

The Effect of Fruit and Vegetable Intake on the Incidence of Diabetes

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STUDY

Carter P, Gray LJ, Troughton J, Khunti K, Davies MJ: Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. *BMJ* 341:c422, 2010

SUMMARY

Design. Systematic review and meta-analysis.

Subjects. Six prospective cohort studies with 223,412 total participants were performed; only two studies included men. The mean age of participants ranged from 30 to 74 years. Study length ranged from 4.6 to 23 years (median length was 13.4 years). All studies included an individual measure of fruits, vegetables, or combined fruit and vegetable intake. Three provided information on fruit and vegetable intake separately and combined; two provided information on fruit and vegetable intake separately only; and one study provided only combined data. Four studies also included separate data on the intake of green leafy vegetables.

Methods. Investigators calculated summary hazard ratios (HRs) and 95% confidence intervals (CIs) for incidence of type 2 diabetes for the highest versus lowest quintiles of intake of fruit and/or vegetable consumption. HRs or relative risks from each study were pooled to give a summary estimate of risk using a random effects model. Investigators assessed for heterogeneity among studies' estimated effects using the

I^2 statistic. Two reviewers independently assessed all potentially relevant studies for inclusion and assessed the methodological quality of each included study.

Results. The number of incident type 2 diabetes cases ranged from 383 to 4,529 across the six studies. The meta-analysis of highest versus lowest quintiles of intake of fruit and vegetables did not identify statistically significant reductions in risk of type 2 diabetes incidence for consumption of fruit, vegetables, or fruit and vegetables combined. The pooled HRs were 0.93 (95% CI 0.83–1.01) for fruit only, 0.91 (0.76–1.09) for vegetables only, and 1.00 (0.92–1.09) for fruit and vegetables combined. However, summary estimates showed that consuming 1.35 servings a day of green leafy vegetables (highest intake) compared with 0.2 servings (lowest intake) resulted in a 14% reduction in risk ($P = 0.01$) of type 2 diabetes (HR 0.86 [95% CI 0.77–0.96]).

Because of significant heterogeneity observed between studies, investigators did several sensitivity analyses to try to explain whether methodological differences between the studies (i.e., study location, participant sex, classification of food groups, method of dietary assessment, and categorization of dietary intake) might account for the results. However, none of the factors examined accounted for the observed differences in study findings.

Conclusion. Overall, fruit and/or vegetable intake was not associated

with a clearly reduced risk of incident type 2 diabetes. However, increasing consumption of green leafy vegetables of about one serving per day was associated with a statistically significant 14% reduction in the risk of type 2 diabetes.

COMMENTARY

This systematic review and meta-analysis of prospective cohort studies examined whether intake of fruits and vegetables reduced the risk of type 2 diabetes. Although the meta-analysis did not show clear reductions in the risk of incident type 2 diabetes for consumption of fruits, vegetables, or fruits and vegetables combined, there was a statistically significant risk reduction for consumption of green leafy vegetables.

In interpreting these results, it is important to note certain caveats. First, only six studies met the inclusion criteria for this systematic review and only two of the studies included men in their samples. It is particularly noteworthy that none of the three studies that found a statistically significant inverse association between green leafy vegetables and incident type 2 diabetes included men. Second, there was inconsistency in which vegetables were considered to be green leafy vegetables, ranging from spinach and lettuce to Chinese greens. Third, given that the included studies used nonrandomized designs, it is possible that unmeasured or inadequately measured variables that are associ-

ated with both the amount of fruit and/or vegetable intake and incident type 2 diabetes (e.g., race/ethnicity, socioeconomic status, educational level, and physical activity level) might have influenced the results. Fourth, only three of the six studies adjusted for age, BMI, and family history of type 2 diabetes—all known risk factors for incident type 2 diabetes. Finally, only two of the six studies used appropriate inclusion and exclusion criteria, and two studies did not use a validated tool to assess fruit and vegetable intake.

Beginning in 1985, the U.S. Department of Agriculture (USDA) Dietary Guidelines for Healthy Americans recommended consuming at least two servings of fruit and three servings of vegetables daily.¹ Despite these recommendations, national initiatives, and increased media attention to the importance of consuming a healthy diet consisting of a variety of fruits and vegetables, the overwhelming majority of Americans fail to meet USDA dietary guidelines for fruit and vegetable consumption,² and there was no change between the periods 1988–1994 and 1999–2002.²

The 2005 dietary guidelines for Americans recommended consuming 2 cups of fruit and 2.5 cups of vegetables per day for a reference 2,000-calorie intake, with higher or lower amounts depending on the calorie level.³ Furthermore, they suggested selecting from all five vegetable subgroups (dark green, orange, legumes, starchy vegetables, and other vegetables) several times a week.

Unlike the 2005 dietary guidelines, the 2010 guidelines did not recommend precise quantities of fruits and vegetables that should be consumed; instead, they state that Americans should “increase intake of fruit and vegetables,” specifically by allowing half of one’s plate

to consist of fruits and vegetables. Evidence from the systematic review that informed the 2010 guidelines³ is limited and inconsistent but suggests an inverse relationship between total fruit and vegetable intake and the development of type 2 diabetes. Three of the five articles included in that systematic review were the same as those included in the current systematic review. Therefore, it appears that, although the findings are essentially the same, the stated conclusions are slightly different and nuanced.

Findings from the current systematic review and meta-analysis do not support a strong association between intake of fruit, vegetables, or combined fruit and vegetables and reduced type 2 diabetes risk. This finding is consistent with that of a previous systematic review on the topic⁴ as well as the evidence from systematic reviews conducted by the USDA and the U.S. Department of Health and Human Services.³ However, the current systematic review suggests that increased intake of green leafy vegetables may lower type 2 diabetes risk.

This finding needs to be confirmed and further explicated (e.g., which specific vegetables constitute green leafy vegetables) in future research studies so that this information can be incorporated into national recommendations, if appropriate. If it is confirmed, additional work will be required to implement the more specific recommendation to increase green, leafy vegetables. The current, less specific recommendations may be more effective in increasing fruit consumption, which may not be as beneficial in terms of reduction in the risk of diabetes and other adverse health outcomes.

The lack of strong evidence that increased fruit and vegetable intake reduces the risk of type 2 diabetes highlights the need to encourage a

multi-modal approach for diabetes prevention, such as that used in the Diabetes Prevention Program (DPP). The DPP was a multicenter, randomized clinical trial that compared intensive lifestyle modification, standard care plus metformin, and standard care plus placebo to prevent or delay the development of type 2 diabetes in high-risk individuals.⁵ The lifestyle intervention, which was delivered in 16 individual sessions during 24 weeks by a trained lifestyle coach, focused on improving diet, increasing physical activity, and overcoming barriers. Fifty percent of participants met the 7% weight loss goal, and 74% met the 150-minute-per-week physical activity goal at the end of the 24-week core curriculum.⁶

The DPP decreased the incidence of diabetes by 58% in the intensive lifestyle intervention arm, compared to a 31% reduction in the metformin arm after a mean 2.8 years of follow-up.⁶ This study highlighted the superiority of lifestyle modification for reducing diabetes risk. Although the public health community should continue to encourage greater fruit and vegetable (particularly green, leafy vegetable) consumption as a component of a healthy diet, more research is needed to definitively articulate its potential benefit on diabetes prevention.

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