

Citation:

Liu S, Serdula M, Janket SJ, Cook NR, Sesso HD, Willett WC, Manson JE, Buring JE. A prospective study of fruit and vegetable intake and the risk of type 2 diabetes in women. *Diabetes Care*. 2004 Dec;27(12):2993-6.

PubMed ID: [15562224](#)

Study Design:

Prospective Cohort Study

Class:

B - [Click here](#) for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To evaluate the hypothesis that a high intake of fruits and vegetables protects against the incidence of type 2 diabetes and to explore whether specific subgroups of fruits and vegetables differentially affect diabetes risk based on the prospective data from the Women's Health Study (WHS) from 1993 to 2003.

Inclusion Criteria:

- Women's Health Study participants
- 39,876 female health professionals \geq 45 years of age
- Free from heart disease, stroke or cancer at baseline
- 95% of the participants (38,018) completed food frequency questionnaire.

Exclusion Criteria:

None specifically mentioned.

Description of Study Protocol:**Recruitment**

- Data collected as part of Women's Health Study
- 39,876 female health professionals. 95% of the participants (38,018) completed food frequency questionnaire.

Design: Prospective Cohort Study

Blinding used (if applicable): not applicable

Intervention (if applicable): not applicable

Statistical Analysis

- SAS (version 8.0, SAS Institute, Cary, NC)
- Cox proportional hazards models
- Likelihood ratio test for significance of interaction
- Linear trend tests by assigning medians of intakes in quintiles as continuous variables

Data Collection Summary:

Timing of Measurements -

- Data collected from 1993 to 2003
- Fruit and vegetable consumption measured at baseline
- Reported incidence of type 2 diabetes followed for 8.8 years (332,905 person-years)

Dependent Variables

- Development of type 2 diabetes based on self-report

Independent Variables

- Fruit and vegetable consumption
- Calculated average daily intake of individual fruits and vegetables by multiplying the intake frequency by the portion size of the specific items.
- Vegetables were divided into groups: cruciferous (broccoli, cabbage, cauliflower, brussel sprouts), dark yellow (carrots, yellow squash, yams, sweet potatoes), green leafy (spinach, kale, lettuce), and other (corn, mixed vegetables, celery, eggplant, mushrooms, and beets).

Control Variables

- Age
- Total calories
- BMI
- Smoking status
- Alcohol consumption
- Exercise
- History of hypertension
- History of high cholesterol
- Family history of diabetes and more specifically relative to BMI $<$ or \geq 25

Description of Actual Data Sample:

Initial N: 39,876 female health professionals from the Women's Health Study

Attrition (final N): 95% (38,018) completed food frequency information

Age: \geq 45 years at baseline

Ethnicity: not specified

Other relevant demographics:

Anthropometrics

Location: United States

Summary of Results:

Key Findings

- Among women with BMI ≥ 25 kg/m², higher intake of green leafy or dark yellow vegetables was significantly associated with reduced risk of type 2 diabetes (P = 0.02).
- After fully adjusting for BMI, the inverse associations of green leafy and deep yellow vegetables were still observed among overweight women, although the trends were not statistically significant (P for trend = 0.09 for green leafy vegetables, P for trend = 0.13 for dark yellow vegetables).

Other Findings

- Mean daily intake was 2.2 ± 1.6 for fruits, 3.9 ± 2.6 for vegetables and 6.1 ± 3.6 for total fruits and vegetables.
- Women who consumed more fruits and vegetables tended to be older, exercised more and had a lower BMI than those with lower intake.
- During an average of 8.8 years of follow-up (332,905 person-years), 1,614 incident cases of type 2 diabetes were documented

Author Conclusion:

Overall, we found no inverse association between total intakes of fruits and vegetables and risk of incident type 2 diabetes after adjustment for known risk factors, whereas a high intake of green leafy or dark yellow vegetables was associated with reduced risk of type 2 diabetes among overweight women. In conclusion, our results suggest that higher intake of dark yellow and green leafy vegetables may be beneficial for preventing type 2 diabetes among overweight women.

Reviewer Comments:

Large population studied. Fruit and vegetable consumption only measured at baseline. Development of diabetes based on self-report.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

- | | | |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1. | Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies) | Yes |
| 2. | Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about? | Yes |

3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	Was the research question clearly stated?	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	Was the selection of study subjects/patients free from bias?	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	No
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	Were study groups comparable?	N/A
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A

3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	Was method of handling withdrawals described?	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	Was blinding used to prevent introduction of bias?	N/A
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A

6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	Were outcomes clearly defined and the measurements valid and reliable?	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	N/A
8.	Was the statistical analysis appropriate for the study design and type of outcome indicators?	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	Are conclusions supported by results with biases and limitations taken into consideration?	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	Is bias due to study's funding or sponsorship unlikely?	Yes

10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes

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