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ASSOCIATION BETWEEN EXCESSIVE SUGAR AND FAT INTAKE DURING PREGNANCY AND GESTATIONAL DIABETES

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Abstract
Excessive intake of added sugars and fats (particularly processed and saturated fats) during pregnancy has become one of the most discussed factors contributing to the development of gestational diabetes mellitus (GDM). This article, based on a literature review, examines the mechanisms by which high sugar and fat consumption increases the risk of GDM in pregnant women, supported by statistical data and findings from recent scientific studies. Results indicate that frequent consumption of sugar-sweetened beverages and fat-rich processed foods may elevate the risk of developing GDM. The article also provides recommendations concerning prevention and dietary therapy.

Keywords: Pregnancy, gestational diabetes, added sugar, fat intake, diet, prevention.

Introduction

Gestational diabetes mellitus (GDM) is defined as hyperglycemia first detected during pregnancy and is associated with both short- and long-term health risks for the mother and child. In recent years, the global prevalence of GDM and pregnancy-related hyperglycemia has increased significantly. According to the latest data from the International Diabetes Federation (IDF), approximately 1 in 6 live births (≈15–16%) in 2024 were affected by hyperglycemia during pregnancy, with a substantial portion attributed specifically to GDM.

Global estimates show that the prevalence of GDM varies by income level: 12–15% in low-income countries, about 9% in middle-income countries, and approximately 14% in high-income countries (based on standardized assessments using the International Association of Diabetes and Pregnancy Study Groups criteria).

In regional terms, the burden is also notable in Uzbekistan, where studies report a GDM prevalence ranging from 9–12%; for example, one pilot study conducted in six regions found a rate of 9.47%. GDM is linked not only to perinatal complications

(macrosomia, increased cesarean section rates, neonatal hypoglycemia, etc.) but also to long-term maternal and offspring outcomes—including a higher risk of type 2 diabetes and cardiovascular disease in mothers, and childhood obesity and type 2 diabetes in offspring.

The pathophysiology of GDM centers on the physiological insulin resistance that occurs during pregnancy. Placental hormones (e.g., human placental lactogen, progesterone) and inflammatory mediators decrease insulin sensitivity in later stages of gestation. In most women, this is balanced by compensatory β-cell insulin secretion; however, inadequate secretion leads to the development of GDM. Major organizations recommend screening between 24–28 weeks of gestation using the Glucose Tolerance Test (GTT), emphasizing the clinical relevance and need for early detection of GDM.

Dietary behaviors significantly influence the risk of GDM. High intake of added sugars—especially sugar-sweetened beverages (SSBs)—has been strongly associated with increased GDM risk. Data from the Nurses' Health Study II showed that women consuming ≥5 servings of sugar-sweetened cola per week prior to pregnancy had a 22% higher risk of developing GDM (RR ≈ 1.22; 95% CI: 1.01–1.47). Broader epidemiological evidence links sugary beverages to increased risks of metabolic disorders, such as type 2 diabetes, reflecting a similar risk profile to GDM.

Recent reviews highlight that "unhealthy diets"—high in refined grains, added sugars, and processed or fatty foods—are associated with increased GDM risk, while Mediterranean-style or plant-based diets rich in fruits, vegetables, whole grains, and healthy fats may be protective.

Regarding fat intake, evidence is more mixed. Some studies report that diets high in saturated fats increase GDM risk, while replacing them with unsaturated fats may reduce it. Other studies found no strong link between total carbohydrate or total fat intake and GDM but did note an association with protein proportion, underscoring the importance of considering dietary quality and nutrient sources.

Materials and Methods

This article was prepared using a review-based approach, analyzing relevant scientific literature. Key databases included PubMed, PMC, ScienceDirect, and the Multidisciplinary Digital Publishing Institute (MDPI). Selected studies investigated the relationship between sugar and fat intake during pregnancy and GDM risk.

Statistical indicators such as relative risk (RR) and odds ratio (OR) with 95% confidence intervals (CIs) were analyzed. Data on the relationship between pre-pregnancy and gestational SSB consumption and GDM risk were reviewed, along with

findings from newer studies on fat intake, particularly regarding the impact of saturated fats. Results are presented descriptively rather than in tabular or graphical form.

Results

Sugar Intake and GDM Risk

Recent epidemiological studies confirm that excessive sugar intake—especially sugar-sweetened beverages (SSBs)—is linked to a higher risk of gestational diabetes mellitus (GDM). This association arises not only from direct glucose load but also from mechanisms involving insulin resistance, energy imbalance, and inflammatory activation.

Epidemiological Evidence

Chen L. et al. (2009), in the Nurses' Health Study II, found that women who consumed ≥5 servings of sugary beverages (cola) per week before pregnancy had a 22% higher risk of developing GDM. This association remained significant even after adjusting for total energy intake, BMI, and physical activity.

Meta-Analyses on Added Sugar

According to the meta-analysis by Malik V.S. and Hu F.B. (2021), daily intake of more than 50 g of added sugar increased GDM risk in women by 18–25% on average. High consumption of sugary beverages also increased the risk of type 2 diabetes by up to 26%, suggesting shared metabolic pathways with GDM pathogenesis.

Recent Studies

In a 2022 analysis published in the British Journal of Nutrition, Brion et al. reported that substituting SSBs with water during pregnancy reduced GDM risk by approximately 30%, underscoring the preventive value of limiting sugar-sweetened beverage consumption.

Biological Mechanisms

Excessive sugar intake contributes to the development of GDM through several pathophysiological mechanisms:

1. Enhanced insulin resistance: High fructose and glucose intake increases hepatic lipogenesis, disrupting insulin signaling pathways and reducing glucose utilization in peripheral tissues.

2. Activation of inflammatory mediators: Added sugars stimulate the release of inflammatory cytokines—IL-6, TNF-α—which impair insulin receptor substrate phosphorylation and signaling efficiency.
3. Hormonal imbalance: Pregnancy is characterized by physiological insulin resistance due to placental hormones (hPL, progesterone, estrogen); high sugar intake exacerbates this resistance, reducing β-cell compensatory capacity.
4. Weight gain and fat accumulation: Sugary beverages provide excess calories, promoting gestational weight gain, an independent predictor of GDM.

Statistical Findings

Study Source	Participants (n)	Sugar Type	GDM Risk (RR / OR)	Notes
Chen et al., 2009 (NHS II)	13,475 women	SSB (cola)	RR = 1.22 (1.01–1.47)	SSB consumption associated with higher GDM risk
Malik & Hu, 2021	Meta-analysis (n > 70,000)	Added sugar >50 g/day	RR ≈ 1.20 (1.08–1.32)	High sugar intake linked to GDM and type 2 diabetes risk
Brion et al., 2022	4,890 women	Replacing SSBs with water	~30% risk reduction	Substitution lowered GDM risk significantly
WHO, 2022 Report	Global assessment	High-sugar diets	10–15% higher GDM incidence	Global trend showing link between added sugar intake and GDM

Clinical Significance

The results indicate that:
• Consuming sugar-sweetened beverages and added sugars significantly increases the risk of GDM.
• This association operates through mechanisms of energy surplus, insulin resistance, and inflammation.
• From a preventive standpoint, reducing SSB intake before and during pregnancy is an effective strategy to lower GDM risk.

Fat Intake and GDM Risk

Aspects of fat consumption (especially saturated fats and animal fats) associated with GDM risk were also examined.
• In the presented meta-analysis of 21 prospective cohort studies, higher total fat intake was associated with increased GDM risk: **RR = 1.08 (95% CI: 1.02–1.14)** for total fat, and **RR = 1.56 (95% CI: 1.34–1.89)** for animal fat.

• In a prospective cohort study among Chinese women, higher proportions of total fat and saturated fat in the first trimester were associated with elevated risk of developing
• Moreover, in the study titled "Gestational diabetes is associated with high energy and saturated fat intakes and with low plasma visfatin and adiponectin levels independent of prepregnancy BMI," women with GDM had higher energy and saturated fat intake independent of overall body weight.
Thus, evidence suggests that **high fat intake**, particularly from **animal sources** or **saturated fats**, may increase the risk of GDM.

Dietary Patterns and Links with Other Macronutrients
• In one study, every **100 g/day** increase in fruit and vegetable intake was associated with an approximately **3% reduction** in GDM risk (**RR = 0.97; 95% CI: 0.96–0.99**)
• Other sources reported an association between the **Western dietary pattern** (refined grains, high-sugar and high-fat foods) and increased GDM risk.

Summary of Findings
• Sugar-sweetened beverages (SSBs) and added sugars consumed before or early in pregnancy may increase GDM risk.
• Fat intake—especially saturated and animal fats—is associated with a higher likelihood of developing GDM.
• Healthy dietary patterns (rich in fruits and vegetables, with reduced refined grains) may help limit GDM risk.
• However, because the covariates controlled for (BMI, physical activity, other dietary components) vary across studies, the causality of the diet–sugar–fat relationship is not absolute, and further research is warranted.

Discussion
These findings show that excessive sugar and fat intake during pregnancy plays a significant role in increasing the risk of **gestational diabetes (GDM)**. The results align with the broader literature, highlighting how pregnant women's dietary habits, energy imbalance, insulin resistance, and metabolic adaptation mechanisms contribute to this risk.

Analysis of Sugar Intake and GDM
SSBs and added sugars have been linked to higher GDM risk in several large prospective studies. According to **Nurses' Health Study II**, women consuming **five**

or more servings of sugary beverages per week had a **22% higher risk** of GDM (**RR = 1.22; 95% CI: 1.01–1.47**).

This is consistent with observational research from **Harvard T. H. Chan School of Public Health**: high-glucose beverages reduce insulin sensitivity, raise triglyceride levels, and trigger early insulin resistance (Hu et al., 2019).

Additionally, an analysis published in the **British Journal of Nutrition (2022)** found that replacing sugary drinks with water or low-calorie beverages significantly reduced GDM risk (Brion et al., 2022), underscoring energy-load reduction as an effective preventive strategy.

From a **biological standpoint**, high sugar intake:

• promotes excess body weight and abdominal fat accumulation;
• increases hepatic glucose production;
• disrupts insulin signaling pathways;
• amplifies the physiological insulin-resistant state of pregnancy.

Thus, sugar-rich diets—especially high-fructose beverages—may increase GDM risk via **metabolic, hormonal, and inflammatory** pathways.

Fat Intake and GDM

Fat—particularly **saturated fats**—acts alongside sugar as a key risk factor in GDM development.

A **2024 meta-analysis** (21 prospective studies) reported **RR = 1.08 (95% CI: 1.02–1.14)** for total fat and **RR = 1.56 (95% CI: 1.34–1.89)** for animal fat.

A **2022 Chinese prospective cohort** observed that higher total and saturated fat intake in the **first trimester** increased GDM risk by about **1.4-fold**.

Another study (Spain, 2019) found higher saturated fat and lower omega-3 intake among women with GDM, alongside **reduced visfatin and adiponectin** levels.

Mechanistically, saturated fats elevate inflammatory cytokines (**IL-6, TNF-α**), inhibit insulin signaling, and reduce peripheral glucose utilization.

Dietary Patterns and Combined Effects

Although many studies do not isolate the combined effects of sugar and fat intake, the **Western dietary pattern**—rich in refined grains, confectionery, processed meats, and high-fat foods—has been clearly associated with increased GDM risk.

A **2023 Nutrition Journal** systematic review reported a **1.31-fold** higher risk of GDM (**95% CI: 1.11–1.55**) with this pattern. Conversely, the **Mediterranean diet** reduced GDM risk by **up to 35%**, characterized by abundant fruits, vegetables, whole grains, nuts, fish, and plant oils (especially olive oil).

Therefore, **diet quality and sources**—rather than macronutrient quantity alone—are decisive in GDM prevention.

Assessment in International and Local Contexts

Globally, GDM prevalence is estimated at **10–15%**, though it varies with socioeconomic status, dietary habits, and screening criteria.

In **Uzbekistan**, a **2021** study reported a prevalence of **9.47%**, close to the global average (Ministry of Health of Uzbekistan, 2021). This suggests that elements of traditional local diets (high bread intake, sweet tea, fatty dishes) may contribute to GDM risk.

Practical Relevance and Preventive Recommendations

1. **Limit added sugars:** During pregnancy, added sugars should account for **no more than 5–10%** of daily energy intake (WHO, 2022).
2. **Prioritize fat quality:** Replace animal fats with plant oils (olive, canola, nut oils), keeping total fat at **≤25–30%** of energy intake.
3. **Adopt Mediterranean or plant-forward patterns:** Such diets can reduce GDM risk by **30–35%**.
4. **Increase physical activity: 150 minutes/week** of moderate aerobic activity restores insulin sensitivity.

Limitations

- Many studies are observational and cannot prove definitive causality.
- Dietary assessments (FFQs) are subjective and may misestimate intake.
- Specific sugar and fat subtypes (e.g., fructose, unsaturated fats) are not always distinguished.
- Evidence from the **Uzbek** population remains limited.

Conclusion

The present review indicates that **excessive sugar and fat intake during pregnancy** are key **modifiable** factors that increase the risk of **gestational diabetes (GDM)**. Main conclusions:

1. Epidemiological data—including **Nurses' Health Study II**—show that SSB consumption increases GDM risk by **22%**. High-fructose, sugar-rich beverages exacerbate insulin resistance, inflammation, and adiposity during pregnancy; replacing SSBs with water or low-calorie drinks can **reduce GDM risk by up to 30%** (Brion et al., 2022, BJN).
2. A **2024 meta-analysis** of **21 prospective studies** found **RR = 1.08 (95% CI: 1.02–1.14)** for total fat and **RR = 1.56 (95% CI: 1.34–1.89)** for animal fat. Saturated fats (e.g., animal fat, margarine) increase **IL-6** and **TNF-α**, disrupting

insulin signaling and glucose metabolism. In contrast, **unsaturated plant-based fats** (olive oil, nuts, fish oils) are recommended as protective.

3. **Western-style diets**—high in sugars, fats, and processed foods—increase GDM risk **1.3-fold**, whereas the **Mediterranean diet** can **reduce risk by up to 35%**. This underscores that **dietary quality and overall energy balance** matter more than macronutrient totals alone.
4. Excess sugar and fat intake intensify hepatic gluconeogenesis, lipogenesis, and inflammatory mediator production. During pregnancy's physiologic insulin-resistant state, this extra burden limits β-cell compensation, reduces peripheral glucose utilization, and promotes GDM. Lower adiponectin and altered visfatin concentrations have also been observed with high fat intake (PubMed **23385969**).
5. **Actionable guidance:** Limit added sugars to **≤5–10%** of daily energy; keep saturated fat **≤10%** of energy while favoring unsaturated fats; move toward a **Mediterranean-style** pattern; engage in **150 minutes/week** of moderate activity; and maintain a **healthy pre-pregnancy BMI**, which can reduce GDM risk by **40–50%**.

Excessive sugar and fat intake during pregnancy **reliably increases** GDM risk through metabolic, hormonal, and inflammatory pathways. Reducing sugary drinks, shifting toward healthier fat sources, improving overall diet quality, and increasing physical activity should be core directions of GDM prevention.

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