

# Dairy Products and Metabolic Risk Factors: How Much Do We Know?

Less than a decade ago, epidemiological research classified high-fat dairy products as integral to a “Western” dietary pattern that was associated with an increased risk for developing type 2 diabetes (1). Animal fat, including that found in whole milk and high-fat dairy products, was thought to be the pathogenic factor with little consideration of the composition of milk fat, which has the potential opposite effects of various fatty acids (saturated fatty acids, *trans* fatty acids, and conjugated linoleic acid) (2).

The study by Fumeron et al. (3) in this issue of *Diabetes Care* found an inverse relationship between intake of dairy products and incident diabetes and several cardiometabolic risk factors in the French DESIR (Data from the Epidemiological Study on the Insulin Resistance Syndrome) study. A limitation of the DESIR analysis is the homogeneity of the French study population. Generalizing the study finding to more diverse population groups, especially populations of color with disparate rates of diabetes, may not be appropriate. However, the DESIR findings are consistent with a number of recent epidemiological studies that have also reported an inverse relationship between intake of dairy products or nutrients in dairy products and the risk of developing obesity-related chronic diseases including diabetes in a variety of population groups (4–13).

Much of the early interest in dairy intake focused on its mineral content in relation to blood pressure. Although calcium is the nutrient most often associated with dairy products, a broader view of the mineral content is needed. Dairy products provide magnesium and potassium to the dietary intake as well as calcium. Although the effects of dairy products on the reduction in blood pressure may be related to the balance of these minerals (11,14), mineral supplementation trials found little benefit (15,16).

Trying to examine why dairy products may reduce diabetes risk is fraught with difficulty. Examination of dairy intake in relation to obesity, diabetes, and cardiometabolic risk requires consideration of a wide range of nutrients. Although

vitamin D has been postulated to reduce diabetes risk and convey cardiometabolic benefit, the evidence base is weak (17). Furthermore, the DESIR food frequency questionnaire is not structured to provide vitamin D values for exploration of the relationship. For example, the role of dairy protein also needs to be considered (18). Trying to extrapolate from observational data, in which dairy products are associated with lower risk, to food or nutrient recommendations is extremely challenging.

Dairy products have long been integral to federal dietary recommendations, but current recommendations are based on evidence from the Dietary Approaches to Stop Hypertension (DASH) study, which evaluated the blood pressure and other health outcomes of a dietary pattern containing low-fat dairy foods (three servings) (19). The DASH dietary pattern is highlighted in the 2010 Dietary Guidelines and has potential cardiometabolic benefits beyond reducing blood pressure (20–22). A literature search yielded no articles that examined the relative contribution of dairy products of the DASH dietary pattern to the effects on blood pressure or other cardiometabolic risk factors.

Although the DASH dietary pattern only contains low-fat dairy products, the French DESIR and other epidemiological studies suggest that intake of full fat as well as low-fat dairy products may reduce diabetes risk and provide cardiometabolic benefits. These findings raise questions about the role of fatty acids in dairy products. Biomarkers related to dairy intake as well as metabolic biomarkers may provide insights to explain the observational data.

Biomarkers related to fatty acid intake are of particular interest as research has suggested that the tertiary structure and shape of saturated fatty acids (SFA) affects their biological function (23). Exposure of pancreatic  $\beta$ -cells to long-chain SFA can affect their function by what has been termed endoplasmic reticulum (ER) stress, which can ultimately lead to cell death. This process is thought to play a role in the development of type 2

diabetes via a decrease in  $\beta$ -cell mass. Research using a yeast-based model has examined many features of lipotoxicity in human cells, to screen fatty acids of various structures for their capacity to counter ER stress. Findings from this research suggest that the tendency of a fatty acid to reduce SFA toxicity depends on a complex conjunction of parameters, including chain length, level of unsaturation, position of the double-bonds, and the nature of the isomers (*cis* or *trans*). As building blocks for phospholipid synthesis, fatty acids help regulate cell membrane organization and ER function of the  $\beta$ -cell.

Examination of the role of dairy products in obesity should consider the effects of fatty acids in dairy products on insulin resistance and diabetes-related risk. Ruminant animals, such as cows, sheep and goats synthesize both *cis* and *trans* isomers for the monounsaturated fatty acids of fatty acids with chain lengths of 14 to 18 carbons. *Trans*-palmitoleic acid (also known as *trans*-palmitoleate) is a 16 carbon *trans* fatty acid found in the milk produced by ruminant animals. Recently published research has reported that higher levels of circulating *trans*-palmitoleate were associated with lower levels of insulin resistance, dyslipidemia, and incident diabetes in a 14-year follow-up of adults in the Cardiovascular Health Study (24).

Research suggesting that intake of dairy products is associated with lower risk of diabetes is intriguing. However, a note of caution is needed to avoid jumping on a treatment bandwagon based on epidemiological data without evidence of benefit from well-controlled clinical trials (25). When dietary patterns are associated with lower disease risk, the shortcut approach for a quick fix that focuses on nutrient supplementation can be ill advised.

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