https://doi.org/10.46389/rjd-2020-1027
www.rjdnmd.org

Rom J Diabetes Nutr Metab Dis
2020; volume 27, issue 2, pages 168-179

Review

Does Consumption of Refined Carbohydrates Predict the Incidence of Type 2 Diabetes Mellitus? A Systematic Review and Meta-Analysis

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Received: December 8th, 2019 / Accepted: February 18th, 2020

Abstract

Introduction: Type two diabetes mellitus is a highly prevalent health disorder among adult males and females worldwide. There is consistent evidence that unhealthy diets and physical inactivity play an essential role in the development of this condition. Many people consume refined carbohydrates as part of their daily meals. However, the evidence on whether refined carbohydrates predict type two diabetes mellitus is inconclusive. This study aims to provide evidence on the association between refined carbohydrates and the incidence of type two diabetes mellitus. **Material and Methods:** The literature search through PubMed, Embase, CINHAL, and Scopus identified prospective cohort studies that associated refined carbohydrate intake with the incidence of type two diabetes mellitus in non-diabetic participants. We then summarized the evidence by performing a systematic review and meta-analysis. **Results:** A systematic review and a meta-analysis were conducted for prospective cohort studies that examined the intake of refined carbohydrates and the incidence of type 2 diabetes mellitus. Eight articles were included in the systematic review and meta-analysis. Our findings from the systematic review suggest that a significant link exists between high consumption of refined carbohydrates, especially white rice and diabetes development. In the meta-analysis, the random-effects model of included studies suggests a positive linkage between refined carbohydrate intake and the incidence of type two diabetes mellitus with a pooled RR = 1.33, 95% CI [1.18, 1.48]. **Conclusions:** Consumption of high amounts of refined carbohydrates is significantly associated with increased incidence of type 2 diabetes. Reducing refined carbohydrates and improved information about their risk and access to this information may prevent diabetes development worldwide.

Keywords: Type two diabetes mellitus, refined carbohydrates

Introduction

Diabetes mellitus has become increasingly prevalent in recent years, which might indicate an actual increase in the number of individuals with this condition. It might also indicate that, over the past century, we have developed technology that is better able to detect diabetes mellitus [1]. A total of 415 million adults people worldwide were estimated to have diabetes in 2015. If these trends continue, 642 million people will have diabetes by 2040 [2].

Diabetes is genetically driven; that is, it is thought to be passed on from parent to child. Type 2 diabetes mellitus (T2DM), which is the more prevalent form, occurs amongst individuals once they reach middle age, while type 1 is a chronic condition that occurs amongst children or young adults and lasts throughout their lifetime [3]. Therefore, in the case of T2DM, while the hereditary factor is given much focus, there is also a certain degree of control that needs to be established in the diet of patients [4].

There are specific arguments related to the regulation of diet amongst diabetic patients, most of which involve the control of sugar intake to maintain normal blood sugar levels [5, 6]. However, other studies have considered the intake of refined carbohydrates as a contributing factor towards blood sugar increase in diabetic patients as well [7]. Either way, it has been well established that T2DM is at least partially genetic, although certain environmental factors have also been counted as contributory towards its existence and, more importantly, towards its progression over time. One of the issues concerning the suggested environmental causes is the change in dietary habits worldwide. In contrast to the substantial fiber-based intake of earlier times, there has been an increase in the consumption of carbohydrates as well as processed and fat-based foods in the contemporary world [8], paired with a relatively sedentary lifestyle [9, 10]. Some adverse effects can occur in the body with regard to various illnesses, and, despite its heritability [11], T2DM gains traction through such dietary and lifestyle choices, as is argued in many cases [12].

Refined carbohydrates are the result of a refining process in which fibers and valuable nutrients are extracted from grains and sugar at a processing plant [13]. Upon consumption of these carbohydrates, which are rapidly digested and assimilated after the intake, postprandial blood glucose and insulin levels become elevated [14]. Thus, regarding the glycemic index (GI), which measures the potential of foods to elicit the postprandial elevation of blood sugar, refined carbohydrates have a very high score (GI = 70 or more) [15].

Various studies reported a positive association between the consumption of refined carbohydrates and T2DM [16–19]. However, such an association has been considered significant in another study [20]. A recent systematic review and a meta-analysis show that the inclusion of simple carbohydrates within the diet seems to have a significant effect on the acquisition of T2DM [20]. This review has been restricted to a single pattern: the consumption of white rice. Although this pattern has been found to relate to the risk of diabetes, the evidence is inconclusive. Thus, through a systematic review and meta-analysis, we aim to summarize the evidence of published prospective cohort studies by evaluating the association between all different patterns of refined carbohydrates and T2DM. This is the first systematic review and meta-analysis that aims to assess the risk of refined carbohydrates to the incidence of T2DM conclusively.

Material and Methods

A systematic search was conducted on PubMed, Embase, CINAHL and Scopus for prospective cohort studies to identify published studies that examined the relationship between refined carbohydrate intake and T2DM. The key terms for the search were “diabetes mellitus”, “type 2 diabetes mellitus” and “non-insulin dependent diabetes mellitus”, in combination with “refined carbohydrates” or “dietary carbohydrates” and in combination with cohort studies, follow-up. For further relevant articles, reference lists of articles were screened.

We included prospective cohort studies that examined the relationship between refined carbohydrate intake and T2DM, studies published up to July 2017, journals in the English language, participants aged 18 years and above, research carried out globally and studies that reported risk estimates (odds ratio or relative risk) with 95% confidence intervals.

Figure 1 demonstrates the study selection process and results. A total of 334 articles were identified through database searching, 89 of which were identified from PubMed, 115 from Embase, 39 from CINAHL and 91 from Scopus. Forty-one studies remained after excluding the duplicated articles and those studies that did not meet our inclusion criteria. Of these 41 published articles, we evaluated the full text and excluded 29 studies. Of these excluded articles, 16 studies did not have original data that could be extracted (letters and reviews articles), and 13 studies were irrelevant (no relevant outcome, no relevant exposure, no risk estimation, and not in English). Finally, we identified 12 studies that matched the inclusion criteria. A manual search of references cited by these studies yielded four new eligible articles. Ultimately, eight articles were included in the systematic review and meta-analysis, which only examined refined carbohydrates separately from other diets. Of these eight studies included in the meta-analysis, men and women were examined separately in the study by Nanri et al., three independent cohort studies were conducted by Sun et al’s study, and two types of refined carbohydrates were examined separately by both Hodge et al’s and Villegas et al’s studies. Thus, a total of 13 comparisons were included in the meta-analysis (Figure 1).

Data Extraction

From each study, the following information was extracted: study characteristics, including author names, publication year, study participants, incident cases, study location, follow-up period, and person-time. Participants’ characteristics included

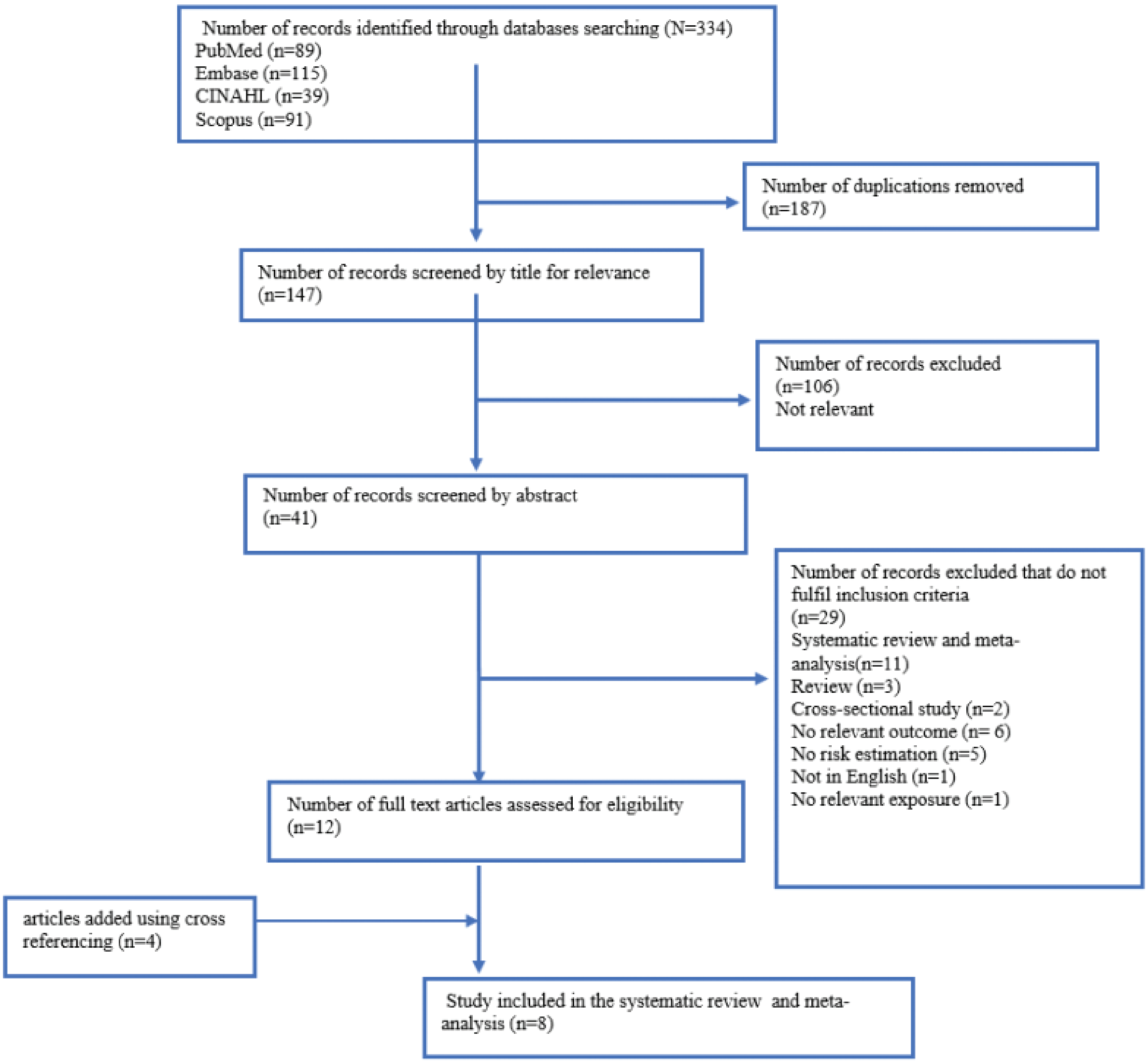

Figure 1: Literature search and study selection (based on PRISMA reporting).

age, sex, exposure to refined carbohydrates, assessment methods of dietary exposure, including reproducibility and validity, outcome (type 2 diabetes) and its measures and risk estimation for each category. Studies that had multiple cohorts or expressed data for men and women separately were considered to be independent and were extracted separately.

Statistical Analysis

For all included studies in this systematic review and meta-analysis, the information regarding dietary intake among participants was collected using a validated food frequency questionnaire (FFQ) designed to determine the average intake of food during the studies follow-up period.

The included studies measured the incidence of type 2 diabetes mellitus, which was identified through many methods, including self-reports and a validated supplementary questionnaire, and then confirmed using various measures, such as medical records, the National Diabetes Data Group, the American Diabetes Association diagnostic criteria (1997), the World Health Organization criteria (1985, 1999), the use of anti-diabetic medication, the Japan Diabetes Society diagnostic criteria (1982) for the Nanri et al's study from Japan and the enzymatic colorimetric for the study of Denova-Gutiérrez et al's study.

All the cohort studies included in the meta-analysis used relative risks (RRs) as a measure of association except for those by Hodge et al., Nanri et al. and Golozar et al., all of which used odds ratios (ORs) for their measurements. Due to a low incidence of T2DM in these studies (e.g., the incidence was 1.9% for Nanri et al., 1.2% for Hodge et al. and 3.7% for Golozar et al.), ORs were considered comparable to RRs as a measure of association.

https://doi.org/10.46389/rjd-2020-1027

All RRs that compared extreme categories of consumption were pooled by using a random-effects model. A forest plot was subsequently produced for visual assessment of the multivariate-adjusted RRs and their concordant 95% confidence intervals. The evaluation of heterogeneity between studies was assessed by Cochrane's Q and I2 statistical tests (where an I2 value of 25% is indicative of low heterogeneity, 50% is moderate heterogeneity, 75% is high heterogeneity and p<0.05 indicates a statistical significance for heterogeneity). Finally, a funnel plot was used to address any potential publication bias. All analysis was performed by using the MetaXl statistical software, version 5.3.

Results

Study characteristics

The study characteristics are shown in Table 1. In summary, all studies examined the risk of type 2 diabetes among a prospective cohort of participants that were free of the disease at baseline. During the period from two to twenty-two, 17,779 cases of T2DM were identified.

Five studies were conducted among Western populations (four studies in the United States and one study in Australia), and the other three studies were conducted among Asian populations (one study in China, one study in Japan and one study in Iran). In each included study, validated food frequency questionnaires were used to assess dietary intake.

Refined carbohydrate intake and risk of type 2 diabetes

The long-term effects of refined carbohydrates on the incidence of T2DM were evaluated in eight cohort studies [22-29].

Salmeron et al. [22] assessed an association between the risk of non-insulin dependent diabetes mellitus (NIDDM) and dietary patterns featuring a high glycemic load. A significant positive association was established between a diet characterized by an elevated glycemic load in conjunction with a low cereal fiber content and the risk of NIDDM in women (relative risk [RR] = 2.50, 95% confidence interval [CI]: 1.14–5.51). It is worth noting that such a diet was also reflective of the consumption of refined dietary carbohydrates, and this was stated explicitly by the researchers.

The study by Liu et al. [23] was one of the first studies in which a relationship between diet and chronic diseases was determined. A validated food frequency questionnaire was administered to 75,521 female registered nurses with the objective of conducting a dietary assessment, including that of the consumption of refined grains. A significantly increased incidence of T2DM (according to higher Rutter scores) was reported in relation to the consumption of refined grains (RR = 1.31, 95% CI: 1.12–1.53, p = 0.000). The risk was shown to escalate in increasing quintiles of refined grain intake. Conversely, the risk was seen to decrease in those who consumed whole grains (RR = 0.62, 95% CI: 0.53–0.71, p = < 0.000).

Van Dam et al. [24] found that the adoption of Western dietary patterns contributed to the increasing prevalence of T2DM in obese and physically inactive men. The dietary pattern followed was found to be the primary contributing factor to the risk of acquiring T2DM. A healthy dietary pattern, especially one involving the consumption of whole grains, was found to be inversely associated with the risk of T2DM in extreme quintiles of wholegrain intake (multivariate RR = 0.77, 95% CI: 0.64–0.93, p = < 0.001). By contrast, the consumption of a Western-type diet, and refined grains specifically, was found to be positively associated with the risk of T2DM in extreme quintiles of intake (RR = 1.37, 95% CI: 1.13–1.66).

Hodge et al. [25] studied the impact of the dietary GI on the incidence of T2DM in a mixed-gender cohort and established that starch and refined carbohydrates were connected to an increased incidence of the disease in the highest quartile of starch and carbohydrate intake (white bread: odds ratio [OR] = 1.37, 95% CI: 1.04–1.81, p = < 0.001; starch: OR = 1.47, 95% CI: 1.06–2.05). Nevertheless, the authors suggested that effecting a reduction in dietary GI, rather than carbohydrates, by substituting white bread with low-GI bread, might reduce T2DM risk.

Villegas et al. [26] researched the role of a diet that was characterized by a high GI and glycemic load (GL) in relation to T2DM in their study on 64,227 Chinese women whose diet primarily consisted of staple foods, such as rice, noodles, steamed bread, and bread. An association was identified between the consumption of a high-GI and -GL carbohydrate diet, especially rice, and the risk of T2DM (rice: RR = 1.78, 95% CI: 1.48–2.15; refined carbohydrates: RR = 1.28, 95% CI, 1.09–1.50).

Three prospective cohort studies on 39,765 men and 157,463 women in the USA were carried out by

Table 1: Characteristics of prospective studies of refined carbohydrate intake in relation to the incidene of type 2 diabetes: participants, follow-up, exposures, outcomes, relative risks, and covariates.

Author	Study participants	Follow-up period and person time	Exposure and assessment method	Study outcome and ascertainment	Comparison categories and corresponding covariates in fully adjusted model relative risk (95% CI)	Covariates in fully adjusted model
Salmeron et al. (1997)	The Nurses' Health Study: Total: 65173 women Cases:915 Age: 40 to 65 United States	Follow-up: 6 years; Person-years: NA	Refined carbohydrate diets "high glycemic load and low cereal fibre" assessed by FFQ consisting of 134 food items.	Type 2 diabetes identified through self-reports and confirmed by validated supplementary questionnaire; National Diabetes Data Group (before 1998) and American Diabetes Association 1997 (after 1998) diagnostic criteria	2.50 (1.14-5.51)	Age; ethnicity (white, African-American, Hispanic, and Asian); body mass index; smoking status; alcohol intake; multivitamin use; physical activity; family history of diabetes; total energy; intakes of red meat, fruits and vegetables, whole grains, and coffee
Liu et al. (2000) Van Dam et al. (2002)	Nurses' Health Study: total= 75 521 female; cases= 1879; age 38 to 63 years; United States	Follow-up: 10 years; Person-years 722 419	refined-grain foods assessed by FFQ consisting of 126 food items.	Type 2 diabetes identified through self-reports and confirmed by validated supplementary questionnaire; National Diabetes Data Group (before 1997) and American Diabetes Association 1997 (after 1997) diagnostic criteria	Q1: 1.0 (referent); Q2: 1.09 (0.94, 1.26); Q3: 1.01 (0.86, 1.17); Q4: 1.09 (0.92, 1.27); Q5: 1.11 (0.94, 1.30)	adjustment for age, BMI, cigarette smoking, alcohol intake, history of diabetes in first- degree relatives, use of multi-vitamins, use of vitamin E supplements, physical activity, and total energy intake.
Van Dam et al. (2002)	Male health professionals,	Follow-up: 12 years;	Consumption	Type 2 diabetes identified	1.32 [1.09, 1.60]	adjusted for age, body mass

https://doi.org/10.46389/rjd-2020-1027

	total= 42 504 males cases= 1321 cases aged 40 to 75 years US	Person-years: 466 508	of refined grains. assessed by FFQ consisting of 131 food items.	through a validated sup-plementary questionnaire and confirmed by the 1985 World Health Organization criteria		index, total energy intake (quintiles), and time period, physical activity), cigarette smoking, alcohol consumption, ancestry (Northern European, Southern European, or other), hyperchol-esterolemia, hypertension, and family history of type 2 diabetes mellitus.
Hodge et al. (2004)	Melbourne Collaborative Cohort Study: total=31 641; cases=365; male and female; age 40-69 years; Melbourne, Australia	Follow-up: 4 years; Person-years 129 190	White bread intake assessed by FFQ consisting of 121 food items.	type 2 diabetes identified through self-reports; 83% (303/365) cases confirmed by medical practitioners	Q1: 1.0 (referent); Q2:0.66 (0.44–0.99); Q3: 0.95 (0.67–1.35); Q4: 1.13 (0.86–1.50)	Age, sex, country of birth, physical activity, family history of diabetes, alcohol, total energy intake, education, 5 year weight change, body mass index, and waist: hip ratio
	Same as above	Same as above	Intake of starch assessed by FFQ consisting of 121 food items.	Same as above	100 g/ day: 1.52 (1.09–2.11)	Same as above
Villegas et al. (2007) I	Shanghai Women's Health Study: total=64 191; 100% female; cases=1608; age 40-70	Follow-up: 5 years; Person-years 297 755	White rice assessed by FFQ consisting of 77 food items.	type 2 diabetes identified through self-reports; American Diabetes Association	Q1:1.0 (referent); Q2: 1.04 (0.86 to 1.25); Q3: 1.29 (1.08 to 1.54); Q4: 1.78	Age, body mass index, waist:hip ratio, smoking status, alcohol consumption, physical

	years; Shanghai, China			1997 diagnostic criteria	(1.48 to 2.15)	activity, income level, education level, occupation, diagnosis of hypertension, and total energy
Villegas et al. (2007) II	Same as above	Same as above	Refined carbohydrates	Same as above	1.28 (1.09-1.50)	Same as above
Nanri et al. (2010) MALE	Japan Public Health Center-based Prospective Study: total=25 666; 100% male; cases=625; age 45-75 years; Japan	Follow-up: 5 years; Person-years 128 330	White rice assessed by FFQ consisting of 147 food items.	Type 2 diabetes identified through self reports and confirmed by medical records; Japan Diabetes Society 1982 diagnostic criteria	Q1: 1.00 (referent); Q2: 1.24 (1.00 to 1.55); Q3: 1.25 (0.93 to 1.67); Q4: 1.19 (0.85 to 1.68)	Age; study area; smoking status; alcohol consumption; family history of diabetes mellitus; total physical activity; history of hypertension; occupation; total energy intake; intakes of calcium, magnesium, fibre, fruit, vegetables, fish, coffee, bread, and noodles; and body mass index
Nanri et al. (2010) Female	Japan Public Health Center-based Prospective Study: total=33 622; 100% female cases=478; age 45-75 years; Japan	Follow-up: 5 years; Person-years 168 110	Same as above	Same as above	Q1: 1.00 (referent); Q2: 1.15 (0.85 to 1.55); Q3: 1.48 (1.08 to 2.02); Q4: 1.65 (1.06 to 2.57)	Same as above
Sun et al. (2010) HPFS	Health Professionals Follow-up Study: total=39 765;	Follow-up: 20 years; Person-years 702 920	Cooked white rice assessed by FFQ consisting of 116-131	Type 2 diabetes identified through self reports and confirmed	Q1: 1.0 (referent); Q2: 1.09 (0.96 to 1.24); Q3: 1.07	Age; ethnicity (white, African-American, Hispanic, and

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	100% male cases=2648; age 32-87 years; United States		food items.	by validated supp-lementary questionnaire; National Diabetes Data Group (before 1998) and American Diabetes Association 1997 (after 1998) diagnostic criteria	(0.93 to 1.23); Q4: 1.30 (1.12 to 1.50); Q5: 1.02 (0.77 to 1.34)	Asian); body mass index; smoking status; alcohol intake; multivitamin use; physical activity; family history of diabetes; total energy; intakes of red meat, fruits and vegetables, whole grains, and coffee
Sun et al. (2010) NHS I	Nurses' Health Study: total=69 120; 100% female cases=5500; age 37-65 years; United States	Follow-up 22 years; Person-years 1 404 373	Same as above	Same as above	Q1: 1.0 (referent); Q2: 1.00 (0.90 to 1.11); Q3: 1.07 (0.96 to 1.20); Q4: 1.09 (0.97 to 1.23); Q5: 1.11 (0.87 to 1.43)	Same as above, plus further adjustments for the post-menopausal status, hormone use, and oral contraceptive use
Sun et al. (2010) NHS II	Nurses' Health Study II: total=88 343; 100% female; cases=2359; age 26-45 years; United States	Follow-up 14 years; Person-years 1 210 903	Same as above	Same as above	Q1: 1.0 (referent); Q2: 0.93 (0.81 to 1.07); Q3: 0.94 (0.81 to 1.10); Q4: 0.95 (0.81 to 1.11); Q5: 1.40 (1.09 to 1.80)	Same as above
Golozar et al. (2017)	Tehran Lipid and Glucose Follow-up Study: total= 2,173 male and female; cases= 81; aged 20 years and above; Tehran, Iran	Follow-up: 3 years; Person-years: NA	Cooked white rice assessed by FFQ consisting of 121 food items.	Type 2 diabetes identified through self-reports; American Diabetes Association 1997 diagnostic criteria	Q1: 1.0 (referent); Q2: 1.08 (0.61, 1.92) ; Q3: 2.28 (1.19, 4.37)	Age, sex, race/ ethnicity, wealth score, education, marital status, employment status, opium, alcohol, occupation, physical activity, smoking, daily meat intake and daily calorie intake and body mass index.

Sun et al. [27], who examined the association between the consumption of white and brown rice, and the risk of T2DM. A positive association was established between the intake of white rice in large amounts (≥ 5 servings/week vs. ≤ 1 serving/month) and the increased incidence of T2DM (pooled RR = 1.17, 95% CI: 1.02–1.36). By contrast, brown rice consumption was associated with a lower risk of T2DM (pooled RR = 0.89, 95% CI: 0.81–0.97) when comparing ≥ 2 servings/week vs. ≤ 1 serving/month.

Sun et al. [27] observed a 16% decrease in the risk of T2DM (95% CI: 9.00-21.00%) in all three cohorts when 50 g/day of white rice intake was replaced with an equal quantity of brown rice. Thus, T2DM was linked to the regular consumption of white rice, independent of ethnicity, lifestyle, or even dietary risk factors for T2DM, and the recommendation was that carbohydrate intake should be in the form of wholegrains, rather than refined grains. These results are especially meaningful in the context of dietary choices and reducing T2DM risk.

Similarly, in a study set in Japan, Nanri et al. [28] observed a positive correlation between white rice intake and the risk of T2DM in both men and women. In particular, a strong association was identified between the increased consumption of white rice and risk in Japanese women (OR = 1.65, 95% CI: 1.06–2.57, p = 0.005) for the highest vs. the lowest quartiles in the multivariate-adjusted model. This association was also found in men, but it was not significant (p = 0.080). Thus, the link between dietary patterns and the risk of T2DM, although strong, has not been shown to be absolute. Additional factors may influence risk levels in significant ways.

Lastly, the study by Golozar et al. [29] investigated an association between white rice intake and the incidence of T2DM. The study setting was Iran (Tehran and Golestan) owing to the fact that "Iran is the thirteenth largest white rice consumer worldwide, with an average annual per capita consumption of approximately 34 kg" [29, p.2]. Once again, a positive association between white rice intake and the T2DM risk was identified in Tehran (OR = 1.01, 95% CI: 0.58–1.75), but no such association was observed in Golestan [29]. In Tehran, 250 g/day consumption was associated with a significant incidence of T2DM, which doubled with an intake of ≥ 250 g/day (OR = 2.08, 95% CI: 1.10–3.91). This could be elucidated by the fact that the daily intake of white rice is higher in Tehran than in Golestan (median daily intake of 250 g vs. 120 g in Tehran and Golestan, respectively; p = ≤ 0.001) [25]. Thus, a high white rice intake was linked to an increased risk of T2DM. Further research is warranted to explore the lack of a definitive association between lower white rice intake levels and T2DM.

Quantitative synthesis

In the meta-analysis, data were used from 8 prospective cohort studies, including 13 datasets, containing a total sample of 487,719 male and female participants aged 20 years and above (21-25; 33–35). In the systematic review, the random-effects model used for the included studies indicated a positive link between refined carbohydrate consumption and the increased incidence of T2DM (pooled relative risk [RR] = 1.33; 95% confidence interval [CI] = 1.18–1.48), with moderate heterogeneity (I2 = 57%) of a non-practical type (Figure 2).

Asian populations were found to be at a higher risk of T2DM than those in the West. After conducting a subgroup analysis, there was a relatively stronger association amongst Asians (RR = 1.51; 95% CI = 1.22–1.86) compared to Western populations (RR = 1.22; 95% CI = 1.10–1.37; see supplementary Fig. 3). Studies with a smaller sample size may have biased this association; therefore, secondary analyses were conducted that excluded such studies (Golozar et al's and Salmeron et al's studies; see supplementary Figure 4). There was a slight decrease in the relative risk (pooled RR = 1.29; 95% CI = 1.16–1.44), but the association between the consumption of refined carbohydrates and incidence of T2DM was still significant, which confirmed that the results of those two studies did not drive the pooled effect.

Exploration of heterogeneity and publication bias

A gross asymmetry can be seen in the Doi and funnel plots with a paucity of higher effect studies (supplementary Figure 4). This asymmetry is likely due to the effects of small studies or to the heterogeneity across the studies included.

Discussion

The findings from this systematic review and meta-analysis study showed a significant association

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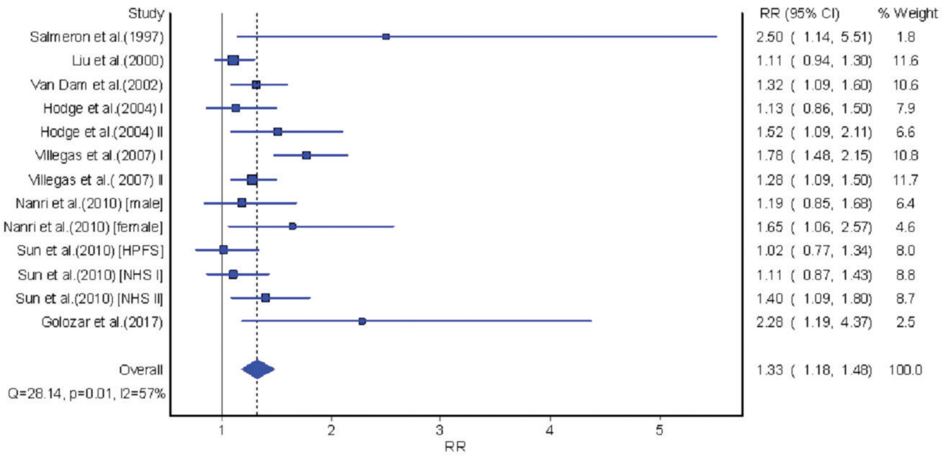

Figure 2: The forest plot of the random-effect model examines the effect of refined carbohydrates intake on the incidence of T2DM.

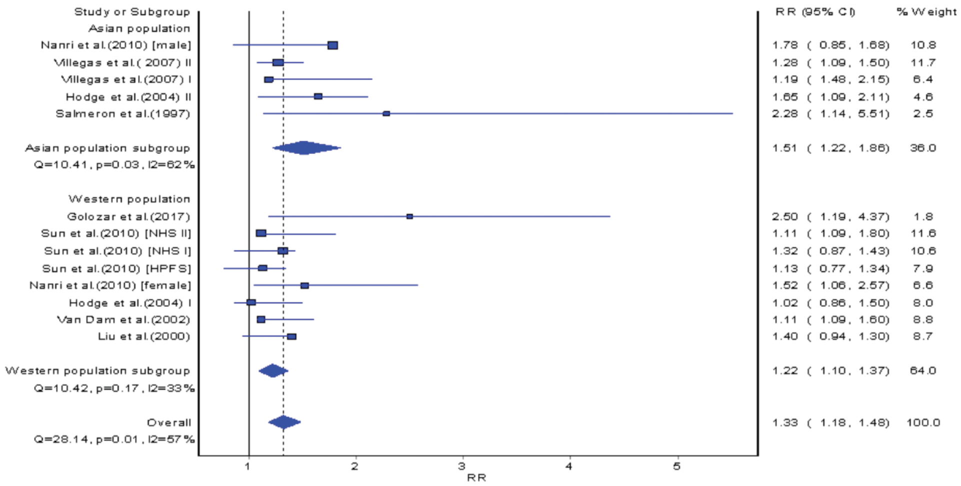

Figure 3: The forest plot of the random-effect model examines the effect of refined carbohydrates intake on incidence of T2DM using subgroups analysis.

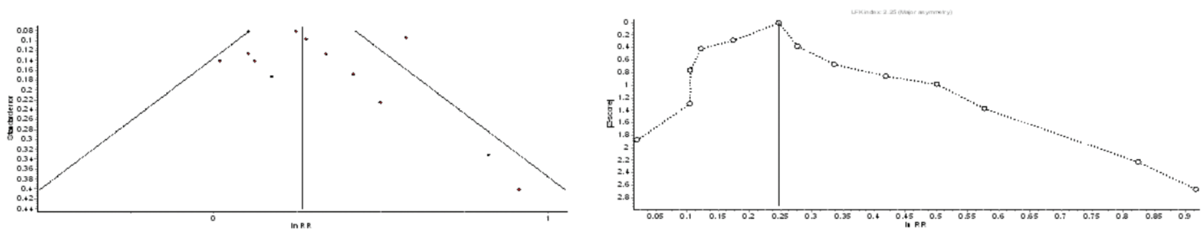

Figure 4: Funnel plot (left) and Doi plot (right) suggest gross publication bias favoring the positive effects.

between the consumption of diets high in refined carbohydrates and an increased incidence of T2DM. However, Asians were found to be at a higher risk of T2DM compared with the Western population. The relatively higher risk among Asians could be due to the fact that refined carbohydrates, particularly white rice, are dietary staples among the Asian population [30]. For each serving of refined carbohydrates per day, the risk of T2DM increased by 33% in the overall population. This study's findings are based on prospective cohort studies and a more rigorous methodology that involved the full adjustment of all confounders. After bias adjustment, the strong association between the high consumption of refined carbohydrates and the risk of T2DM remained. The results of this study also concur with the systematic review and meta-analysis of Hu et al. that examined the association of refined carbohydrates, more specifically white rice, with the incidence of T2DM [20]; however, the present study found an even stronger association than that previous study (RR:1.11, 95%; CI: 1.08–1.14). Furthermore, the inclusion of 8 studies in the meta-analysis compared to 4 studies by Hu et al. makes it more strong and reliable.

Conclusion

The systematic review and meta-analysis of the prospective cohort studies suggest that the high consumption of refined carbohydrates predicts the development of T2DM. The variety of studies considered and their various contexts mean that this finding is conclusive. Furthermore, as dietary guidelines strive to reflect optimal dietary health information, this finding should be further incorporated into guidelines.
Additional primary research and review of studies are necessary to understand this correlation better. Notably, the intersection between food groups and dietary patterns, as opposed to individual foods, must be explored further in order to thoroughly comprehend the significance of refined carbohydrates in a variety of dietary contexts.

With the influence of globalization, the spread of Western eating patterns and, subsequently, increased T2DM risk is expected to grow worldwide. However, T2DM risk is also observed in many nations where the primary cultural diet contains refined carbohydrates as a primary energy source, particularly white rice. Therefore, while the Western diet has been found to influence this disease risk, improved information about their risk and access to this information is needed worldwide.

Conflict of Interest

The authors declare that there is no conflict of interest.

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