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Yogurt consumption during pregnancy and preterm delivery in Mexican women: A prospective analysis of interaction with maternal overweight status

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Abstract

Preterm delivery is an important cause of perinatal morbidity and mortality, often precipitated by maternal infection or inflammation. Probiotic-containing foods, such as yogurt, may reduce systemic inflammatory responses. We sought to evaluate whether yogurt consumption during pregnancy is associated with decreased preterm delivery. We studied 965 women enrolled at mid-pregnancy into a clinical trial of prenatal docosahexaenoic acid supplementation in Mexico. Yogurt consumption during the previous three months was categorized as ≥5, 2–4, or <2 cups per week. Preterm delivery was defined as delivery of a live infant before 37 weeks gestation. We used logistic regression to evaluate the association between prenatal yogurt consumption and preterm delivery, and examined interaction with maternal overweight status. The prevalence of preterm delivery was 8.9%. In this population, 25.4%, 34.2%, and 40.4% of women reported consuming ≥5, 2–4, and <2 cups of yogurt per week, respectively. Differences in preterm delivery were non-significant across maternal yogurt consumption groups; compared with women reporting <2 cups of yogurt per week, those reporting 2–4 cups of yogurt per week had adjusted odds ratio [aOR] for preterm delivery of 0.81 (95% confidence interval [CI]: 0.46–1.41), and those reporting ≥5 cups of yogurt per week had aOR of 0.94 (95% CI: 0.51–1.72). The association between maternal yogurt consumption and preterm delivery differed significantly for non-overweight women compared with overweight women (p for interaction = 0.01). Compared with non-overweight women who

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The authors have no potential conflicts of interest to disclose.

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UR, ADS and JAR designed the study, developed the protocol, and managed data collection. JLK designed and conducted the statistical analysis and wrote the manuscript with assistance from JLR, VKP, and SBO. All authors read and edited the manuscript.

consumed <2 cups of yogurt per week, non-overweight women who consumed ≥5 cups of yogurt per week had aOR for preterm delivery of 0.24, 95% CI: 0.07–0.89). Among overweight women, there was no significant association. In this population, there was no overall association between prenatal yogurt consumption and preterm delivery. However, there was significant interaction with maternal overweight status; among non-overweight women, higher prenatal yogurt consumption was associated with reduced preterm delivery.

Keywords

Preterm birth; probiotics; inflammation; obesity; overweight; Mexico

Introduction

Preterm delivery is the second leading cause of death among children under five years of age worldwide, and in developing countries it confers an increased risk of morbidity and mortality (Blencowe et al., 2013; Howson et al., 2013). Preterm delivery has multiple causes, and its etiologic pathways are not fully understood (Goldenberg et al., 2008). Infection and inflammation may account for 25–40% of preterm deliveries (Bastek et al., 2011).

Bacterial and viral infections during pregnancy increase the risk of preterm delivery, putatively through stimulating inflammatory responses leading to preterm parturition (Goldenberg et al., 2008; Goodnight et al., 2005; Krauss-Silva et al., 2014; Pierce et al., 2011). Interventions that directly target inflammation during pregnancy, such as micronutrients, progesterone, and fatty acid supplements, have the potential to reduce the risk of preterm delivery (Larque et al., 2012; Ramakrishnan et al., 2012; Rinaldi et al., 2011; Zerofsky et al., 2016). Consumption of probiotics may reduce systemic inflammation through modulating secretion of proinflammatory cytokines by gut epithelial cells (Madsen, 2006), and have a localized immunomodulatory effect on expression of proinflammatory cytokines and prostaglandins in the placenta and vagina (Genc et al., 2004; Rautava et al., 2012). Further, consumption of probiotics during pregnancy may increase vaginal *Lactobacillus* colonization and prevent or treat bacterial vaginosis that contributes to early spontaneous labor (Hanson et al., 2016; Heczko et al., 2015; Reid et al., 2004; Yang et al., 2015).

Recent epidemiologic studies suggest that probiotic consumption during pregnancy could prevent preterm delivery and other adverse pregnancy outcomes. A sub-study within the Norwegian Mother and Child Cohort Study (Myhre et al., 2011) found that consumption of any milk-based probiotic foods by pregnant women was associated with a 14% reduction in risk of spontaneous preterm delivery compared with no consumption of such foods. Another study within the same cohort found that daily consumption of probiotic milk products during pregnancy was associated with a 20% reduction in risk of preeclampsia (Brantsaeter et al., 2011). Preliminary findings from a randomized trial in Brazil (Krauss-Silva et al., 2011) also suggested that consumption of probiotic supplements was associated with reduced risk of spontaneous preterm delivery – unfortunately the trial was stopped early due to inability to recruit a sufficient sample size.

Importantly, obesity is associated with increased levels of markers of chronic inflammation (Festa et al., 2001), and is a known risk factor for preterm delivery (McDonald et al., 2010). Chronic inflammation consequent to obesity may overwhelm any anti-inflammatory effect of probiotic-containing foods. In the Norwegian Mother and Child Cohort Study, an inverse association of probiotic consumption with preeclampsia was stronger among normal weight women than overweight women (Brantsaeter et al., 2011). Other studies examining associations of obstetrical outcomes, including preterm delivery and preeclampsia, with diet and physical activity have observed similar interaction with maternal weight. For example, a reduced risk of preterm delivery associated with a prudent dietary pattern (characterized by high intake of vegetables, fruit, olive oil, nuts, whole grains, yogurt, and poultry) was found only among normal weight women, but not overweight women (Englund-Ögge et al., 2014). Another study found that physical activity was associated with a reduced risk of preeclampsia only among non-obese women (Magnus et al., 2008). Notably, no previous studies evaluating the relationship between the consumption of probiotic-containing foods and preterm delivery have evaluated differences by maternal overweight status.

To address this knowledge gap, we analyzed data from a randomized placebo-controlled trial (Ramakrishnan et al., 2010) of prenatal docosahexaenoic acid (DHA) – an omega-3 fatty acid – supplementation to test the *a priori* hypothesis that consumption of yogurt (a probiotic-containing food) during pregnancy would be associated with decreased preterm delivery. Given the potential interaction between obesity and the anti-inflammatory effects of probiotic-containing foods, we conducted an analysis stratified by maternal overweight status.

Materials and methods

Study population

The study population consisted of women enrolled in a randomized controlled trial of prenatal DHA supplementation on infant growth and development in Cuernavaca, Mexico (POSGRAD, clinical trial registration #NCT00646360) (Ramakrishnan et al., 2010). Participants were recruited at the Mexican Institute of Social Security (IMSS) General Hospital and three IMSS health clinics in Cuernavaca during routine prenatal care visits between February 2005 and February 2007. Eligible women were 18 to 39 years of age, were in gestational weeks 18 to 22, and planned to deliver at the IMSS General Hospital in Cuernavaca, to exclusively or predominantly breast feed for at least three months, and to live in the geographic area for at least two years after delivery. Married women under the age of 18 were eligible for the study as they are not treated as minors by Mexican law. Written informed consent was obtained from all participants (Ramakrishnan et al., 2010).

Women were excluded if any of the following criteria were present: high-risk pregnancy (history of and/or current pregnancy complications, including abruptio placentae, preeclampsia, pregnancy-induced hypertension, any serious bleeding episode during the current pregnancy, and/or physician referral); lipid metabolism or absorption disorders;

regular intake of fish oil or DHA supplements; or chronic use of certain medications (e.g., medications for epilepsy).

Measurement of exposure

Yogurt consumption was assessed at enrollment into the main trial using a semi-quantitative food frequency questionnaire that asked about intake of 110 food items in the past three months (Ramakrishnan et al., 2010). Specifically, women were asked how often they ate a cup of yogurt. Response categories were never, <1 per month, 1–3 per month, 1 time per week, 2–4 times per week, 5–6 times per week, 1 time per day, 2–3 times per day, 4–5 times per day, or six times per day. To ensure sufficient sample sizes for subgroup analyses, consumption was categorized into three groups: ≥5, 2–4, and <2 cups per week. Although the food frequency questionnaire did not ask separately about yogurt that did and did not contain probiotic bacteria, we assume that probiotic yogurts comprised a large enough share of the market in Mexico at the time of the study that the majority of reported consumption of yogurt did include probiotic bacteria.

Measurement of outcome

Gestational age at delivery was calculated based on last menstrual period (LMP) as reported at enrollment and date at delivery. If a woman had delivered in the six months prior to enrollment, the dating ultrasound was used instead of LMP. Preterm delivery was defined as a live birth occurring before 37 weeks of gestation (Kramer et al., 2012).

Statistical analysis

In the main trial, the planned sample size of 338 mother-child pairs per group provided at least 80% power to detect a difference in birthweight of 100g (0.2 SD) between the two groups (Ramakrishnan et al., 2010). For this secondary analysis, power and sample size calculations were based on ensuring adequate power for the outcome of preterm birth; based on a total sample size of 965, divided between the three yogurt consumption groups, we had >80% power to detect a decrease in preterm birth associated with a difference in yogurt consumption.

We compared baseline maternal characteristics and infant characteristics across categories of yogurt consumption. We used F-tests to compare means for continuous variables and chi-square tests to compare proportions for categorical variables.

We used logistic regression to evaluate the association between yogurt consumption during pregnancy and the odds of preterm delivery. Unadjusted and adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated. Potential confounders were selected *a priori* for inclusion in the model. These included demographic characteristics (maternal age, socioeconomic status (SES), schooling, marital status), pregnancy and health characteristics (gravidity, overweight status, hypertension), nutrition measures (total daily caloric intake, use of iron and folic acid supplements, dietary DHA, saturated fat, monounsaturated and polyunsaturated fat), infant characteristics (multiple birth, any congenital malformation), and the woman's randomization group in the original randomized controlled trial. We also conducted sensitivity analyses after restricting the sample to singleton births.

Because of the potential for interaction between the anti-inflammatory effects of probiotic-containing foods and obesity, we conducted an analysis testing for interaction between maternal overweight status and yogurt consumption. We also determined a priori two additional sources of potential interaction, and tested for interaction by randomization group in the underlying placebo-controlled trial (DHA vs. placebo) and primigravida. Body mass index (BMI) was calculated based on height and weight measurements obtained at a scheduled hospital visit soon after enrollment. Women were categorized as overweight or non-overweight for gestational age based on a methodology for categorizing BMI during pregnancy, which uses different cut-offs based on gestational age (see reference for a table of pregnancy BMI cutoffs) (Atalah et al., 1997). Using this methodology, overweight is categorized based on a range of cut-offs, for example, ≥25.0 kg/m^2 at six weeks of gestation, ≥26.0 kg/m^2 at 16 weeks of gestation, ≥27.0 kg/m^2 at 24 weeks of gestation, ≥28.0 kg/m^2 at 31 weeks of gestation, and ≥29.0 kg/m^2 at 39 weeks of gestation. Interaction was evaluated using likelihood ratio tests to compare models including the interaction terms to models without the interaction terms. Where interaction was significant at p<0.05, we conducted stratified analyses.

All statistical analyses were conducted using SAS version 9.3 (SAS Institute, Inc, Cary, NC). A p-value less than 0.05 was considered to be statistically significant. The study protocol was approved by the Emory University Institutional Review Board and by the Instituto Nacional de Salud Publica (INSP) Biosafety and Ethics Committees.

Results

The POSGRAD trial randomized 1,094 women. Women were excluded from this analysis due to declining to participate in the trial after randomization (n=54), loss to follow-up before delivery (n=67), non-live births (n=5), and missing information on gestational age (n=3) (Figure 1). For this study the analytic sample included 965 deliveries, of which 960 were singletons and five were twin pairs. All births occurred between June 2005 and July 2007.

Mean maternal age at enrollment was 26.3 years (Table 1), and mean gestational age at enrollment was 20.6 weeks (SD 2.0). Slightly more than half of the women (58.4%) had completed high school, and 9.3% were unmarried. This was the first pregnancy for 37.8% of the women. Mean maternal BMI at enrollment was 26.0 kg/m^2 (SD 4.2), and 41.0% of women were classified as overweight. The mean gestational age at birth was 39.1 weeks (SD 1.8). There were 86 preterm deliveries (8.9%). All preterm deliveries occurred after the 28th week of gestation; three were before 32 weeks.

During the previous three months, 245 women (25.4%), 330 women (34.2%), and 390 women (40.4%) reported consuming ≥5 cups of yogurt per week, 2–4 cups per week, and <2 cups per week, respectively. Reported yogurt consumption was positively associated with SES and schooling and inversely associated with gravidity (Table 1). Yogurt consumption was positively associated with several measures of daily dietary intake including calories, DHA, total fat, saturated fat, monounsaturated fatty acids, and polyunsaturated fatty acids. Infant and delivery characteristics such as low birthweight, multiple birth, and congenital disease were not significantly different across the three maternal yogurt consumption groups (Table 2).

Women who reported consuming 2–4 cups of yogurt per week had the lowest proportion of preterm delivery (7.9%), compared with 9.2% and 9.8% of women who consumed <2 cups or ≥5 cups of yogurt per week, but differences were not statistically significant (Table 3). In both unadjusted and adjusted regression models, differences in preterm delivery were slight and non-significant across maternal yogurt consumption groups. Compared with women who consumed <2 cups of yogurt per week, the odds of preterm delivery among women who consumed 2–4 cups of yogurt per week were 19% lower (adjusted OR [aOR] = 0.81, 95% confidence interval [CI]: 0.46–1.41, p-value = 0.46), and the odds of preterm delivery among women who consumed ≥5 cups of yogurt per week were 6% lower (aOR = 0.94, 95% CI: 0.51–1.72, p-value = 0.83).

The association between maternal yogurt consumption and preterm delivery differed significantly between women who were overweight and women who were not overweight (p for interaction = 0.01) (Table 3). In analyses stratified by maternal overweight status, 13.6% of overweight women had a preterm delivery, compared with 5.6% of non-overweight women (p<0.01) (Table 4). There was no evidence of interaction by randomization group (p=0.58) or primigravida (p=0.53).

Among non-overweight women (n=569), maternal yogurt consumption was inversely associated with preterm delivery. Compared with non-overweight women who consumed <2 cups of yogurt per week, non-overweight women who consumed 2–4 cups of yogurt per week were 29% less likely to deliver preterm (aOR = 0.71, 95% CI: 0.32–1.58), and non-overweight women who consumed ≥5 cups of yogurt per week were 76% less likely to deliver preterm (aOR = 0.24, 95% CI: 0.07–0.89) (Table 3). Among overweight or obese women (n=396), there was no statistically significant difference in the odds of preterm delivery across categories of yogurt consumption (compared with <2 cups per week, 2–4 cups per week aOR = 0.93, 95% CI: 0.44–1.99, ≥5 cups per week aOR = 1.74, 95% CI: 0.82–3.68).

Discussion

In a population of pregnant women in Mexico, we found that higher yogurt consumption was associated with reduced preterm delivery among non-overweight women, but not among overweight women.

Previous studies have found mixed results for the relationship between preterm delivery and consumption of probiotic-containing foods during pregnancy. In the Norwegian Mother and Child Cohort Study, women who consumed any milk-based probiotic products during pregnancy had 14% (95% CI: 1%–26%) lower odds of spontaneous preterm delivery, compared with women who consumed none, controlling for gravidity, physical activity, and maternal schooling (Myhre et al., 2011). In that study, when probiotic products consumption was categorized into none, low, and high intake, a dose-response relationship was observed between intake level and spontaneous preterm delivery. There was a statistically significant association for high intake compared with no intake of probiotic products (OR = 0.82, 95% CI: 0.68–0.99). We found a similar dose-response relationship, but among non-overweight women only. Preliminary results from a randomized trial in Brazil showed that women who received oral probiotic supplements up to 24–26 weeks of gestation had a decreased risk of spontaneous preterm delivery (risk ratio = 0.69, 95% CI: 0.26–1.78) (Krauss-Silva et al., 2011). A prospective observational study in South Korea (Lee et al., 2012) compared women who consumed oral Lactobacillus supplements during pregnancy with those who did not, and found no significant differences in average gestational age at delivery or percentage of preterm deliveries between the two groups. To our knowledge, none of the previously mentioned studies considered maternal overweight status. A placebo-controlled randomized trial of probiotic supplementation which was conducted only among obese pregnant women (n=138) – and therefore could not make comparisons between obese and non-obese women – found no effect on neonatal measures including birth weight, preeclampsia, pregnancy-induced hypertension, induction of labor, or admission to NICU, but did not assess preterm delivery or gestation at time of delivery (Lindsay et al., 2014).

Our findings of an interaction between maternal overweight status and yogurt consumption on the association with preterm delivery have biological basis. Yogurt consumption may reduce the risk of preterm delivery through the mechanisms of reduced inflammation and infection due to probiotic compounds that are contained in most yogurt (Madsen, 2006; Reid & Devillard, 2004; Yang et al., 2015). Microbiota in the gut has been shown to be associated with obesity, and changes in gut microbiota could modify the development of overweight and obesity in childhood (Luoto et al., 2010), although it is unclear whether the same effect may be seen in adulthood. Obesity leads to increased chronic inflammation, in part because adipose tissue contains increased levels of proinflammatory mediators(Cancello et al., 2005; Cinti et al., 2005), and previous studies have shown that obesity is associated with increased risk of preterm delivery (McDonald et al., 2010). We hypothesized that the amount of probiotics in yogurt may be insufficient to overcome the impact of obesity-related chronic inflammation.

This study has some limitations. In terms of the exposure status, consumption of yogurt was based on self-report only. Therefore it is possible that classification of weekly yogurt consumption may have been inaccurate due to recall errors. However, women were only asked to report their yogurt consumption for the past three months – a fairly short time period – thus reducing the chance for recall errors. To address overall over- or under-reporting of dietary intakes we adjusted for energy intake in our models. Similarly, we did not collect information on the type or content of the yogurt. It is likely that women were eating different types of yogurt with varying amounts of probiotics, sugar, and fat. To the extent that the type of yogurt is associated with SES, overweight status, and other characteristics, adjustment for these characteristics addresses this source of misclassification. In terms of the outcome measure, the study did not collect information on the characteristics of preterm deliveries, such as whether they were spontaneous or medically indicated, or history of prior preterm delivery, so subgroup analysis based on specific preterm delivery characteristics could not be conducted. Another potential limitation is that the BMI measure we used was based on a mid-pregnancy weight measurement, since pre-pregnancy weight was not measured as part of the study. We have used a method for categorizing BMI based on gestational age (Atalah et al., 1997), which addresses this issue in part, but the possibility of misclassification of maternal overweight status remains especially if the women experienced differential rates of weight gain prior to enrollment. Finally, our results may be partly attributable to unmeasured residual confounding. Since yogurt consumption subgroups were defined post hoc, it is possible that the effect on preterm delivery may be explained by other baseline differences in these subgroups such as physical activity, other healthful prenatal dietary patterns, or health-seeking behaviors that were not measured. However our findings are similar to previous studies that have explored the impact of maternal overweight status on the association between prenatal dietary patterns and preterm delivery (Brantsaeter et al., 2011; Englund-Ögge et al., 2014).

In conclusion, yogurt consumption of more than five cups per week may be associated with reduced preterm delivery among non-overweight women.

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Key Messages

- In this population, 25.4%, 34.2%, and 40.4% of women reported consuming ≥5, 2–4, and <2 cups of yogurt per week, respectively, during pregnancy.
- We found no overall association between prenatal yogurt consumption and preterm delivery in this Mexican population. However, there was significant interaction by maternal overweight status; prenatal consumption of yogurt was associated with reduced preterm delivery among non-overweight women, but not among overweight women.
- Yogurt consumption may reduce the risk of preterm delivery through the mechanisms of reduced inflammation and infection due to probiotic compounds that are contained in most yogurt; however, the amount of probiotics in yogurt may be insufficient to overcome the impact of obesity-related chronic inflammation.

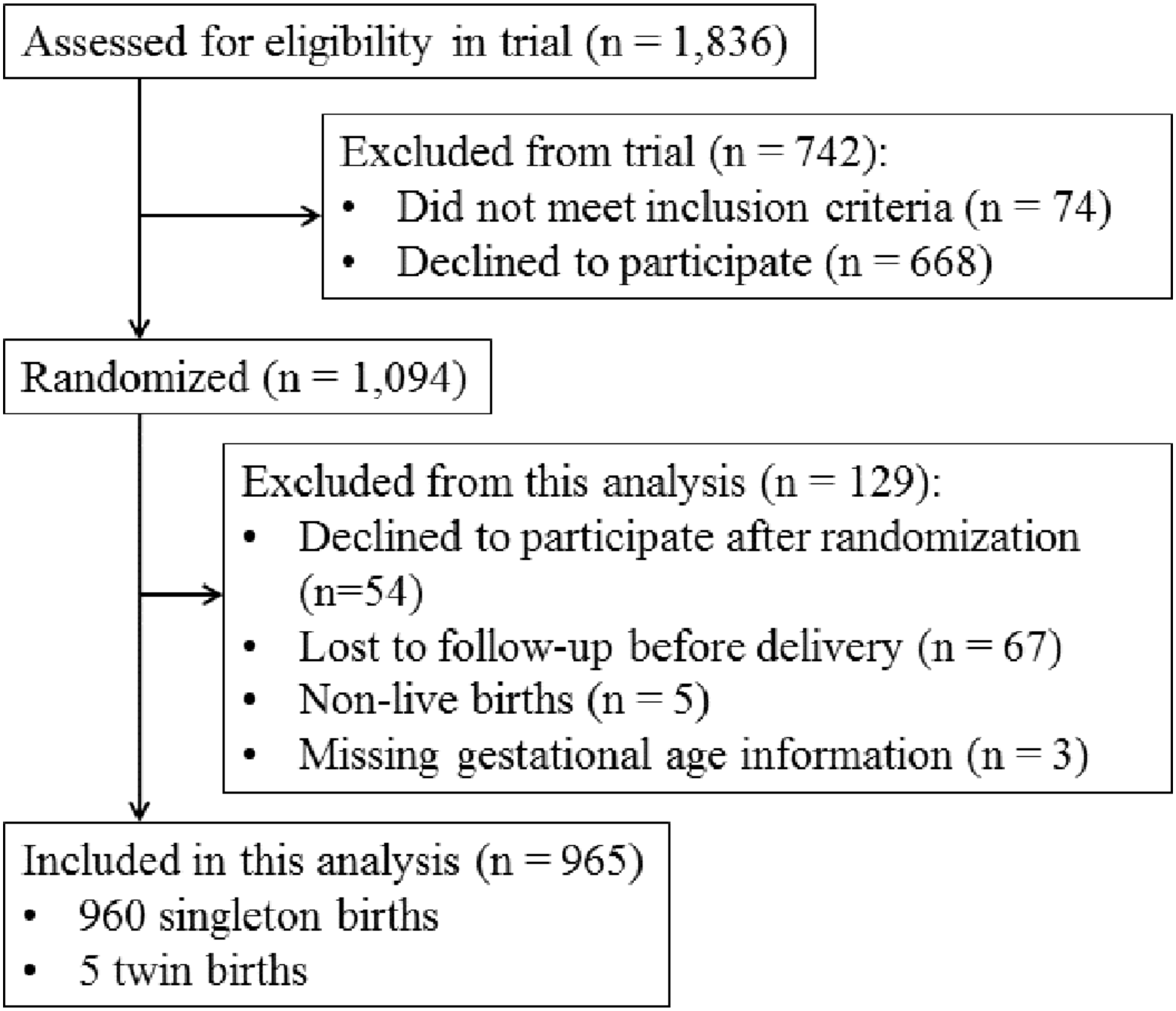

Figure 1.

Inclusion of study participants from the DHA supplementation trial for this analysis

Table 1

Selected characteristics at randomization of pregnant women enrolled in a DHA supplementation trial in Mexico between 2005 and 2007, by maternal yogurt consumption during pregnancy

	Maternal yogurt consumption			
	<2 cups per week	2–4 cups per week	≥5 cups per week	p-value
Total, n (%)	390 (40.4)	330 (34.2)	245 (25.4)	
Demographic Characteristics				
Maternal age, y, mean (SD)	25.9 (4.7)	26.5 (4.6)	26.6 (4.8)	0.09
Maternal age categories, %				
16–19[a]	10.8	7.6	10.2	0.45
20–24	34.9	33.3	31.4	
25–29	33.8	32.7	30.2	
30–34	17.9	23.6	25.3	
35–39	2.6	2.7	2.9	
SES, %				
Low	34.9	30.9	27.3	0.03
Medium	35.6	31.8	31.0	
High	29.5	37.3	41.6	
High school or more, %	51.4	61.4	65.3	<0.01
Single, %	7.9	10.3	10.2	0.48
Pregnancy Characteristics				
Gravidity[b], %				
1	32.3	37.0	47.8	<0.01
2 or more	67.7	63.0	52.2	
Health Characteristics				
BMI categories, %				
Non-overweight	60.0	58.8	57.6	0.97
Overweight	29.0	30.6	31.8	
Obese	11.0	10.6	10.6	
Hypertension, %	3.6	4.8	1.6	0.12
Nutrition				
Daily caloric intake, kcal, mean (SD)	3201 (1576)	3583 (1095)	3863 (1300)	<0.01
Took iron supplements in 6 months before pregnancy, %	3.3	3.6	5.3	0.43
Took folic acid supplements in 6 months before pregnancy, %	4.9	7.3	4.9	0.32
Dietary DHA intake, mg/day, mean (SD)	0.07 (0.08)	0.08 (0.06)	0.10 (0.10)	<0.01
Dietary fat intake, g/day, mean (SD)	90.2 (41.6)	102.4 (32.4)	114.8 (39.7)	<0.01
Dietary saturated fat intake, g/day, mean (SD)	27.5 (12.6)	31.9 (10.7)	37.0 (12.9)	<0.01
Dietary monounsaturated fatty acid intake, g/day, mean (SD)	34.6 (17.4)	39.2 (15.2)	43.9 (18.8)	<0.01
Dietary polyunsaturated fatty acid intake, g/day, mean (SD)	19.7 (10.7)	21.7 (8.2)	23.6 (10.2)	<0.01
Randomized to DHA group, %	52.1	46.7	51.0	0.33

P-values for continuous variables were calculated by F-test for equality of means.

P-values for categorical variables were calculated by chi-square test for equality of proportions.

[a]Married women under the age of 18 are not treated as minors by Mexican law and were eligible for the study.

[b]Includes current pregnancy.

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Table 2

Selected characteristics of infants born to women enrolled in a DHA supplementation trial in Mexico between 2005 and 2007, by maternal yogurt consumption during pregnancy

	Maternal yogurt consumption			
	<2 cups per week	**2–4 cups per week**	**≥5 cups per week**	**p-value**
Total, n (%)	390 (40.4)	330 (34.2)	245 (25.4)	
Low birthweight[a], %	4.9	5.2	5.3	0.97
Preterm delivery[b], %	9.2	7.9	9.8	0.70
Twin, %	0.5	0.3	0.8	0.70
Any congenital disease, %	3.8	3.0	2.4	0.61

P-values for categorical variables were calculated by chi-square test for equality of proportions.

[a]Low birthweight defined as <2,500 grams.

[b]Preterm delivery defined as a live birth occurring before gestational age 37 weeks.

Table 3

Estimates of the association between maternal yogurt consumption during pregnancy and preterm delivery among pregnant women enrolled in a DHA supplementation trial in Mexico between 2005 and 2007

	Preterm delivery	Not preterm	Unadjusted	Adjusted[a]	
	N (%)	**N (%)**	**OR (95% CI)**	**OR (95% CI)**	**p-value for interaction[b]**
<2 cups per week	36 (9.2)	354 (90.8)	Reference	Reference	
2–4 cups per week	26 (7.9)	304 (92.1)	0.84 (0.50–1.43)	0.81 (0.46–1.41)	
≥5 cups per week	24 (9.8)	221 (90.2)	1.07 (0.62–1.84)	0.94 (0.51–1.72)	
Non-overweight (n=569)[c]					
<2 cups per week	18 (7.7)	216 (92.3)	Reference	Reference	0.01
2–4 cups per week	11 (5.7)	183 (94.3)	0.72 (0.33–1.57)	0.71 (0.32–1.58)	
≥5 cups per week	3 (2.1)	138 (97.9)	0.26 (0.08–0.90)	0.24 (0.07–0.89)	
Overweight (n=396)[d]					
<2 cups per week	18 (11.5)	138 (88.5)	Reference	Reference	
2–4 cups per week	15 (11.0)	121 (89.0)	0.95 (0.46–1.97)	0.93 (0.44–1.99)	
≥5 cups per week	21 (20.2)	83 (79.8)	1.94 (0.98–3.85)	1.74 (0.82–3.68)	

[a] Adjusts for maternal age, SES, schooling, marital status, gravidity, obesity status, hypertension, total daily caloric intake, iron supplements, folic acid supplements, dietary DHA, saturated fat, monounsaturated fat, polyunsaturated fat, randomization group in RCT, twin, any congenital malformation.

[b] P-value for interaction was calculated by likelihood ratio test, using the adjusted model.

[c] Includes normal weight and underweight.

[d] Includes overweight and obese.

Table 4

Estimates of the association between maternal obesity status and preterm delivery among pregnant women enrolled in a DHA supplementation trial in Mexico between 2005 and 2007

	Preterm delivery	Not preterm	Unadjusted		Adjusted[a]	
	N (%)	N (%)	OR (95% CI)	p-value	OR (95% CI)	p-value
Non-overweight[b]	32 (5.6)	537 (94.4)	Reference		Reference	
Overweight[c]	54 (13.6)	342 (86.4)	2.65 (1.68–4.19)	<0.01	2.61 (1.61–4.24)	<0.01

[a]Adjusts for maternal age, SES, schooling, marital status, gravidity, hypertension, total daily caloric intake, iron supplements, folic acid supplements, dietary DHA, saturated fat, monounsaturated fat, polyunsaturated fat, randomization group in RCT, twin, any congenital malformation.

[b]Includes normal weight and underweight.

[c]Includes overweight and obese.