–2/wk 3–4/wk ≥5/wk	Age, education, BMI, physical activity, smoking, intakes of total energy, alcohol, coffee, red meat, processed meat, fish, fruits, vegetables, white bread, caviar, sweet buns/biscuits and fibre, and history of cardiovascular disease at baseline
Lajous[13]	2015	France	43–70	65,364	14	Never 0.1–0.9 eggs/wk 1–1.9 eggs/wk 2–4.9 eggs/wk ≥5 eggs/wk	Age, education, BMI, smoking, physical activity, menopause, hormone replacement therapy, hypertension, hypercholesterolaemia, energy, alcohol, processed red meat, coffee, fruits, vegetables, sugar-sweetened and artificially sweetened drinks
Ericson[14]	2015	Sweden	45–74	24,070	14	4 g/d (median) 12 g/d 19 g/d 28 g/d 45 g/d	Age, sex, method version, season, education, BMI, leisure-time physical activity, smoking, intakes of total energy and alcohol
Djoussé [15]	2015	USA	21–95	1297	7.2	<1/mo, 1–3/mo, 1/wk, 2/wk, 3–4/wk, ≥5/wk	Age, sex, education, BMI, waist circumference, physical activity score, smoking, history of hypertension, history of cardiovascular disease, intakes of total energy, alcohol, red meat (including bacon), fruit and vegetables, fibre, magnesium, and trans-fatty acids
Djoussé[15]	2015	USA	21–92	2267	7.3	<1/mo, 1–3/mo, 1/wk, 2/wk, 3–4/wk, ≥5/wk	Age, sex, education, BMI, waist circumference, physical activity score, smoking, history of hypertension, history of cardiovascular disease, intakes of total energy, alcohol, red meat (including bacon), fruit and vegetables, fibre, magnesium, and trans-fatty acids
Djoussé[16]	2010	USA	65–95	1669	11.3	0, <1/mo, 1–3/mo, 1–4/wk, and almost every day	Age, race, BMI, smoking, alcohol, exercise, cereal-fiber intake, and field center
Djoussé[16]	2010	USA	65–98	2229	11.3	0, <1/mo, 1–3/mo, 1–4/wk, and almost every day	Age, race, BMI, smoking, alcohol, exercise, cereal-fiber intake, and field center
Djoussé[17]	2009	USA	39.7–85.9	20,703	20	0, <1, 1, 2–4, 5–6, and ≥7/wk	Age, BMI, smoking, alcohol, exercise, HTN, and dyslipidemia
Djoussé[17]	2009	USA	38.7–89.9	36,295	11.7	0, <1, 1, 2–4, 5–6, and ≥7/wk	Age, BMI, smoking, alcohol, exercise, energy intake, fruits and vegetables, saturated FA, trans FA, PUFA, red meat, HTN, dyslipidemia, and family history of diabetes mellitus
Vang[18]	2008	USA	45–88	8401	17	>0 to <1/wk ≥1/wk	Age, sex
Montonen[19]	2005	Finland	40–69	4,304	23	<12 g/d 12–23 g/d 24–40 g/d >40 g/d	Age, sex, geographic area, BMI, smoking, family history of diabetes, total energy intake

Continued.

Study	Year	Country	Age	Participants	Years of follow-up	Categories of egg intake	Adjusted variables
Virtanen[20]	2015	Finland	42–60	2332	19.3	<14 g/d 14–26 g/d 26–45 g/d >45 g/d	Age, examination year, education, family history of type 2 diabetes, BMI, leisure-time physical activity, smoking, hypertension, serum long-chain n-3 PUFAs, and intakes of total energy, alcohol, linoleic acid, fibre, fruit, berries, and vegetables
Kurotani[21]	2014	Japan	45–75	27,248	5	11, 21, 33, and 64 g/d	Age, BMI, smoking, alcohol, physical activity, energy, dietary variables, public health center area, HTN, and family history of diabetes mellitus
Kurotani[21]	2014	Japan	45–75	36,218	5	10, 19, 29, and 56 g/d	Age, BMI, smoking, alcohol, physical activity, energy, dietary variables, public health center area, HTN, and family history of diabetes mellitus
Zazpe[22]	2013	Spain	20–90	15,956	6.6	<1, 1, 2–4, and >4/wk	Age, sex, BMI, smoking, alcohol, exercise, adherence to Mediterranean food pattern, energy intake, CVD, HTN, dyslipidemia, and family history of diabetes mellitus

Table 2: Relationship of egg consumption with diabetes risk.

Study	OR	95% CI
Wallin[12]	1.06	(1.00–1.13)
Lajous[13]	1.00	(0.78–1.29)
Ericson[14]	1.07	(1.01–1.14)
Djoussé[15]	1.07	(0.61–1.89)
Djoussé[15]	1.09	(0.70–1.70)
Djoussé[16]	1.81	(0.77–4.22)
Djoussé[16]	0.37	(0.10–1.37)
Djoussé[17]	1.58	(1.25–2.01)
Djoussé[17]	1.77	(1.28–2.43)
Vang[18]	1.15	(0.85–1.54)
Montonen[19]	0.93	(0.79–1.09)
Virtanen[20]	0.55	(0.38–0.79)
Kurotani[21]	1.06	(0.85–1.32)
Kurotani[21]	0.82	(0.63–1.06)
Zazpe[22]	0.70	(0.30–1.70)

DISCUSSION

In the present meta-analysis of 15 prospective cohort studies, we found that consumption of <4 eggs/wk was not linked with the risk of diabetes mellitus. Nevertheless, a stratified analysis presented a higher risk of diabetes mellitus with consumption of ≥3 eggs/wk between US studies but no eminent risk between non-US studies (P-difference <0.001). There was no indication of publication bias or influential study. Notwithstanding the set number of distributed examinations on egg utilization with diabetes mellitus hazard, this meta-analysis gives vital data on the dosage reaction connection. To start with, our outcomes are reliable with no raised danger of diabetes mellitus with rare egg utilization, paying little heed to geographic locale. This is consoling for people who depend on eggs as an origin of reasonable protein. Second, our meta-relapse uncovered a factually noteworthy contrast amongst US and non-US contemplates in that hoisted danger of diabetes mellitus was seen with ≥3 eggs/wk just in US yet not European or Japanese examinations. This brings up the issue in the matter of whether regular utilization of eggs in the United States is for the most part connected with other dietary factors that may increase the danger of diabetes mellitus or whether eggs can autonomously raise the danger of diabetes mellitus such as, regular intake of eggs with processed meats that has been presented to be related with a higher risk of diabetes mellitus might deliver a substitute explanation for observed higher risk of diabetes mellitus with ≥3 eggs/wk in the United States.

A few studies have recommended that trimethylamine-N-oxide (TMAO) a metabolite of choline found in eggs along with seafood could support to clarify the positive association of eggs with DM.[23] Another study presented a positive relationship between egg intake and TMAO concentration.[24] It is possible that TMAO increases LDL oxidation and endorses inflammation, thus leading to an intensified risk of DM.[25] Nevertheless, specified the limited amount of TMAO produced from eggs when compared with other sources, it is more averse to be the capable intermediary. The absence of prospective investigations of TMAO and DM hazard keeps us from affirming earlier guess on the connection of TMAO with DM. Furthermore, few of the examinations meta-analysis balanced for pertinent dietary components or dietary examples to additionally clarify this issue. This recommends impenetrable by dietary examples remains a feasible and likely clarification of the perceived positive connection of ≥3 eggs/wk with DM hazard in US studies. It is vital for future investigations to represent general dietary examples as well as nutrients consumed with by eggs that may increase the danger of DM to additionally clarify this subject.

Limitations of the present meta-analysis comprise the observational nature of studies pooled that cannot exclude unmeasured or residual confounding as a partial or complete source of explanation for observed results. Furthermore, it was impossible to capture all forms of egg consumption or method of preparation in most studies. Self-reported egg consumption could have led to misclassification of egg consumption.

CONCLUSION

The present meta-analysis presented no relation between infrequent egg consumption and diabetes risk, however, recommends a diffident elevated risk of diabetes with consumption of ≥3 eggs/wk. Egg consumption traditions and related overall dietary patterns might vary among populaces and might possibly clarify inconsistencies among the described results. To confirm these results, further studies should be made to make a better understanding of the potential biological mechanisms. Large-scale and long-term randomized controlled trials in various populations must be carried out in future studies to deliver more significant evidence.

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