Whole Grain Consumption Reduces the Risk of Diabetes Type Two

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Abstract

The type two diabetes (T2D) is a preventable disease. However, its incidence is on the rise worldwide. The consumption of foods and beverages made with refined grains increase the risk of T2D. The predominant sources of carbohydrates in the U.S. are the refined grains, while the intake of whole grains (WGs) is low. The large-scale cohort and case-control studies reported that the consumption of WGs such as oats, whole wheat, rye, corn, buckwheat, brown rice, and others had been associated with the reduced insulin resistance, fasting blood glucose, and the incidence of newly diagnosed T2D in different populations. The insulin-sparing and blood sugar regulating effect of WGs can be due to their intact structural constituents such as bran, germ, and endosperm, as well as their fiber, vitamins, minerals, phytonutrients, and antioxidants. The interventional studies examined different WGs and WG products and reported no beneficial effects on the glycemic parameters and the risk of T2D. Different types of WGs and their degrees of processing, methods of preparation, additional ingredients, as well as consuming WGs alone or with other foods affected the blood glucose differently. It can be beneficial for the public to know the difference between WGs, WG products, and refined grains, as well as how their methods of preparation and consumption can affect the blood sugar levels. The purpose of this study was to assess whether the consumption of WGs reduced the risk T2D.

Keywords: blood sugar, diabetes risk reduction, whole grains, whole grain products.

Introduction

For the past several decades, T2D has been an international pandemic. Currently, T2D affects about 400 million worldwide, and it can involve 600 million by 2035 (Biskup et al., 2016). In the U.S., 14 % of adults have T2D, and 40% have prediabetes. It is a most prevalent type of diabetes and a seventh leading cause of mortality due to cardiovascular and renal complications (McMacken & Shah, 2017). This paper focuses on the examining the role of WGs in the prevention of T2D.

The dietary choices are the key modifiable risk factors in glucose metabolism, and the consumption of foods and beverages containing refined grains is associated with high risk of T2D (AlEssa et al., 2015). Refined grains are the primary source of carbohydrates in the U.S. population due to their availability and convenience, while the consumption of the WGs is low, about one serving per day (De Munter, Hu, Spiegelman, Franz, & van Dam, 2007). The WG intake has been consistently showing a lower risk of T2D in various populations (Aune, Norat, Romundstad, & Vatten, 2013). The kernels of WGs can be flaked, cracked, or ground, and contain the endosperm, germ, and bran in their original proportion (Aune et al., 2013). The WGs include brown rice, whole wheat, oats, buckwheat, millet, amaranth, quinoa, rye, and barley. The WGs slow the digestion and absorption of carbohydrates, and decrease postprandial blood glucose and insulin secretion; consuming three-five servings or 48-80 grams of WGs has been associated with reduced risk of diabetes by 26% (Ye, Chacko, Chou, Kugizaki, & Liu, 2012). The aim of this paper is to assess whether the WG consumption reduces the risk of T2D.

Methods

The goal was to find at least ten scientific, peer-reviewed, full-text articles that studied the relationship between WG consumption and the incidence of T2D. The LIRN, PubMed, and ProQuest Central databases were used to search for the studies done on humans. In the search field, "WGs and T2D", "WGs and risk of T2D", "WGs and T2D prevention", "WGs and blood glucose", "WGs and insulin resistance", and "WG products and blood glucose" were used. The initial outcome of the search contained more than 2000 articles, and the modification of the search keywords and the dates of publication narrowed it down. The preference was to select the observational and interventional studies.

Results

A cohort study examined the association between the intake of white rice and brown rice on the incidence of T2D in 39,765 men and 157,463 women, 26-87 years old, during a 22-year follow-up. The consumption of white rice demonstrated the higher risk of T2D. The brown rice intake had a lower risk of T2D, and the replacement of 50 g of white rice with 50 g of brown rice or other WGs showed a significantly lower risk of T2D (Sun et al., 2010).

A cohort study evaluated the effect of consuming WGs and risk of T2D in 161,737 women, 26-65 years old, during an 18-year follow-up. The WGs included the intact and pulverized kernels containing the natural proportions of bran, germ, and endosperm: WG wheat and flour, WG oats and flour, WG cornmeal and flour, WG brown rice and flour, WG rye and flour, barley, bulgur, buckwheat, popcorn, amaranth, and psyllium. The WG intake showed an inverse association with the risk of T2D. Bran intake significantly decreased the incidence of T2D. A two-servings a day increase in the WG consumption showed a 21% decrease in risk of T2D (De Munter et al., 2007).

A cohort study examined the relationship between the intake of WGs and refined grains and the incidence of T2D in healthy 42,898 men, 40-74 years old, during a 12-year follow-up. WG items included brown rice, dark bread, cereal, popcorn, wheat germ, bran, and other WG products. The authors observed a significant inverse association between the WG consumption and the risk of T2D; a diet high in WGs showed a 42-87% reduced risk of T2D in men, especially in non-obese men, while refined grains were not associated with the risk of T2D (Fung et al., 2002).

A cohort study with seven-year follow up evaluated the effect of consumption of WGs and WG products such as bread and cereal on the incidence of T2D in 72,215 women, 50-79 years old. An increased intake of WGs demonstrated a significantly reduced risk of T2D. Consumption of two or more servings of WGs per day showed a 43% risk of reduction of T2D and consuming one serving of WGs per day showed a decreased incidence (Parker et al., 2013).

In a 30-day randomized, controlled, double-blinded trial with one-year follow-up, 298 subjects were randomized into four groups: control, low-fat high-fiber diet, 50-gram oats, and 100-gram oats. Both oat groups had decreased postprandial glucose and insulin resistance. The 100-gram oats group showed a higher reduction in glycosylated hemoglobin and postprandial glucose. The intake of oats had a significant effect on lowering blood glucose (Li et al., 2016).

A randomized crossover study examined the effect of consumption of WG bread, WG pasta, and refined bread and pasta on postprandial blood glucose in 16 adults. The authors observed no difference in glycemic response in all groups. The WG bread resulted in significantly higher blood glucose level than WG pasta (Kristensen et al., 2009).

The randomized crossover blinded study examined the effect of WG rye bread and white bread on blood glucose in ten healthy subjects, 23-35 years old. The groups received 150 g white bread and 150 g WG rye bread. The authors observed no difference in postprandial blood glucose after consumption of WG rye and white wheat bread (Hlebowicz et al., 2009).

The crossover study evaluated the effect of ingesting commercial sprouted, white, sourdough, 11-grain, and 12-grain bread on glucose metabolism in 12 overweight men. The subjects received the equivalent of 50 g of available carbohydrates. Sprouted bread lowered blood glucose and insulin response, and 12-grain bread had a significantly lower glucose response. The 11-grain, sourdough, and white bread had a similar effect on blood glucose (Mofidi et al., 2012).

In a six-week randomized controlled crossover trial, Tucker et al. (2012) studied the effect of WG wheat sourdough bread and white bread intake on 28 adults. The WG sourdough bread contained WG spelt, rye, wheat, brown rice, millet, durum semolina, and barley flours, organic natural bacterial culture, cracked soy, flax seeds, and rolled oats. The blood glucose, insulin, glucagon, and insulin resistance were not significantly different in white bread and WG bread groups (Tucker et al., 2012).

The single-blinded, randomized, crossover study examined the effect of consumption of 100 g of white, whole wheat, whole barley, and sourdough bread on glucose metabolism in 11 overweight men. The sourdough bread had a significantly lower glycemic response than other bread. The WG barley bread shower a lower glucose response than WG wheat bread. There were no significant differences in postprandial insulin responses and insulin sensitivity to all types of bread. The WG bread made from ultra-fine ground flour showed the highest glucose response (Najjar et al., 2008).

Discussion

The presented studies show mixed results: some researchers reported that WG consumption decreased the risk of T2D, while others did not observe the beneficial effects of the WG intake on blood glucose. It is essential to have more evidence to confirm that the WG intake reduces the risk of T2D. The strengths of the cohort and case-control studies include large sample sizes, long follow-ups, and multivariate adjustments for other risk factors for T2D. The recall and selection bias, residual confounding, biennial questionnaires, misdiagnosis, self-reporting errors, and misclassification of WGs and WG products could have affected the results. The strengths of the interventional studies include controlled settings, randomization, and blinded design, while the small sample size and a short duration of intervention and follow-up could have limited the results. Each study has its additional strengths and limitations.

Sun et al. (2010) tested the WG brown rice and white rice kernels, made repeated assessments and had consistent results in the sample of European health professionals. The National Institutes of Health provided the funding. De Munter et al. (2007) calculated WG intake in grams per day and separately analyzed the consumption of the bran and germ in European female health professionals. The study did not perform a blood glucose screening, nor evaluated the intake of WG kernels versus WG products. Fung et al. (2002) confirmed T2D by tests and treatments, analyzed the intake of various WGs and WG products in European male health professionals, and classified the WG cereal based on its 25% WG content by weight. The study did not perform a separate analysis of the consumption of WG kernels versus WG products. Parker et al. (2013) had limited WG items on the questionnaires. Li et al. (2016) tested oats and other WG products separately, provided the meals, and supervised and recorded the intake. After initial 30 days, the participants received a supply of the WG oats and regular check-ins, and the study had a double-blind design. The potentially recognizable difference in taste and texture in oats and other WG products was a limitation. Kristensen et al. (2009) had a blinded study with a washout period, and the meals had similar macronutrient and calorie content. Serving the bread and pasta with cheese and water could have affected the blood sugar results. Hlebowicz et al. (2009) used WG rye and white bread with different calories and did not examine the difference in the structure or composition of bread or fiber. Mofidi et al. (2012) tested only acute postprandial blood samples in overweight male subjects and, while noticing a higher insoluble fiber content in sprouted and 12-grain bread, they did not look closer at the bread composition and processing. Tucker et al. (2012) recruited Caucasian and African Canadian subjects and did not analyze the bread's particle size and potential confounding by the bread ingredients. Najjar et al. (2008) prepared all the bread from ultra-fine ground flours with similar particles sizes, the white and sourdough bread had similar recipes and same white flour, however, each type of bread had different macronutrients. The study measured only the acute postprandial effect in sedentary overweight obese males.

The glucose metabolism is complex and multifactorial. The structure and type of the WGs can determine the glycemic response (Mofidi et al., 2012). The botanical origin of the kernel, milling, processing of the dough, and baking conditions can influence the metabolic responses to the WG products by affecting the rates of gastric emptying, hydrolysis, and absorption of the carbohydrates (Najjar et al., 2008). The presence of lactic acid in sourdough products can slow the gastric emptying, while the ultra-fine particles of the flour can induce insulin response (Najjar et al., 2008). The beneficial effects of WGs are attributed to their fiber, minerals, vitamins, phytonutrients, phytoestrogens, phytic acid, lignans, ferulic acid, and beta-glucans, which synergistically slow down digestion, increase the production of short-chain fatty acids in the small intestine, increase diversity of gut flora, and reduce the demand on insulin (Li et al., 2016). Therefore, many factors can influence the glycemic response after the WG consumption: the type of WGs, the degree of the kernels' processing and preparation, the presence of additional ingredients in WG products, the ratio of macronutrients, as well as consuming WGs alone or with other foods. Additional observational and randomized controlled studies done on large samples with long-term follow-up, testing different WGs and WG products and considering all possible confounding factors, can show stronger evidence, evaluate the mechanism of action, monitor both acute and chronic glycemic response, and explore the dose-response relationships between WG consumption and the risk of T2D.

Conclusions and Recommendations

The cohort and interventional studies reported mixed results. The beneficial effects of WG consumption on the insulin sensitivity, blood glucose, and the risk of T2D, attributed to their fiber, minerals, vitamins, phytonutrients, and antioxidants, need further exploration. In the U.S., the majority of carbohydrates come from the refined grains associated with the increased risk of T2D. While more studies are in progress, the consumers can benefit from learning about the structural difference between WGs, WG products, and refined grains, as well as that their ingredients and methods of processing, preparation, and consumption can influence the blood sugar differently.

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