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Dietary intake, nutrition, and fetal alcohol spectrum disorders in the Western Cape Province of South Africa

Philip A. May [a,b,*], Kari J. Hamrick [c], Karen D. Corbin [a], Julie M. Hasken [a], Anna-Susan Marais [d], Lesley E. Brooke [e], Jason Blankenship [b], H. Eugene Hoyme [f], J. Phillip Gossage [b]

[a] University of North Carolina at Chapel Hill, Nutrition Research Institute, Gillings School of Global Public Health, USA
[b] The University of New Mexico Center on Alcoholism, Substance Abuse, and Addictions (CASAA), Albuquerque, USA
[c] Navigate Nutrition Consulting, PLLC, Seattle, USA
[d] Stellenbosch University, Faculty of Health Sciences, Tygerberg, South Africa
[e] Formerly with the University of Cape Town, Foundation for Alcohol Related Research (FARR), Cape Town, South Africa
[f] Sanford Research and Sanford School of Medicine, The University of South Dakota, Sioux Falls, USA

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ABSTRACT

In this study, we describe the nutritional status of women from a South African community with very high rates of fetal alcohol spectrum disorders (FASD). Nutrient intake (24-h recall) of mothers of children with FASD was compared to mothers of normal controls. Nutrient adequacy was assessed using Dietary Reference Intakes (DRIs). More than 50% of all mothers were below the Estimated Average Requirement (EAR) for vitamins A, D, E, and C, thiamin, riboflavin, vitamin B_6, folate, calcium, magnesium, iron, and zinc. Mean intakes were below the Adequate Intake (AI) for vitamin K, potassium, and choline. Mothers of children with FASD reported significantly lower intake of calcium, docosapentaenoic acid (DPA), riboflavin, and choline than controls. Lower intake of multiple key nutrients correlates significantly with heavy drinking. Poor diet quality and multiple nutritional inadequacies coupled with prenatal alcohol exposure may increase the risk for FASD in this population.

1. Introduction

1.1. Nutrition status and alcohol consumption in South African populations

During pregnancy, maternal alcohol consumption and dietary intake may have a profound impact on the health and development of the fetus. Malnutrition, food insecurity, and risky drinking patterns are pervasive in certain segments of the population of South Africa (ZA) [1–10]. Low vitamin A intake, iron deficiency anemia, and stunted growth all represent significant health concerns for ZA [11]. Nutritional inadequacies in school-aged children are common, resulting in underweight (16.8%), wasted (2.5%), and stunted (23.5%) growth [12,13].

Additionally, alcohol use among pregnant women is a major concern. Nearly half (42.8%) of pregnant women surveyed in a Western Cape Province (WCP) study reported drinking alcohol during pregnancy, and over half who drank consumed enough alcohol to place their unborn children at "high risk" for fetal alcohol syndrome (FAS) [7]. The prevalence of fetal alcohol spectrum disorders (FASD) in the Western and Northern Cape Provinces of ZA is among the highest in the world (135.1–207.5 per 1000) [14–18], many times higher than prevalence estimates for the United States and Europe [19].

Alcohol and food absorption are affected by multiple factors including: concurrent consumption, sex, hormones, pregnancy, and/or disease status. While food intake can, in the short term, exert a protective effect from the toxic effects of alcohol consumption [20–22], alcohol consumption over time can adversely affect the quality and quantity of proper nutrient supply and energy intake, particularly for women [23,24]. Dietary intake among heavy drinkers is generally considered poor [25]. A recent study of Ukrainian and Russian mothers found lower mean blood plasma levels for most minerals and significant differences in zinc and copper between drinking mothers and non-drinking mothers [26].

Poor maternal nutrition during the prenatal period can cause low birth weight [27,28]. Dietary intake and alcohol consumption during breastfeeding (median duration 18–24 months in ZA)

* Corresponding author at: UNC Nutrition Research Institute, Gillings School of Global Public Health, 500 Laureate Way, Room 3229, Kannapolis, NC 28081, USA. Tel.: +1 704 250 5002; fax: +1 704 250 5036.
E-mail address: philip_may@unc.edu (P.A. May).

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may place newborns at an additional disadvantage due to inadequate delivery of nutrients through breastmilk and exposure to alcohol, a known teratogen [29]. The teratogenic effects of alcohol are increased under certain micronutrient deficiencies such as iron [30], zinc [26], and choline [31,32]. Chronic alcohol use can affect micronutrient absorption and availability [33], but less is known about the effect of binge drinking (sporadic or regular drinking of four or five drinks or more per occasion). However, adequate nutrient intake may partially mitigate the harmful effects of alcohol on fetal development. Vitamin B_3, folic acid, zinc, iron, and choline have all been shown to prevent and/or mitigate some of the effects of prenatal alcohol exposure [30,31,34,35].

1.2. Impetus of this study

In three separate samples in this study community, the body mass index (BMI) of mothers of children with FASD was found to be significantly lower than that of controls, and mothers of children with FASD in most populations have been disproportionally of lower socioeconomic status (SES) [8,9,15,16,18,36]. Dietary intake or other nutrition analyses have not been previously undertaken for mothers of children diagnosed with an FASD. This paper examines dietary and alcohol intake of mothers in a community in the WCP of ZA. Two questions are addressed. First, what proportion of the overall community maternal sample is likely deficient on essential macro and micronutrients? Second, is there a significant difference in dietary intake between mothers of children with FASD and mothers of controls?

2. Methods

2.1. Data collection and instruments

The data in this paper originate from a nested study in a larger epidemiologic inquiry of the prevalence and characteristics of FASD in a community in ZA. A two-tiered process in elementary schools, described fully elsewhere [8,15,18], identified children with FASD and randomly-selected, verified, not-FASD controls. All children in first grade classrooms of all thirteen community primary schools were screened for height, weight, and occipitofrontal head circumference (OFC). All children who were ≤10th centile in height and weight and/or ≤10th centile in OFC and randomly-selected candidates for normal controls received a standardized, comprehensive evaluation, including: (1) independent dysmorphology examinations by at least two dysmorphologists and (2) assessment of IQ, behavioral, and neuropsychological functioning via a battery of eleven tests/scales [37,38]. Biological mothers of children suspected to have an FASD and of the control children were interviewed on maternal risk variables including: use of alcohol at time of interview and during gestation of the index child [8]. Final diagnoses were assigned at a case conference where all findings (child physical, cognitive/behavioral, and maternal risk factors) were reviewed and weighed using revised Institute of Medicine (IOM) criteria [39,40]. If randomly-selected children were found to have an FASD, they were removed from the control group and placed into the FASD group. In this sample, there were 43 children with FASD (24 children diagnosed with FAS, 14 with PFAS (partial fetal alcohol syndrome), and 5 with ARND (alcohol-related neurodevelopmental deficits)) and 85 normal children for comparison.

2.2. Dietary information

Drinking data, current and past, were gathered via a structured interview with the mothers utilizing a time-line, follow-back technique [41,42] to collect multiple measures of drinking. Current drinking questions established a baseline of alcohol use and aid in accurate calibration and recall of drinking. Subsequent questions explored drinking 3 months prior to pregnancy and during each trimester of the index pregnancy. Photographs of the most popular sizes and brands of each type of local alcoholic beverage were used to standardize ethanol units (one standard drink equals 340 mL can/bottle of beer (5% ethanol), 120 mL of wine (11% ethanol), 95 mL of wine (13.5% ethanol) or 44 mL of distilled spirits (43% ethanol)) [43,44].

Dietary intake data originate from the maternal risk factor questionnaire and were neither analyzed nor utilized prior to case conference and the assignment of a final diagnosis. Each respondent was queried about food and liquid consumption in a 24-h dietary recall [45,46]. Field interviewers asked detailed questions to ascertain everything each woman drank or ate in the day preceding her interview by portion size, type, preparation, and seasoning. Data were entered into NDSR (version 4.04/32) to obtain estimated nutrient intake for each woman. Having collected baseline information, the interviewer then asked each woman to recall the time of her pregnancy with the index child and to reflect on how her current (preceding day) food and beverage intake was similar to or different from the time of her pregnancy. The 24-h recall method is a commonly used method for dietary surveys. They have been used frequently in African and South African populations [46]. Additional questions assessed the availability of food within the household at the time of that pregnancy.

2.3. Data analysis

Epi-Info software and SPSS were used to input and analyze the data. Chi-square tests were calculated on frequencies for nominal or ordinal-level data, and z-tests and difference of means tests were utilized for interval-level measures to determine difference between study groups. Pearson product-moment correlations were used to determine associations between particular nutrients and alcohol use. Because this is a first exploratory study of nutrition effecting diagnoses of FASD in humans, an alpha level of .05 (two-tailed) was used for determining significance for case control comparison and for correlations, as this study attempted to explore any possible association between nutrition and risk for FASD. Therefore, the alpha of .05 reduces the risk for Type II error (failing to reject a false, null hypothesis), but increases the likelihood of a Type I error (accepting a false, null hypothesis).

Dietary intakes were compared with the Dietary Reference Intakes (DRIs) established by the IOM [47]. The Estimated Average Requirements (EARs) are defined to be an intake that meets the nutritional needs for 50% of individuals in a specific gender and life stage. If there is not sufficient evidence for an EAR to be established, an Adequate Intake (AI) is established. Recommended Dietary Allowance (RDA) is defined to meet the nutritional needs of 97–98% of healthy individuals in a specific gender and life stage. If less than 50% of the sample had nutrient intake below EAR or the mean intake was below AI, we classified the intake to be likely inadequate. If an observed nutrient intake is above the RDA, the observed intake is considered to likely be adequate. Due to extreme variation among individuals of the same sex and ages, and because of the necessity to estimate adequate pregnancy intake from interviews conducted when the subjects were often not pregnant, conclusions about the intake adequacies for nutrient intake between EARs and RDA cannot be easily made [48].

Table 3 represents a link of the post hoc interviews to the index pregnancy. Due to the inter-correlations of energy requirements and energy intake (e.g. higher energy requirements need higher energy intakes), definite conclusions about prevalence of macronutrient adequacy cannot be made. However, the Acceptable Macronutrient Distribution Range (AMDR) indicates a range that provides the essential nutrients for a particular energy source