

Whole grain foods

No. 2021/41Ce, The Hague, November 16, 2021

Background document to:

Dutch dietary guidelines for people with type 2 diabetes

No. 2021/41e, The Hague, November 16, 2021

Health Council of the Netherlands



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01 introduction

The current background document belongs to the advisory report *Dutch dietary guidelines for people with type 2 diabetes*.¹ It describes the methodology for the search, selection and evaluation of the literature regarding the relationship of whole grain food consumption with health outcomes in people with type 2 diabetes. It furthermore describes the scientific evidence on this topic and the conclusions that have been drawn by the Committee on Nutrition of the Health Council of the Netherlands.

The Council included two guidelines for whole grain food consumption in the *Dutch dietary guidelines 2015*², which are as follows:

- Eat at least 90 grams of brown bread, wholemeal bread or other whole grain products daily;
- Replace refined cereal products by whole grain products.

Data from the most recent Dutch National Food Consumption Survey (2012-2016) shows that the general Dutch population aged 19 to 79 years consumes on average 199 grams of bread or cereal products daily, of which 47% consists of brown or whole grain cereal products.³



02 methodology

2.1 Research question

The Committee aimed to answer the following question: what is the relationship (effect or association) of whole grain food consumption with health outcomes in people with type 2 diabetes?

The Committee aimed to distinguish between short-term and long-term effects or associations where possible.

2.2 Nutritional topics

The Committee searched for studies into whole grain food consumption or oat consumption. Ancillary evidence on the contribution of whole grain food consumption to health outcomes can be obtained from studies into dietary fibre intake. Specifically, the Committee searched for literature into intakes of dietary fibre from whole grain foods and the dietary fibre *beta-glucan*, which is mainly present in oats and barley. The current background document solely focuses on the evidence for whole grain food consumption. The evidence for fibre intake is described in the background document *Dietary fibre*.⁴

2.3 Outcomes

The health outcomes selected by the Committee for this advisory report are presented in the background document *Methodology for the evaluation of evidence*.⁵ Those included long-term health outcomes, such as morbidity from stroke or coronary heart disease, and short-term surrogate outcomes, such as fasting blood glucose and systolic blood pressure. For prospective cohort studies, the Committee included only studies with long-term health outcomes.

2.4 Selection and evaluation of literature

A detailed description of the approach used by the Committee for selecting and evaluating the scientific literature and for drawing conclusions is provided in the background document *Methodology for the evaluation of evidence*.⁵ In short, the Committee aimed to base its evaluation of scientific literature on systematic reviews (SRs), including meta-analyses (MAs), of randomised controlled trials (RCTs) and/or prospective cohort studies examining the relationship of whole grain food consumption and oat consumption with the selected health outcomes in people with type 2 diabetes. In addition, the Committee searched for more recent individual studies into oat consumption that were not included in the most recent SR or MA. The Committee performed literature searches in PubMed and Scopus in the period from July to September 2020. The search strategy, flow diagrams of the



literature search and detailed description of the study selection are provided in **Annex A**.

2.4.1 Selection of randomised controlled trials

The Committee did not retrieve any relevant SRs (or MAs) of RCTs on the relationship of whole grain food consumption or oat consumption with health outcomes. The Committee initially found SRs into oat consumption, but the RCTs included in these SRs turned out not to be focused on whole oats but on fibre from oats. The relevant (individual) studies^{6,7} are therefore described in the background document *Dietary fibre*.⁴ Additional literature searches for individual RCTs into oat consumption in relation to short-term health outcomes yielded no additional relevant publications.

2.4.2 Selection of prospective cohort studies

The Committee found no SRs (or MAs) of prospective cohort studies. One SR⁸, however, included an individual prospective study on whole grain foods in relation to all-cause mortality and mortality from cardiovascular disease (CVD) (Table 1).⁹ The Committee also searched for literature references of prospective cohort studies addressing associations of whole grain food consumption with long-term health outcomes in people with type 2 diabetes in existing external dietary guidelines for diabetes.¹⁰⁻¹⁵ This search yielded the same cohort study⁹ as already found but no additional relevant publications.

Table 1 Overview of prospective cohort studies selected by the Committee for the evaluation of the association of whole grain food consumption with health outcomes in people with type 2 diabetes.

Health outcome ^a	Individual prospective cohort studies
All-cause mortality	He et al., 2010 ⁹
Mortality due to CVD	He et al., 2010 ⁹

CVD: cardiovascular disease

^a The table contains the health outcomes for which (relevant) studies were found. For the health outcomes that are not listed in the table, no (relevant) studies were found.

2.4.3 Drawing conclusions

Conclusions regarding the associations of whole grain food consumption with risks of all-cause mortality and CVD mortality in people with type 2 diabetes were based on the single prospective cohort study. The decision tree (**Annex B**) was used to draw conclusions.



03 associations of whole grain foods

Table 2 summarises the characteristics and results of the prospective cohort study providing evidence regarding the associations of whole grain food consumption with risks of all-cause mortality and CVD mortality in people with type 2 diabetes.

Table 2 Summary of the associations of whole grain food consumption with the risk of all-cause mortality and mortality due to CVD in people with type 2 diabetes: prospective cohort study.

Study; study duration	He et al., 2010^a; 26 years
Cohort name	Nurses' Health Study (NHS)
Exposure(s)	Whole grain consumption (including rice, pasta, bread and breakfast cereals)
Dietary assessment method	Semi-quantitative food frequency questionnaires administered at baseline and at 6 follow-up rounds (with intervals of 4 y); cumulative average was used
Number of participants; number of cases	7822 participants; All-cause mortality: 852 CVD mortality: 295
Strength of the association: RR (95%CI)	Q5 vs. Q1 of whole grain food consumption: ALL-CAUSE MORTALITY: 0.89 (0.69-1.14) ^a , P-trend: 0.11 CVD MORTALITY: 0.70 (0.46-1.06) ^a , P-trend: 0.07
Study population	Participants with type 2 diabetes (diagnosed after age of 30 y); BMI: 30 kg/m ² (mean); diabetes duration: NR; diabetes medication; NR; women; USA

BMI: body mass index; CI: confidence interval; CVD: cardiovascular disease; NR: not reported; Q: quartile; RR: relative risk; USA: United States of America; y: years.

^a Associations were adjusted for age, smoking status, BMI, alcohol intake, physical activity, parental history of MI, menopausal status and use of hormone therapy, duration of diabetes, energy intake and intakes of polyunsaturated fat, saturated fat, *trans* fat, magnesium and folate.



The Committee concluded the following:

There is too little research to draw conclusions regarding the association of whole grain food consumption with the risk of all-cause mortality in people with type 2 diabetes.

The following considerations were made by the Committee, following the steps of the decision tree, to come to this conclusion:

There are no MAs of prospective cohort studies that address associations of whole grain food consumption with risk of all-cause mortality. There is only one individual prospective cohort study that addresses the association with all-cause mortality. That is too little evidence to base conclusions on.

There is too little research to draw conclusions regarding the association of whole grain food consumption with the risk of mortality due to CVD in people with type 2 diabetes.

The following considerations were made by the Committee, following the steps of the decision tree, to come to this conclusion:

There are no MAs of prospective cohort studies that address associations of whole grain food consumption with risk of CVD mortality. There is only one individual prospective cohort study that addresses the association with CVD mortality. That is too little evidence to base conclusions on.

Explanation:

The Committee included one prospective cohort study, by He et al.⁹, in the evaluation of whole grain food consumption with risks of all-cause mortality and CVD mortality in people with type 2 diabetes. The study, including 7800 participants and reporting 852 cases of all-cause mortality and nearly 300 cases of CVD mortality, showed that whole grain food consumption was not statistically significantly associated with the risk of all-cause mortality or CVD mortality.

Funding or author's conflicts of interest likely did not affect the study findings of the study included in this evaluation (**Annex C**).



04 summary of conclusions

The Committee's conclusions regarding associations of whole grain food consumption with health outcomes in people with type 2 diabetes are summarised in Table 3.

Table 3 Overview of conclusions regarding associations of higher whole grain food consumption with health outcomes in people with type 2 diabetes, based on prospective cohort studies.

Health outcome ^a	Conclusion
All-cause mortality	Too little research
Mortality due to CVD	Too little research

CVD: cardiovascular disease.

^a The table contains the health outcomes for which (relevant) studies were found. For the health outcomes that are not listed in the table, no (relevant) studies were found.



references

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- ² Health Council of the Netherlands. *Dutch dietary guidelines 2015*. The Hague: Health Council of the Netherlands, 2015; publication no. 2015/26E.
- ³ van Rossum CTM, Buurma-Rethans EJM, Dinnissen CS, Beukers MH, Brants HAM, Dekkers ALM, et al. *The diet of the Dutch. Results of the Dutch National Food Consumption Survey 2012-2016*. Bilthoven: National Institute for Public Health and the Environment (RIVM), 2020; report no. 2020-0083.
- ⁴ Health Council of the Netherlands. *Dietary fibre. Background document to Dutch dietary guidelines for people with type 2 diabetes*. The Hague: Health Council of the Netherlands, 2021; publication no. 2021/41De.
- ⁵ Health Council of the Netherlands. *Methodology for the evaluation of evidence. Background document to Dutch dietary guidelines for people with type 2 diabetes*. The Hague: Health Council of the Netherlands, 2021; publication no. 2021/41Ae.
- ⁶ Li X, Cai X, Ma X, Jing L, Gu J, Bao L, et al. *Short- and Long-Term Effects of Wholegrain Oat Intake on Weight Management and Glucolipid Metabolism in Overweight Type-2 Diabetics: A Randomized Control Trial*. *Nutrients* 2016; 8(9):
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- ¹⁶ He LX, Zhao J, Huang YS, Li Y. *The difference between oats and beta-glucan extract intake in the management of HbA1c, fasting glucose and insulin sensitivity: a meta-analysis of randomized controlled trials*. Food Funct 2016; 7(3): 1413-1428.
- ¹⁷ Reynolds AN, Akerman AP, Mann J. *Dietary fibre and whole grains in diabetes management: Systematic review and meta-analyses*. PLoS Med 2020; 17(3): e1003053.
- ¹⁸ Shen XL, Zhao T, Zhou Y, Shi X, Zou Y, Zhao G. *Effect of Oat beta-Glucan Intake on Glycaemic Control and Insulin Sensitivity of Diabetic Patients: A Meta-Analysis of Randomized Controlled Trials*. Nutrients 2016; 8(1):
- ¹⁹ Hou Q, Li Y, Li L, Cheng G, Sun X, Li S, et al. *The Metabolic Effects of Oats Intake in Patients with Type 2 Diabetes: A Systematic Review and Meta-Analysis*. Nutrients 2015; 7(12): 10369-10387.



A search strategy, study selection and flow diagrams

Systematic reviews including meta-analyses

The Committee performed a literature search to identify relevant systematic reviews (SRs) including meta-analyses (MAs) on the relationship between carbohydrate-containing food sources and health outcomes in people with type 2 diabetes. Literature searches were performed in PubMed and Scopus on 20th and 29th July 2020, respectively, using the following search strategies:

PubMed

("diabetes mellitus, type 2"[MeSH] OR Diabet*[tiab] OR T2DM[tiab] OR NIDDM[tiab]) AND (("Dietary Fiber"[Mesh] OR "Dietary Carbohydrates"[Mesh] OR "Starch"[Mesh] OR "Polysaccharides"[Mesh] OR "Fructans"[Mesh] OR "Inulin"[Mesh] OR "Dietary sugars"[Mesh] OR (dietary[tiab] AND (fiber*[tiab] OR fibre*[tiab] OR carbohydrates[tiab] OR starch*[tiab] OR fructan[tiab] OR inulin[tiab] OR sugar*[tiab]))) OR (("edible grain"[MeSH] OR "edible grain"[tiab] OR cereals[tiab] OR "Whole Grains"[Mesh] OR grain*[tiab] OR wheat*[tiab] OR oat[tiab]) OR (fruit[MeSH] OR fruit[tiab] OR fruits[tiab]) OR (vegetables[MeSH] OR vegetables[tiab]) OR (((sugars[MeSH] OR sugars[tiab] OR sugar[tiab] OR

sweetened[tiab] OR sweetener[tiab]) AND (beverages[MeSH] OR beverages[tiab] OR drink*[tiab] OR juice*[tiab] OR soda*[tiab]))) OR (fabaceae[MeSH] OR fabaceae[tiab] OR legume[tiab] OR legumes[tiab] OR bean*[tiab] OR "Soybean Proteins"[Mesh] OR soy[tiab] OR soya[-tiab]))) AND (Systematic review[publication type] OR Meta-analysis[publication type] OR review[tiab] OR "meta-analysis"[tiab] OR meta analysis[tiab] OR metaanalysis[tiab] OR quantitative review[tiab] OR quantitative overview[tiab] OR systematic review[tiab] OR systematic overview[tiab] OR methodologic review[tiab] OR methodologic overview[tiab])

Limit: from 2000 + English

Scopus

((((KEY ("diabetes mellitus, type 2") OR TITLE-ABS-KEY (t2dm) OR TITLE-ABS-KEY (niddm))) OR (TITLE-ABS ("diabetes mellitus, type 2") OR TITLE-ABS (diabet*) OR TITLE-ABS (t2dm) OR TITLE-ABS (niddm))) AND (((TITLE-ABS-KEY ("Dietary Fiber") OR TITLE-ABS-KEY ("Dietary Carbohydrates") OR TITLE-ABS-KEY ("Starch") OR TITLE-ABS-KEY ("Polysaccharides") OR TITLE-ABS-KEY ("Fructans") OR TITLE-ABS-KEY ("Inulin")))) OR ((TITLE-ABS (dietary)) AND (TITLE-ABS (fiber*) OR TITLE-ABS (fibre*) OR TITLE-ABS (carbohydrates) OR TITLE-ABS (starch*) OR TITLE-ABS (fructan) OR TITLE-ABS (inulin) OR TITLE-ABS (sugar)))))) OR ((TITLE-ABS-KEY ("edible grain")) OR ((TITLE-ABS-KEY



(cereals) OR KEY (“Whole Grains”) OR TITLE (grain*) OR ABS (grain*) OR TITLE (wheat*) OR ABS (wheat*) OR TITLE (oat) OR ABS (oat))) OR (KEY (fruit) OR TITLE-ABS (fruit) OR TITLE-ABS (fruits)) OR (KEY (vegetables) OR TITLE-ABS (vegetables)) OR (KEY (sugars) OR TITLE-ABS (sugar) OR TITLE-ABS (sugars) OR TITLE-ABS (sweetened) OR TITLE-ABS (sweetener) OR KEY (beverages) OR TITLE-ABS (beverages) OR TITLE-ABS (drink*) OR TITLE-ABS (juice*) OR TITLE-ABS (soda*) OR KEY (fabaceae) OR TITLE-ABS (fabaceae) OR TITLE-ABS (legume) OR TITLE-ABS (legumes) OR KEY (“Soybean Proteins”) OR TITLE-ABS (soy) OR TITLE-ABS (soya)))) AND (((TITLE-ABS-KEY (“Systematic review”) OR TITLE-ABS-KEY (“Meta-analysis”))) OR (TITLE-ABS (review) OR TITLE-ABS (meta-analysis) OR TITLE-ABS (meta analysis) OR TITLE-ABS (“quantitative review”) OR TITLE-ABS (“quantitative overview”) OR TITLE-ABS (“systematic overview”) OR TITLE-ABS (“methodologic review”) OR TITLE-ABS (“methodologic overview”))))

Limit: from 2000 + English

In total, 2054 publications were found in PubMed and 3887 publications in Scopus. After removal of duplicates, 4527 publications remained and were screened for title and abstract. A total of 172 publications remained for full-text assessment, of which 19 were selected for the Committee’s evaluation of carbohydrate quality.

Of those 19 publications, 4 SRs¹⁶⁻¹⁹ included RCTs into fibre from whole grain foods or oats. As the exposure in those RCTs was fibre and not whole grains per se, the Committee decided to include those RCTs in the evaluation of dietary fibre (from whole grain foods). This concerns the RCTs by Stevens et al.⁷ and Li et al.⁶ No SRs remained for the Committee’s evaluation of whole grain food consumption.

Recent individual randomised controlled trials

The Committee performed two literature searches to identify relevant individual RCTs on the effect of oat consumption on health outcomes in people with type 2 diabetes that were published after the inclusion date of the most recent SR/MA. Only health outcomes that were already covered in the selected SR/MA were included in the search. Literature searches were performed in PubMed and Scopus on 31st August and 2nd September 2020, respectively, using the following search strategies:

Oats and DM2 outcomes^a and body weight

PubMed

(“diabetes mellitus, type 2”[MeSH] OR Diabet*[tiab] OR T2DM[tiab] OR NIDDM[tiab]) AND (oat[tiab] OR oats[tiab] OR oatmeal[tiab]) AND (insulin[tiab] OR glucose[tiab] OR glycemic control[tiab] OR glycaemic control[tiab])

^a DM2 outcomes include: HbA1c, fasting blood glucose, glycemia, fasting insulin, body weight and body mass index.



OR glycemia[tiab] OR glycaemia[tiab] OR “Glycated Hemoglobin A”[Mesh] OR HbA1c[tiab] OR Glycated Hemoglobin[tiab] OR Glycosylated Hemoglobin[tiab] OR “Body Weight”[Mesh] OR weight[tiab] OR “Body Mass Index”[Mesh] OR BMI[tiab]) AND (“Clinical Trials as Topic”[Mesh] OR “Clinical Trial” [Publication Type] OR “Cross-Over Studies”[Mesh] OR “Double-Blind Method”[Mesh] OR “Single-Blind Method”[Mesh] OR “Controlled Before-After Studies”[Mesh] OR “Historically Controlled Study”[Mesh] OR randomized[tiab] OR randomised[tiab] OR RCT[tiab] OR controlled*[tiab] OR placebo[tiab] OR clinical trial[tiab] OR trial[tiab] OR intervention[tiab])

Limit: from 2015 + English

Scopus

(KEY (*diabetes AND mellitus, type 2*) OR TITLE-ABS (*diabetes AND mellitus, AND type 2*) OR TITLE-ABS (*diabet**) OR TITLE-ABS (*t2dm*) OR TITLE-ABS (*niddm*)) AND (TITLE-ABS (*oat*) OR TITLE-ABS (*oats*) OR TITLE-ABS (*oatmeal*)) AND (TITLE-ABS (*insulin*) OR TITLE-ABS (*glucose*) OR TITLE-ABS (*glycemic AND control*) OR TITLE-ABS (*glycaemic AND control*) OR TITLE-ABS (*glycemia*) OR TITLE-ABS (*glycaemia*) OR KEY (*glycated AND hemoglobin AND a*) OR TITLE-ABS (*hba1c*) OR TITLE-ABS (*glycated AND hemoglobin*) OR TITLE-ABS (*glycosylated AND hemoglobin*) OR KEY (*body AND weight*) OR TITLE-ABS (*weight*) OR KEY (*body AND mass AND index*) OR

TITLE-ABS (*bmi*)) AND ((TITLE-ABS-KEY (clinical AND trials AND as AND topic) OR TITLE-ABS (clinical AND trial) OR TITLE-ABS-KEY (cross-over AND studies) OR TITLE-ABS-KEY (double-blind AND method) OR TITLE-ABS-KEY (single-blind AND method) OR TITLE-ABS-KEY (controlled AND before-after AND studies) OR TITLE-ABS-KEY (historically AND controlled AND study)) OR (TITLE-ABS (randomised) OR TITLE-ABS (randomized) OR TITLE-ABS (rct) OR TITLE-ABS (controlled*) OR TITLE-ABS (placebo) OR TITLE-ABS (clinical AND trial) OR TITLE-ABS (trial) OR TITLE-ABS (intervention)))

Limit: from 2015 + English

In total, 32 publications were found in PubMed and 34 publications in Scopus. After removal of duplicates, 42 publications remained and were screened for title and abstract. A total of 6 publications remained for full-text assessment. None of these fulfilled the Committee’s criteria and therefore could not be selected for the evaluation of whole grain foods.

Oats and blood lipids

PubMed

(“diabetes mellitus, type 2”[MeSH] OR Diabet*[tiab] OR T2DM[tiab] OR NIDDM[tiab]) AND (oat[tiab] OR oats[tiab] OR oatmeal[tiab]) AND (blood[tiab] AND (“lipids”[MeSH] OR lipid*[tiab])) AND (“Clinical Trials as



Topic"[Mesh] OR "Clinical Trial" [Publication Type] OR "Cross-Over Studies"[Mesh] OR "Double-Blind Method"[Mesh] OR "Single-Blind Method"[Mesh] OR "Controlled Before-After Studies"[Mesh] OR "Historically Controlled Study"[Mesh] OR randomized[tiab] OR randomised[tiab] OR RCT[tiab] OR controlled*[tiab] OR placebo[tiab] OR clinical trial[tiab] OR trial[tiab] OR intervention[tiab])

Limit: from 2013 + English

Scopus

(KEY (*diabetes AND mellitus, type 2*) OR TITLE-ABS (*diabetes AND mellitus, AND type 2*) OR TITLE-ABS (*diabet**) OR TITLE-ABS (*tcdm*) OR TITLE-ABS (*niddm*)) AND (TITLE-ABS (*oat*) OR TITLE-ABS (*oats*) OR TITLE-ABS (*oatmeal*)) AND (TITLE-ABS(blood) AND KEY(lipids) OR TITLE-ABS(lipid*)) AND ((TITLE-ABS-KEY (clinical AND trials AND as AND topic) OR TITLE-ABS (clinical AND trial) OR TITLE-ABS-KEY (cross-over AND studies) OR TITLE-ABS-KEY (double-blind AND method) OR TITLE-ABS-KEY (single-blind AND method) OR TITLE-ABS-KEY (controlled AND before-after AND studies) OR TITLE-ABS-KEY (historically AND controlled AND study)) OR (TITLE-ABS (randomised) OR TITLE-ABS (randomized) OR TITLE-ABS (rct) OR TITLE-ABS (controlled*) OR TITLE-ABS (placebo) OR TITLE-ABS (clinical AND trial) OR TITLE-ABS (trial) OR TITLE-ABS (intervention)))

Limit: from 2013 + English

In total, 9 publications were found in PubMed and 9 publications in Scopus. After removal of duplicates, 12 publications remained and were screened for title and abstract. A total of 3 publications remained for full-text assessment. None of these fulfilled the Committee's criteria and therefore could not be selected for the evaluation of whole grain foods.

Prospective cohort studies

Since no SRs or MAs of (multiple) cohort studies were found, the Committee searched for individual prospective cohort studies on associations of whole grain food or oat consumption with health outcomes in the retrieved SRs and in external dietary guidelines for diabetes of the



following organisations:

- Dutch Diabetes Federation (Nederlandse Diabetes Federatie (NDF)), 2020¹⁰
- European Association for the Study of Diabetes (EASD) & European Society of Cardiology (ESC), 2020¹¹
- American Diabetes Association (ADA), 2019¹²
- Diabetes UK, 2018¹³
- Diabetes Canada, 2018¹⁴
- Swedish Council, 2010¹⁵

One prospective cohort study⁹ was retrieved via the SR of Wheeler et al.⁸, which was also included in the dietary guidelines for diabetes of the ADA.¹² Further screening of SRs and external dietary guidelines for diabetes yielded no additional relevant cohort studies. In addition, subsequent screening of articles citing this cohort study in PubMed yielded no additional relevant studies.

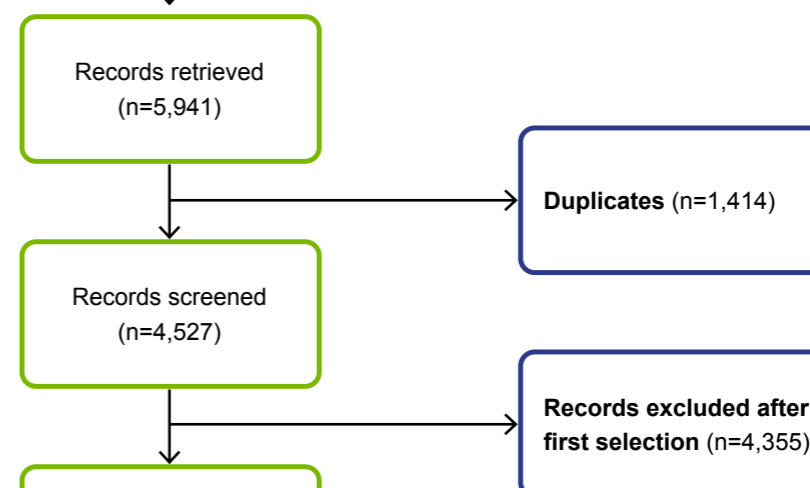
The Committee selected the following prospective cohort study for its evaluation of whole grain food consumption: He et al., 2010.⁹

Flow diagram for the selection of systematic reviews including meta-analyses

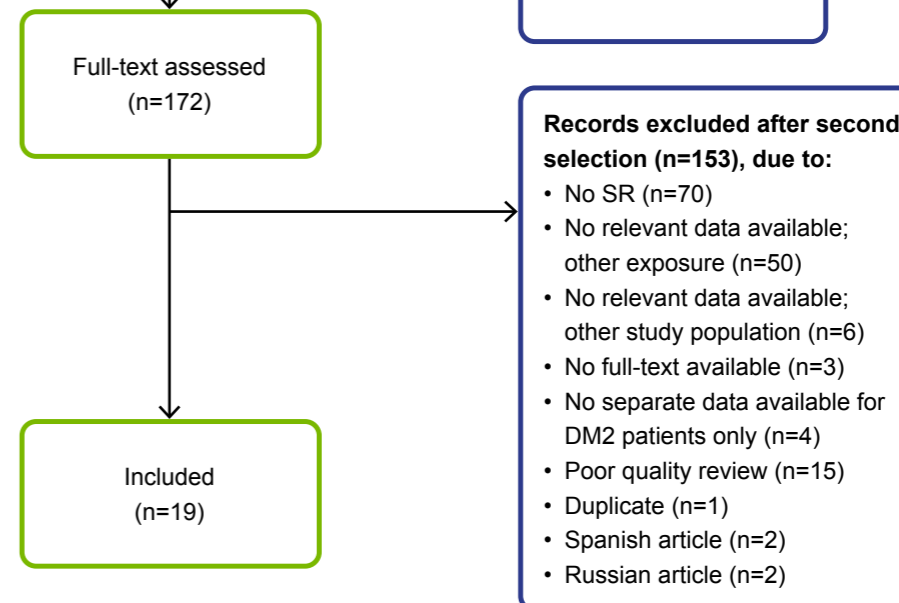
Identification



Screening



Eligibility



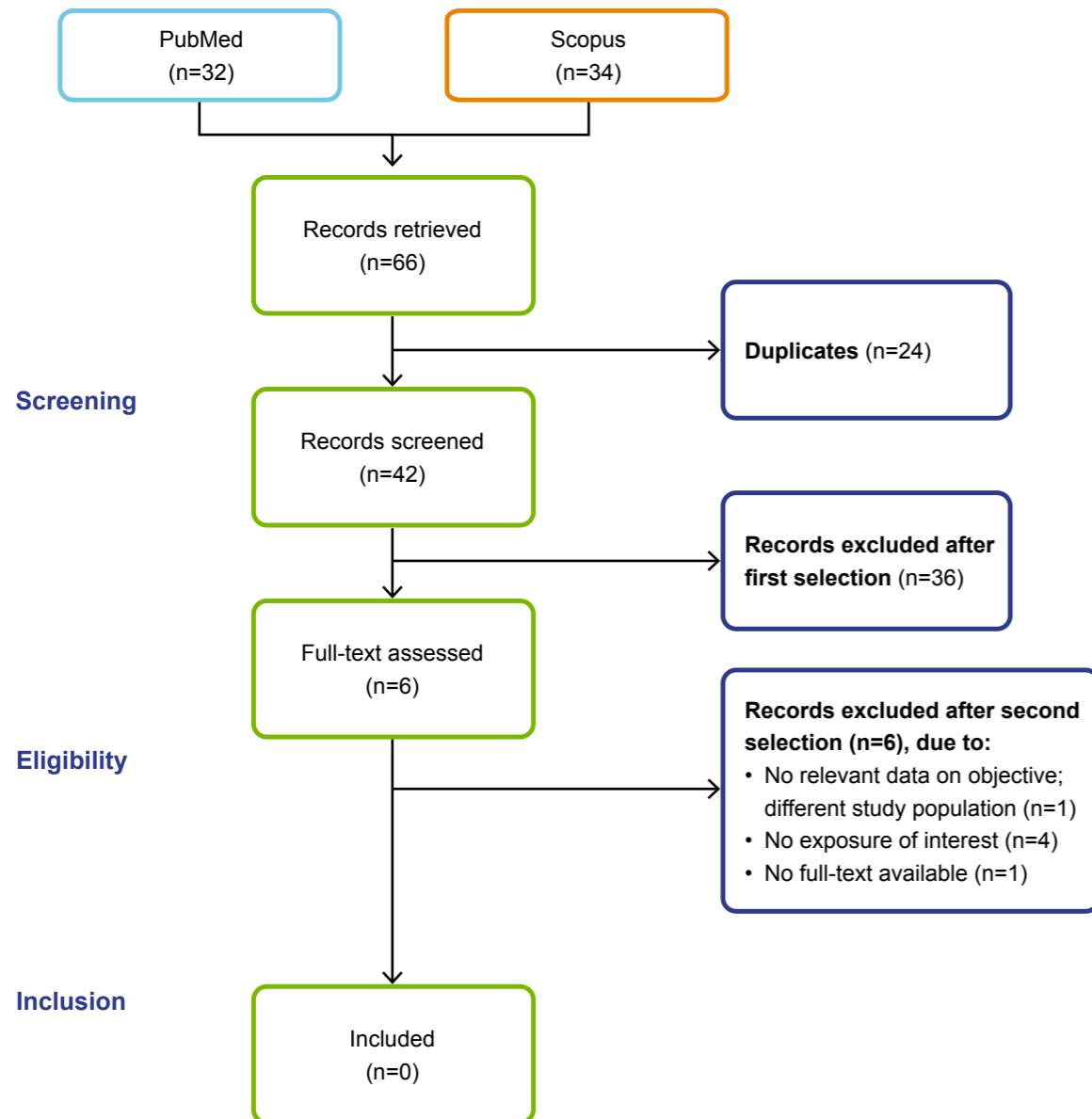
DM2: type 2 diabetes; SR: systematic review.



Flow diagrams for the selection of randomised controlled trials

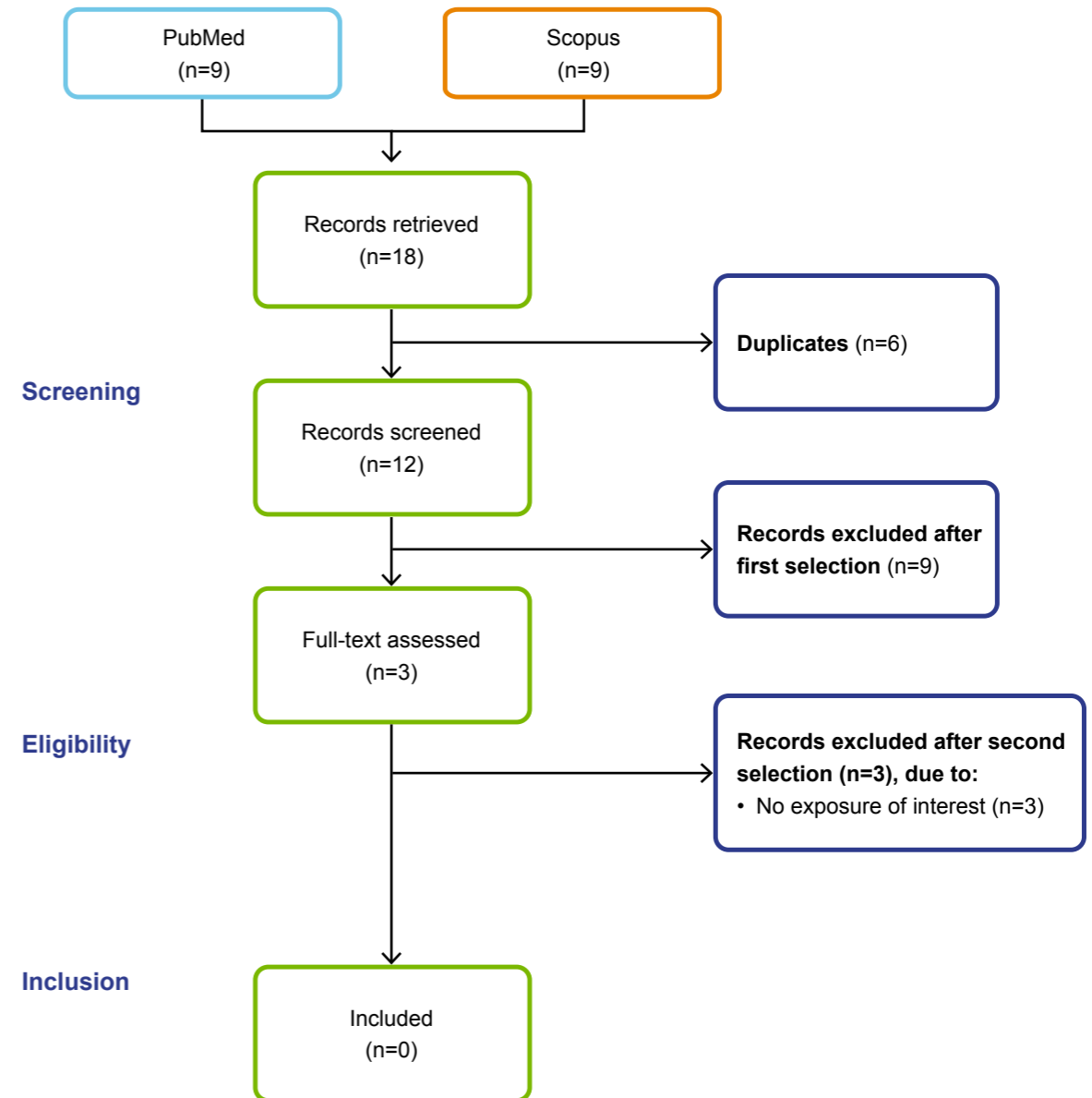
Oats and DM2 outcomes^a and body weight

Identification



Oats and blood lipids

Identification

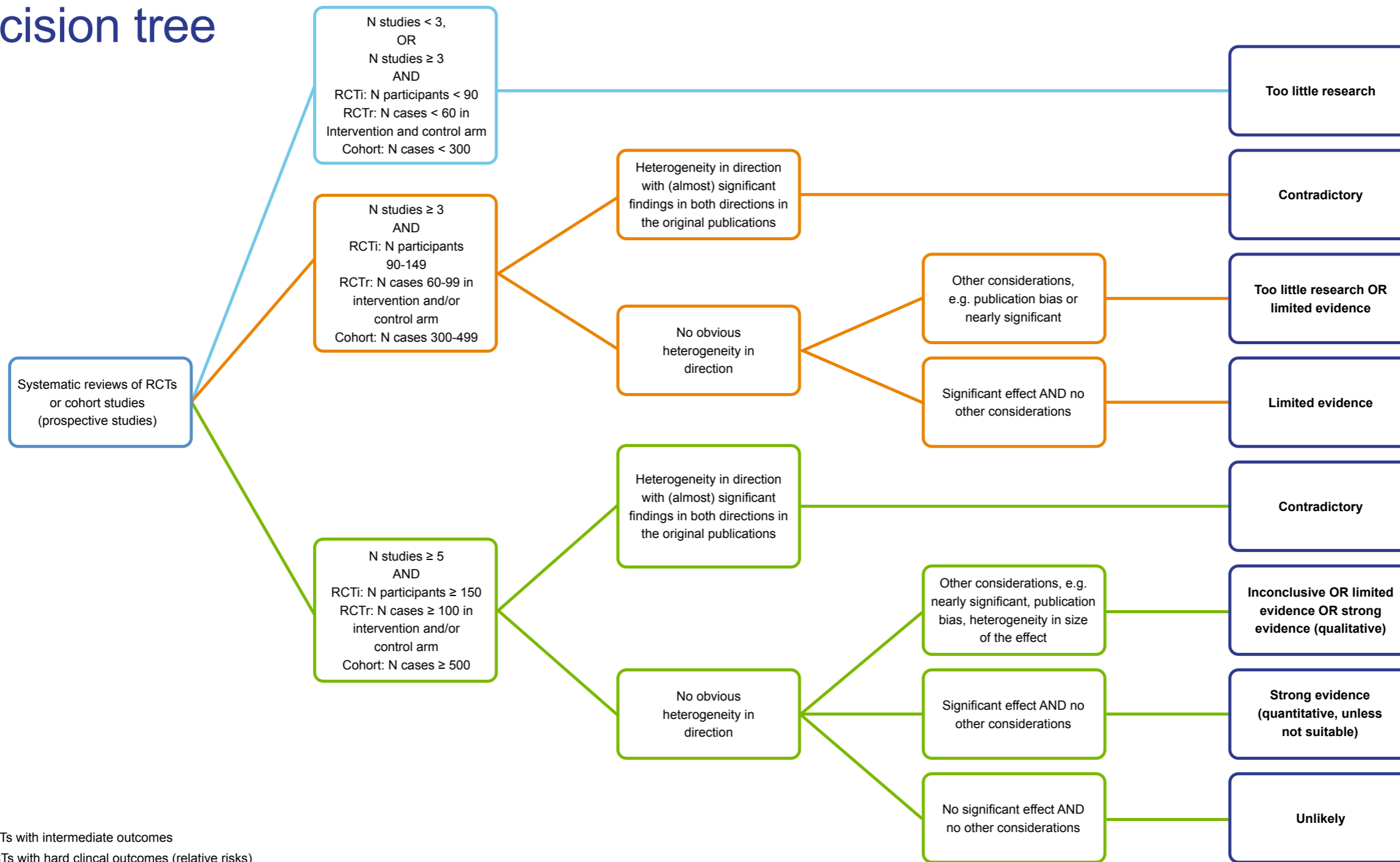


^a DM2 outcomes include: HbA1c, fasting blood glucose, glycaemia, fasting insulin, body weight and body mass index.



annex B

decision tree



RCTi: RCTs with intermediate outcomes
 RCTr: RCTs with hard clinical outcomes (relative risks)



annex C

funding sources and conflicts of interest regarding the article used in this background document

In the table below, the funding sources of the study listed in this background document and conflicts of interests of authors contributing to this study are reported.

Study's first author, year	Funding of the work	Conflicts of interest of authors
He, 2010 ⁹	The study was supported by the National Institutes of Health and the American Heart Association. The last author received a grant from the Boston Obesity Nutrition Research Center.	The authors declared to have no conflicts of interests.



The Health Council of the Netherlands, established in 1902, is an independent scientific advisory body. Its remit is “to advise the government and Parliament on the current level of knowledge with respect to public health issues and health (services) research...” (Section 22, Health Act).

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