Intake of 3 Eggs/Day or Equivalent Amount of Choline as Supplement for 4 Weeks Increases Plasma Choline Without Changing Plasma TMAO in Participants with Metabolic Syndrome

Minu Sara Thomas, Marissa Dibella, Christopher Blesso and Maria Luz Fernandez
Department of Nutritional Sciences, University of Connecticut, Storrs CT

ABSTRACT

Objective: The purpose of this study was to compare equivalent amounts of two choline sources on plasma choline and its derivatives including trimethylamine N-oxide (TMAO), inflammatory markers and changes in fecal microbiota in men and women aged 32 to 70 years old with metabolic syndrome (MetS).
Methods: Twenty-three subjects with MetS were included in this randomized, crossover clinical trial. Participants underwent an initial period of 2 weeks without consuming any eggs, which was followed by a random allocation to either 3 eggs/day or a choline-supplement for 4 weeks (both diets had a choline equivalent of 400 mg per day). Following a 3-week washout period, participants were allocated to the alternate diet. We measured plasma choline and plasma TMAO as well as C-reactive protein (CRP), inflammatory markers, insulin, liver enzymes and analyzed fecal microbiota.
Results: Although there was an overall significant increase in plasma choline after egg intake, compared to baseline ($P < 0.01$), there were no significant differences between egg and supplement at the end of the respective interventions ($P > 0.05$). Baseline values were 7.9 ± 2.1 nmol/ml compared to 9.9 ± 2.2 and 9.5 ± 2.1 nmol/ml for the egg and supplement, respectively ($P < 0.01$). In addition, plasma TMAO was not different between baseline, or at the end of the egg and supplement periods ($P > 0.1$). In regards to inflammatory and insulin resistance markers, C-reactive protein, plasma insulin, and insulin resistance (HOMA-IR) were each lower after the egg period compared to baseline, while no differences in these parameters were observed after the supplement period when compared to baseline. In contrast, plasma IL-6 concentrations were lower by both dietary treatments compared to baseline. There were no significant differences in fecal bacterial diversity when baseline was compared to either the egg or the choline supplement treatment by using the Shannon diversity index or when time and treatment were compared. Some interesting observations were that the family of *Lachnospiracae* (Phylum Bacteroidetes) appeared to increase after choline treatment (both after the supplement and the egg period). Also *Akkermansia* (Phylum Verrucomicrobia) was higher after both treatments, yet more so during after the choline period.
Conclusions: These studies indicate that plasma choline response appears to be similar in MetS participants, independent of its source or chemical composition. Analyzing the fecal microbiota of these subjects also indicated no significant differences between treatments indicating that both bioavailability of choline, TMAO production and microbiota composition are not affected by choline source in MetS patients.

OBJECTIVE AND AIMS

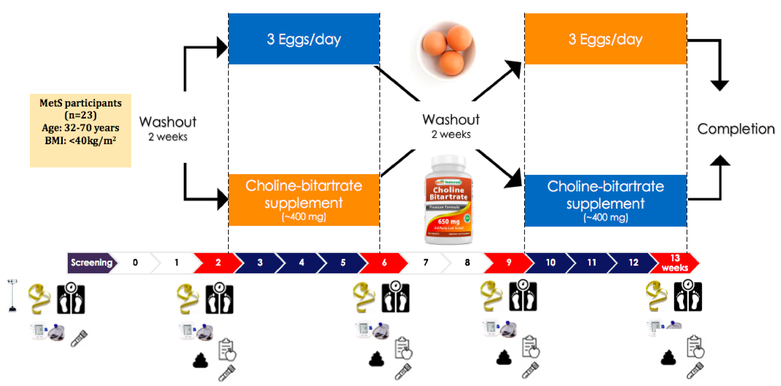
Objective: To evaluate the effect of two sources of choline: phosphatidyl choline (from eggs) vs choline bitartrate from supplement on choline metabolism and microbiota diversity in participants with MetS.

AIM 1: Measure plasma choline and metabolites including betaine, dimethylglycine (DGM), and TMAO

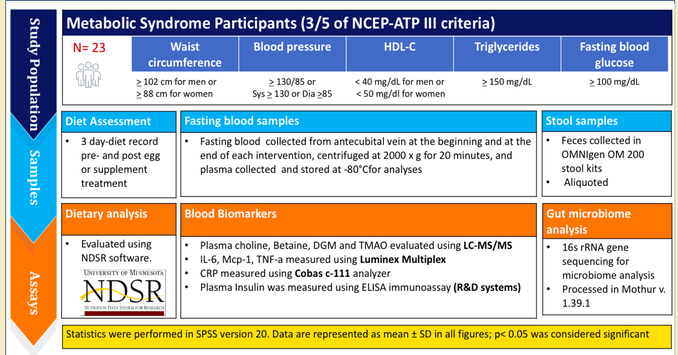
AIM 2: Evaluate whether inflammatory markers were reduced in these subjects

AIM 3: Evaluate microbiota diversity and potential changes due to dietary treatments

EXPERIMENTAL DESIGN



MATERIALS AND METHODS



RESULTS

- Dietary choline significantly increased to meet the DRI (DRI: 550 mg/day of choline for men and 425 mg/day for women)

Plasma concentration of Choline and metabolites at baseline and after consumption of 3 eggs or choline bitartrate supplementation for 4 weeks

Parameter	Baseline	Eggs	Choline supplement
Choline (nmol/mL)[2]	7.9 ± 2.0[a]	9.9 ± 2.2[b]	9.6 ± 2.1[b]
TMAO (nmol/mL)	4.1 ± 3.0	5.6 ± 3.5	5.2 ± 5.3
Methionine (nmol/mL)	29.4 ± 4.0	29.8 ± 4.0	29.9 ± 5.2
Betaine (nmol/mL)	37.6 ± 14.8[a]	43.0 ± 14.7[b]	43.5 ± 18.7[b]
DGM (nmol/mL)	2.4 ± 0.6[a]	2.8 ± 0.7[b]	2.8 ± 0.6[b]

[1]Data are presented as mean ± SD for n = 23 subjects. [2] Numbers in the same row with different superscripts are significantly different ($P < 0.01$)

Concentration of inflammatory markers IL-6, CRP and Insulin at baseline and after consumption of 3 eggs or choline bitartrate supplementation for 4 weeks

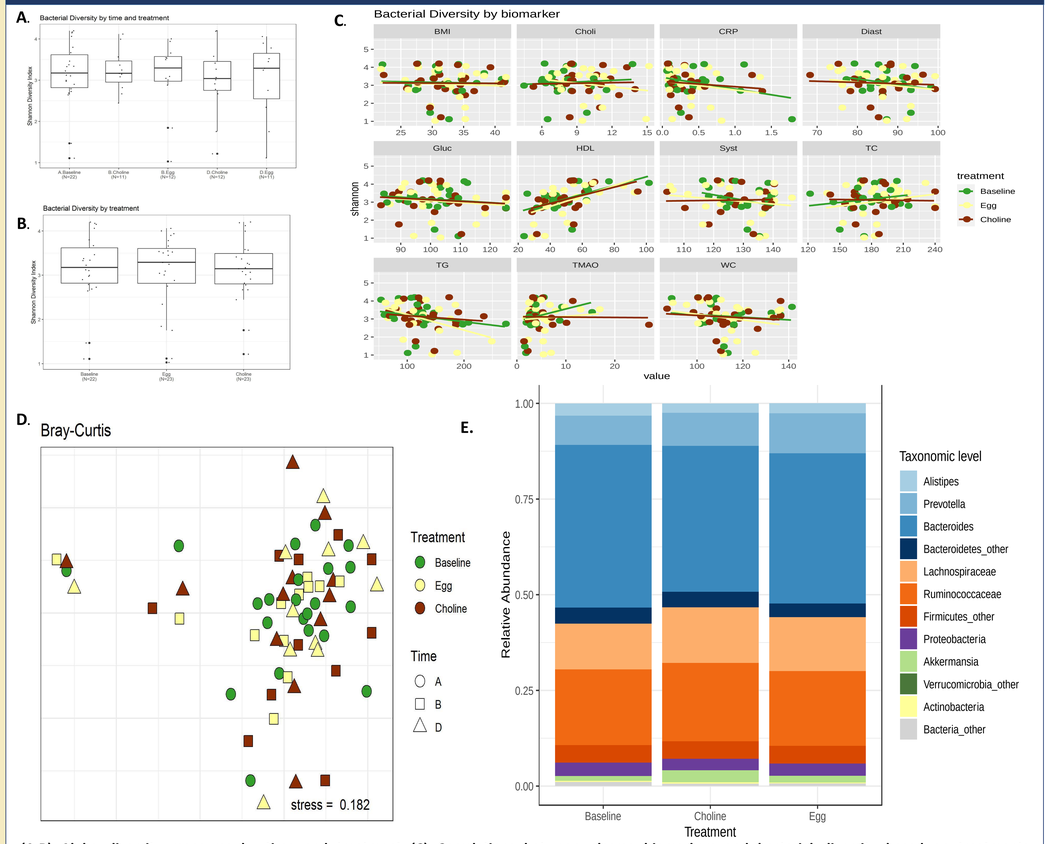
Parameter	Baseline	Egg	Choline supplement
Il-6 (pg/ml)2	5.6 ± 0.9 [a]	4.6 ± 1.7 [b]	4.4 ± 1.3 [b]
CRP	0.48 ± 0.57[a]	0.32 ± 0.31[b]	0.36 ± 0.31[ab]
Insulin (pg/mL)	152.4 ± 87.2[a]	97.7 ± 66.5[b]	111.3 ± 100[ab]

[1]Data are presented as mean ± SD for n = 23 subjects. [2] Numbers in the same row with different superscripts are significantly different ($P < 0.01$)

FUNDING SOURCE

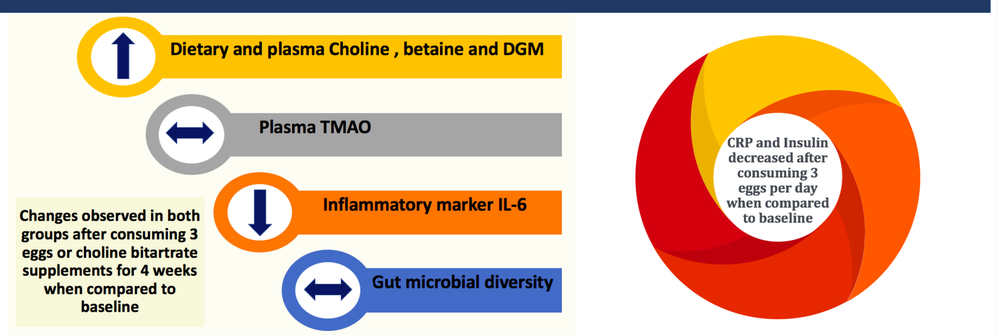
This study was funded Egg Nutrition Center

RESULT



(A,B) Alpha diversity measures by time and treatment (C) Correlations between plasma biomarkers and bacterial diversity based on treatments (D,E)Nonmetric multidimensional scaling of the Bray-Curtis dissimilarity index. This shows the relationship between individual samples based on the species and their abundances. Both ordinations are of the same data, but the ordination on the right also includes an overlay of the OTUs that are significantly correlated with this ordination colored by Taxonomic level.

SUMMARY



CONCLUSION

Choline provided by two distinct sources: Phosphatidyl choline from eggs or choline bitartrate resulted in significant increases in plasma choline without changes in TMAO or microbiota diversity in participants with metabolic syndrome.