Dietary Risk Factors for Gestational Diabetes Mellitus

Are sugar-sweetened soft drinks culpable or guilty by association?

Gestational diabetes mellitus (GDM) is one of the most common medical problems found in pregnancy. Categorizing a woman as having GDM with a glucose tolerance test (GTT) identifies the top 5–10% of a continuum of risk for certain adverse pregnancy outcomes. Women with GDM are themselves very likely to ultimately develop type 2 diabetes. In addition, the offspring of women with GDM have a greater risk of childhood obesity, glucose intolerance, and diabetes in early adulthood. The advantages of treatment on adverse pregnancy outcomes have been clearly identified (1), but more research is needed to determine whether offspring outcomes can also be altered by interventions during pregnancy.

The risk factors for the development of GDM are well established, but of the major ones, only maternal obesity is potentially preventable or reversible. At the time of diagnosis one of the most commonly asked questions by patients relates to whether poor diet may have caused the problem. Although we can say that a change in diet will have a favorable effect, at this stage we cannot say with any certainty that any dietary factor causes GDM.

Epidemiological studies provide clues that generate hypotheses for further research. In this context, for both young and middle-aged women, a habitual diet that is high in fiber has an inverse association with the development of type 2 diabetes (2–4). Because dietary fiber is found only in plant foods closely associated with starch and naturally occurring sugars, the findings imply that low carbohydrate diets are not likely to be protective. In meta-analyses, dietary glycemic index (GI) and glycemic load (GL) are also predictive of type 2 diabetes (5), again suggesting carbohydrate quality is important. Given the similarities between women developing type 2 diabetes and women with GDM who are at high risk of developing type 2 diabetes, these observations are probably pertinent.

The factors that contribute to higher insulin resistance or impaired insulin secretion before pregnancy can be expected to have a legacy during pregnancy. Intensive lifestyle interventions, such as greater physical activity and weight loss, are known to improve insulin sensitivity and insulin secretory function (and thereby reduce the risk of type 2 diabetes) (6) but may not be the most appropriate advice at the start of pregnancy. By contrast, dietary advice based on improving carbohydrate quality may help prevent the development of GDM without the risk of adverse effects. Both high-fiber diets (7,8) and low-GI diets (9,10) have been shown to independently improve insulin sensitivity and glucose tolerance. In the only large prospective observational study of risk of GDM to date, the combination of a diet that was high in fiber and had a low GL was associated with a halving of the risk of GDM during 8 years of follow-up (11).

The findings of Chen et al. (12) in this issue of *Diabetes Care* somewhat extend our understanding of possible dietary factors associated with increased risk of GDM. The authors hypothesized that a higher intake of sugar-sweetened beverages (SSBs) would be associated with a higher prevalence of GDM in the Nurses Health Study II. By their definition, SSBs included Coca-Cola, Pepsi, or other colas with sugar; other carbonated beverages with sugar (caffeinated and caffeine free); and fruit punch. Fruit juices were exempt despite that the energy content and concentration of naturally occurring sugars is similar to that of SSBs. Interestingly, in the most robust model (model 4) that adjusted for age, BMI, parity, family history of type 2 diabetes, Western dietary pattern, and other confounders, there was no statistically significant risk associated with a higher intake of SSBs. Only when cola beverages were separated out from other types of SSBs did they find a significant trend in the fully adjusted model (RR 1.22 [95% CI 1.01–1.47]). There was no risk, nor even a trend to higher risk of GDM, associated with a high intake of other flavored SSBs. Although the authors

speculated that the caramel colors and flavors in cola drinks might translate to higher intake of advanced glycated end products (AGEs) and therefore have potential adverse effects on β-cell function, other sources of AGE were not accounted for. Furthermore, women drinking noncaloric cola drinks did not have a higher risk—indeed, the trend was negative ($P = 0.07$). Although Chen et al. suggest that the high GL (i.e., the mathematical product of carbohydrate content and GI) of cola-flavored SSBs is the mechanism for their association with GDM, cola drinks have the same GL ($\sim$15 g) as a serving of noncola drinks, two slices of white bread, or one serving of breakfast cereal (13). It is conceivable that sweetened cola drinks, but not noncaloric versions, may simply be a marker of an individual for whom healthy lifestyle and behaviors are a low priority.

Although high intakes of refined sugars, and soft drinks in particular, have long been claimed to be a cause of obesity and diabetes, the evidence is inconsistent. Over the past 30 years, high-fructose corn syrup (HFCS) with a ratio of fructose to glucose of 55:45 has replaced sucrose as the source of sweetness in many North American foods, including SSBs. Hence, the overconsumption of HFCS and/or fructose monosaccharide is suspected to have played a role in the epidemic of obesity and diabetes (14). However, elsewhere around the world, cane sugar (sucrose, a disaccharide) is still used as the ingredient in SSBs, and rates of obesity and diabetes have climbed just as sharply (15). If free fructose is implicated, then fruit and fruit juices that contain a mixture of free fructose, glucose, and sucrose in various proportions should be considered as well (and they were specifically excluded from the study by Chen et al.). Finally, it is very possible that the glucose component of HFCS, sucrose, and high-GI starchy foods, is the mechanism for any association among SSBs, obesity, and diabetes.

In our view, the fact that neither total sugar-sweetened soft drinks nor noncola sugar-sweetened soft drinks are convincingly linked to GDM in the study by Chen et al. suggests the strong possibility that cola drinks may suffer guilt by association. High intake of SSBs is often accompanied by a high intake of refined grains and processed meats and a low intake of vegetables, a diet pattern that increases oxidative stress and the risk of diabetes (16). Moreover, the continuing focus on SSBs draws attention away from more critical nutrition concerns such as alcohol intake among women of reproductive age. Indeed, the women in the study by Chen et al. with the lowest SSB intakes were those who consumed the most alcohol (12).

Given the current state of knowledge, what evidence-based dietary advice can we offer women to reduce their risk of developing GDM? A 2008 Cochrane review (17) that specifically addressed this question identified only three relevant studies (all of them small) and concluded that a low-GI diet might be beneficial but larger studies were required. In contrast, a recent and reasonably large prospective study in a cohort of 1,733 American women (18) found that no specific dietary factors predicted the development of GDM. Quality of fat (ratio of saturated to polyunsaturated fat) may be just as important as the quality of carbohydrate but has received little attention (19).

Epidemiological studies have limitations and often pose more questions than they provide answers. Apart from a greater focus on the prevention of maternal obesity, and a logical presumption that a high-fiber and low-GI diet could be beneficial (and are unlikely to do harm), there is currently insufficient evidence to base any firm dietary advice about how to reduce the rate of GDM. Until that evidence becomes available, we can cautiously advise that the overall quality of carbohydrates, fats, and proteins are probably more relevant than the intake of any one single food. In this context one serving of SSB even on a daily basis is unlikely to do harm.

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