Dairy products

No. 2021/41Ge, 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

contents

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 consumption of dairy products 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 Health Council's Committee on Nutrition.

1.1 Definition of dairy products

Dairy products include milk and food products made of milk, such as yoghurt and cheese.[2] Butter is excluded from the definition of dairy products (similar to the *Dutch dietary guidelines 2015*[3]), as it is included in the food group of fats and oils. Generally, a distinction is made between high-fat, semi-fat and low-fat dairy products (in Dutch: volle, halfvolle en magere zuivel). High-fat dairy products include relatively more fat than semi-fat and low-fat dairy products of the same dairy product type. The absolute amount of fat in whole milk is, however, lower than in high-fat cheese, due to the higher moisture content of milk. Within a dairy product type, the semi-fat and low-fat varieties contain similar amounts of protein, water-soluble vitamins and minerals but less fat-soluble vitamins compared to the high-fat varieties.

1.2 Dairy recommendations and intake in the Netherlands

The Health Council of the Netherlands included a guideline for the consumption of dairy products in the *Dutch dietary guidelines 2015*[3], which is as follows: Take a few portions of dairy products daily, including milk or yoghurt.

At the time, the Committee considered studies into high-fat, semi-fat and low-fat dairy products in addition to studies into total dairy products but judged that the evidence was too limited to determine whether the fat content of dairy products would matter in terms of optimal health. Thus, this guideline applies to total dairy. The guideline is applicable to the general Dutch adult population. The Council has not previously made specific dietary recommendations for people with type 2 diabetes.

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 321 (women) to 374 (men) grams of dairy products daily.[4] On average, milk is consumed most, followed by yoghurt and cheese.

02 methodology

2.1 Research question

The Committee aimed to answer the following question: what is the relationship (effect or association) of consumption of dairy products, and subtypes of dairy products, with health outcomes in people with type 2 diabetes?

The Committee aimed to distinguish between short-term and long-term effects or associations, as well as between low-fat, semi-fat and high-fat dairy products, where possible.

2.2 Nutritional topics

The Committee searched for studies into dairy consumption. Various subtypes of dairy products were distinguished in the *Dutch dietary guidelines 2015*[3]. Table 1 describes the used classification of dairy products.

Table 1 Classification of dairy products in the 2015 Dutch dietary guidelines and examples of high-fat, semi-fat and low-fat products.

Food product	High-fat varieties	Semi-fat and low-fat varieties
Milk	Whole milk, cream	Semi-skimmed and skimmed milk
Fermented dairy products	Full-fat yoghurt, full-fat quark, cheese	Semi-fat and low-fat yoghurt, semi-fat and low-fat quark, buttermilk, low-fat cheese, cottage cheese
Other food products	Ice-cream, whole chocolate milk, whole custard, whipped cream	Semi-skimmed and skimmed chocolate milk, semi-fat and low-fat custard

2.2.1 Probiotics and fermented dairy products

Probiotics are live microorganisms that, when administered in adequate amounts, confer a health benefit on the host.[5,6] In order to confer those health benefits, probiotic microorganisms must be capable of surviving passage through the digestive tract, and must be resistant to gastric juices and to exposure to bile. Two types or “genera” of probiotic microorganisms that are commonly used in probiotic foods are *Lactobacillus* and *Bifidobacterium*.[7] Yakult, Actimel and Activia are examples of probiotic dairy food products.[8] The Committee found several RCTs comparing a probiotic dairy product with a dairy product without (live) bacteria. The actual effect measured in those RCTs is the effect of probiotics, and not the effect of dairy per se. The Committee, therefore, disregarded those RCTs.

Fermented dairy products, such as “normal” yoghurt, quark and buttermilk, are dairy products that are produced through fermentation of milk with

living (lactic acid) bacteria. Those “normal” fermented dairy products fall outside the definition of probiotic dairy as the lactic acid bacteria do not survive passage of the stomach[8,9], and would thus be included in the Committee’s evaluation.

2.2.2 Camel milk

Camel milk is a type of dairy commonly consumed in desert areas of Africa and Asia but it is not (broadly) available in Dutch supermarkets. For a number of years now, more attention has been paid to camel milk because of presumed beneficial properties for health. Camel milk differs from most other milk sources in that it is more diluted, i.e. has a higher water content and lower solid content. From a nutritional perspective, in comparison to other milk sources, the fat in camel milk consists for a relative larger amount of polyunsaturated fatty acids. Camel milk generally also includes a higher level of vitamin C and vitamin B3, and a lower amount of vitamin A compared to other milk sources.[10-12]

2.3 Outcomes

The Committee selected the following health outcomes for this advisory report (for which a motivation is provided in the background document *Methodology for the evaluation of evidence*[13]):

Surrogate outcomes:

- Glycated haemoglobin (HbA1c);
- Fasting blood glucose;
- Body weight;
- Systolic blood pressure;
- Low-density lipoprotein (LDL) cholesterol;
- Estimated glomerular filtration rate (eGFR).

Long-term health outcomes:

- All-cause mortality;
- Morbidity and/or mortality from total cardiovascular disease (CVD), coronary heart disease (CHD), stroke, heart failure, chronic obstructive pulmonary disease, total cancer, breast cancer, colorectal cancer, lung cancer, dementia, depression, chronic kidney disease.

Other:

- Diabetes remission: HbA1c <48 mmol/mol and no use of diabetes medication for ≥1 year;
- Diabetes reversion: HbA1c <53 mmol/mol and less medication use for ≥1 year.

For 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 is provided in the back-ground document *Methodology for the evaluation of evidence*.[13] In short, the Committee aimed to base their evaluation of scientific literature on systematic reviews (SRs), including meta-analyses (MAs), of randomised controlled trials (RCTs) and/or prospective cohort studies (i.e. prospective cohort studies, nested case-control studies and case-cohort studies) examining the relationship of dairy consumption with the above-mentioned health outcomes in people with type 2 diabetes. In addition, the Committee searched for more recent individual studies that were not included in the most recent SR or MA. The Committee performed literature searches in PubMed and Scopus in February (SRs and MAs) and May (recent RCTs) 2021. The search strategies, flow diagrams of the literature searches and detailed descriptions of the study selection are provided in **Annex A**.

2.4.1 Selection of randomised controlled trials

The Committee detected two SRs of RCTs into the effect of dairy consumption on short-term surrogate outcomes, that specifically addressed the consumption of camel milk.[14,15] Only one relevant RCT[16] was retrieved from those SRs (Table 2). The additional literature search for recent individual RCTs on camel milk (published since 2016) yielded no relevant publications. The Committee furthermore identified one recent RCT that addressed the effect of increased (low-fat or high-fat) dairy consumption on surrogate outcomes.[17] No publications were available within the inclusion criteria of the Committee regarding the surrogate outcome eGFR, the long-term health outcomes, or diabetes remission and reversion.

Table 2 Overview of randomised controlled trials selected by the Committee for the evaluation of the effect of dairy consumption on health outcomes, grouped by subtype of dairy.

Health outcome[a]	RCTs on total dairy	RCTs on camel milk
HbA1c	Mitri et al., 2020[17]	None
Fasting blood glucose	Mitri et al., 2020[17]	Ejtahed er al., 2015[16]
Body weight	Mitri et al., 2020[17]	None
LDL cholesterol	Mitri et al., 2020[17]	Ejtahed er al., 2015[16]
Systolic blood pressure	Mitri et al., 2020[17]	Ejtahed er al., 2015[16]

HbA1c: glycated haemoglobin; LDL: low-density lipoprotein; MA: meta-analysis; RCT: randomised controlled trial

[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.

2.4.2 Selection of prospective cohort studies

The Committee found no SRs (or MAs) of prospective cohort studies on dairy consumption and long-term health outcomes in people with type 2 diabetes that met the eligibility criteria. Therefore, it searched for individual prospective cohort studies in existing external dietary guidelines for diabetes.[18-23] This yielded one relevant individual prospective cohort study.[24] Through searching the PubMed database for articles citing this study, one additional relevant publication was retrieved. This concerns a pooled analysis of prospective cohort studies.[25] Both studies examined the association with all-cause mortality (Table 3). The Committee did not find prospective cohort studies within the pre-specified in- and exclusion criteria for any of the specified chronic diseases, and diabetes remission or reversion.

Table 3 Overview of (pooled analyses of) prospective cohort studies selected by the Committee for the evaluation of the associations between dairy consumption and health outcomes in people with type 2 diabetes, grouped according to the type of dairy.

Dietary exposure	Health outcome[a]	Pooled analysis (of prospective cohort studies)	Individual prospective cohort studies
Total dairy	All-cause mortality	None	Trichopoulou et al., 2006[24]
Milk	All-cause mortality	Sluik et al., 2014[25]	None
Yoghurt	All-cause mortality	Sluik et al., 2014[25]	None
Cheese	All-cause mortality	Sluik et al., 2014[25]	None

[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

A detailed description of the approach used by the Committee to draw conclusions is provided in the background document *Methodology for the evaluation of evidence*.[13] In short, the Committee drew conclusions regarding the effects of increased total dairy consumption and increased camel milk consumption on surrogate outcomes in people with type 2 diabetes. It also drew conclusions regarding the associations of total dairy and types of dairy with the risk of all-cause mortality.

The Committee took into account the number of studies, number of participants and number of cases that contributed to the evaluation, as well as the heterogeneity between studies in order to judge about the certainty of the evidence. The decision tree **(Annex B)** was used as a tool to support consistency in drawing conclusions.

03 effects and associations of total dairy consumption

3.1 Evidence from randomised controlled trials

The Committee included only one RCT in its evaluation of the effect of total dairy consumption on health outcomes in people with type 2 diabetes. This RCT addressed five surrogate outcomes: HbA1c, fasting blood glucose, body weight, LDL cholesterol and systolic blood pressure. For the benefit of readability, the results for those outcomes are all described in one table (Table 4).

Table 4 Summary of the effects of increased total dairy consumption on HbA1c, fasting blood glucose, body weight, LDL cholesterol and systolic blood pressure in people with type 2 diabetes: individual randomised controlled trial.

Study; study duration	Mitri et al., 2020[17]; 24 weeks
Total number of participants (i/c)	111 (i1: 36, i2: 37, c: 38)[a]
Study design	Parallel
Diet of intervention (i) and control (c) group	i1: ≥3 servings/d of low-fat dairy (<2% of fat)[b] (advised) i2: ≥3 servings/d of high-fat dairy (≥2% of fat)[b] (advised) c: usual dietary intake (including <3 servings/d of dairy[c]) Isocaloric
Result	Absolute mean changes (95%CI) from baseline after 12 and 24 weeks **HbA1c (%)** i1: 12 wk: 0.31 (0.01, 0.6); 24 wk: 0.37 (-0.02, 0.77) i2: 12 wk: 0.25 (-0.05, 0.54); 24 wk: 0.23 (-1.16, 0.6) c: 12 wk: 0.1 (-0.19, 0.4); 24 wk: 0.02 (-0.34, 0.39) P for time*group interaction: 0.77
Result - *continued*	**Fasting blood glucose (mg/dL)** i1: 12 wk: 12 (-9, 33); 24 wk: -2 (-26, 22) i2: 12 wk: -3 (-24, 18); 24 wk: -15 (-38, 9) c: 12 wk: 3 (-18, 23); 24 wk: -13 (-36, 10) P for time*group interaction: 0.88 **Body weight (kg)** i1: 12 wk: 0.1 (-0.7, 0.8); 24 wk: -0.2 (-1, 0.6) i2: 12 wk: 0.6 (-0.1, 1.3); 24 wk: 1 (0.1, 1.8) c: 12 wk: 0.7 (0, 1.4); 24 wk: 0.7 (-0.1, 1.6) P for time*group interaction: 0.4 **LDL cholesterol (mg/dL)** i1: 12 wk: -1 (-8, 6); 24 wk: 5 (-7, 16) i2: 12 wk: -3 (-10, 3); 24 wk: 7 (-3, 18) c: 12 wk: 0 (-7, 7); 24 wk: 0 (-11, 10) P for time*group interaction: 0.68 **Systolic blood pressure (mmHg)** i1: 12 wk: -5 (-10, 1); 24 wk: -1 (-7, 5) i2: 12 wk: -1 (-7, 4); 24 wk: 1 (-5, 6) c: 12 wk: -2 (-7, 3); 24 wk: -5 (-10, 1) P for time*group interaction: 0.39
Study population	Adults diagnosed with type 2 diabetes and HbA1c >7%; BMI ≥25 kg/m^2; diabetes duration: 13 ± 8 y; diabetes medications: lifestyle only (2%), metformin (76%), sulfonylureas (36%), DPP-4 inhibitors (8%), TZDs (4%), SGLT-2 inhibitors (21%), insulin (40%), GLP-1 analogues (26%); men and women; USA

BMI: body mass index; c: control group; CI: confidence interval; DDP: dipeptidyl peptidase; GLP: glucagon-like-peptides; i: intervention group; LDL: low-density lipoprotein; MD: mean difference; NR: not reported; NS, not significant; RCT: randomised controlled trial; SGLT: sodium-glucose transport proteins; TZDs: thiazolidinediones, USA: United States of America, wk: week, y: years.

[a] For intention-to-treat analyses.

[b] Milk, yoghurt and cheese were counted as a serving of dairy. Butter, dairy-based desserts (e.g. ice cream), sour cream, cream cheese, cream and half-and-half (i.e. a mixture of milk and cream) did not count towards the advised 3 daily servings of dairy products.

[c] Participants consuming ≥3 servings of dairy daily were excluded from the study.

The Committee concluded the following:

There is too little research to draw conclusions regarding the effect of increased total dairy consumption on HbA1c, fasting blood glucose, body weight, LDL cholesterol and systolic blood pressure after 24 weeks 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 is only one RCT, with 111 participants, included in the evaluation. This number of RCTs is too small to draw any conclusions.

Explanation:

The Committee included one RCT, by Mitri et al.[17], in the evaluation of the effect of increased (total) dairy consumption on HbA1c, fasting blood glucose, body weight, LDL cholesterol and systolic blood pressure in people with type 2 diabetes. This RCT (n=111) showed no statistically significant difference in the mean change in any of those outcomes after daily consumption of at least 3 servings of low-fat dairy products (<2% fat; mean intake achieved: 3.0 ± 0.7 servings/d) or at least 3 servings of high-fat dairy products (≥2% fat; achieved: 3.0 ± 0.7 servings/d), compared to daily consumption of less than 3 servings of dairy products (achieved: 1.4 ± 0.8 servings/d), for 24 weeks. Milk, yoghurt and cheese were counted as a serving of dairy, whereas butter, dairy-based desserts, sour cream, cream cheese, cream and half-and-half (i.e. a mixture of milk and cream) were not. Participants in the intervention groups received nutritional counseling from a dietitian, amongst others in order to keep diets isocaloric (e.g. through substituting other foods with low-fat dairy products). It was shown that those in the low-fat group increased their protein intake while decreasing their fat intake, whereas those in the high-fat group increased their fat intake while decreasing their carbohydrate intake. The study was supported by the National Dairy Council.

3.2 Evidence from prospective cohort studies

The Committee included one prospective cohort study in its evaluation of the association between total dairy consumption and health outcomes in people with type 2 diabetes. This study addressed the outcome of all-cause mortality. The scientific evidence for the association between total dairy consumption and all-cause mortality in people with diabetes is described in Table 5.

Table 5 Summary of the association of total dairy consumption and the risk of all-cause mortality in people with type 2 diabetes: prospective cohort studies.

Study; study duration	Trichopoulou et al., 2006[24]; 5 years[a]
Study design	Individual cohort study
Cohort name	EPIC-Greece
Exposure	Dairy products
Dietary assessment method	Validated, interviewer-administrated FFQ
Number of participants; number of cases	1013 participants; All-cause mortality: 80
Strength of the association for all-cause mortality: HR (95%CI)	Total dairy, per 150 g/d higher intake: 1.02 (0.80-1.32)[b]
Study population	Participants with self-reported diabetes (type 1 or 2); BMI: <25 (13%), 25-30 (40%), ≥30 kg/m^2 (47%); diabetes duration: NR; diabetes medication: oral glucose-lowering medications only (80%), insulin only or insulin and other oral glucose-lowering medications (20%); men and women; Europe

BMI: body mass index; CI: confidence interval; EPIC: European Prospective Investigation into Cancer and Nutrition; FFQ: food frequency questionnaire; HR: hazard ratio; NR: not reported.

[a] Mean.

[b] Associations were adjusted for sex, age, education level, smoking, waist-to-height, hip circumference, physical activity, total energy intake, treatment with insulin, treatment for hypertension and treatment for hypercholesterolemia.

The Committee concluded the following:

There is too little research to draw conclusions regarding the association between total dairy consumption and 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 total dairy consumption with the risk of all-cause mortality. There is only one individual prospective cohort study that addresses this topic. That is too little evidence to base conclusions on.

Explanation

The Committee included one prospective cohort study, by Trichopoulou et al.[24], in the evaluation of total dairy consumption with the risk of all-cause mortality in people with type 2 diabetes. The study included 1030 participants with self-reported diabetes (either type 1 or 2 diabetes) and reported 80 cases of mortality during 5 years of follow-up.

Mean (± standard deviation) consumption of dairy products at baseline was 239 ± 149 g/d. Multivariable analyses showed no association between total dairy consumption and risk of all-cause 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 effects and associations of types of dairy

4.1 Evidence from randomised controlled trials

The Committee included one RCT in its evaluation of the effect of specific types of dairy products on health outcomes in people with type 2 diabetes. This RCT addressed the effect of camel milk consumption on three surrogate outcomes: fasting blood glucose, LDL cholesterol and systolic blood pressure. For the benefit of readability, the results for those outcomes are all described in one table (Table 6).

Table 6 Summary of the effects of increased camel milk consumption on fasting blood glucose, LDL cholesterol and systolic blood pressure in people with type 2 diabetes: individual randomised controlled trial.

Study; study duration	Ejtahed et al., 2015[16]; 2 months
Total number of participants (i/c)	20 (i: 11, c: 9) (completers)
Study design	Parallel
Type of intervention	i: 500 ml/d of camel milk c: 500 ml/d of cow milk Isocaloric
Result	Mean (± SD) post-intervention values: **Fasting blood glucose (mmol/L)** i: 9.44 ± 2.55 mmol/L c: 8.94 ± 3.22 mmol/L P >0.05[a] **LDL cholesterol** i: 2.67 ± 0.83 mmol/L c: 3.03 ± 0.83 mmol/L P >0.05[a] **Systolic blood pressure (mmHg)** i: 132 ± 20 mmHg c: 122 ± 19 mmHg P >0.05[a]
Study population	Adults with type 2 diabetes; BMI: i: 28 ± 5 kg/m^2, c: 31 ± 4 kg/m^2; diabetes duration: i: 8 ± 8 y, c: 6 ± 4 y; diabetes medication: oral hypoglycaemic agents (metformin and/or glibenclamide; n=18); men and women; Iran

BMI: body mass index; c: control group; CI: confidence interval; i: intervention group; LDL: low-density lipoprotein; MD: mean difference; NR: not reported; NS, not significant; RCT: randomised controlled trial; SD: standard deviation; y: years.

[a] P-value for between-group difference based on analyses of covariance adjusted for baseline.

The Committee concluded the following:

There is too little research to draw conclusions regarding the effect of increased consumption of camel milk, as compared with cow milk, on fasting blood glucose, LDL cholesterol and systolic blood pressure after 2 months 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 is only one RCT, with 20 participants, included in the evaluation.

This number of RCTs is too small to draw any conclusions.

Explanation:

The Committee included one (pilot) RCT, by Ejtahed et al.[16], in the evaluation of the effect of increased camel milk consumption on fasting blood glucose, LDL cholesterol and systolic blood pressure in people with type 2 diabetes. Participants included 20 men or women who used oral hypoglycaemic medication or were on a diet (but not a weight loss diet). Participants in the intervention group were instructed to consume 500 ml camel milk a day and those in the control group were instructed to consume 500 ml of cow milk a day. Both groups were asked to avoid consumption of any milk other than that provided. After two months, no statistically significant difference in the mean change in any of those outcomes was observed between the groups.

4.2 Evidence from prospective cohort studies

The Committee included one pooled analysis of prospective cohort studies in its evaluation of the associations of consumption of specific types of dairy products with health outcomes in people with type 2 diabetes. This study addressed milk consumption, yoghurt consumption and cheese consumption in relation to the risk of all-cause mortality. The scientific evidence for these associations is described in Table 7.

Table 7 Summary of the associations of milk consumption, yoghurt consumption and cheese consumption with the risk of all-cause mortality in people with type 2 diabetes: prospective cohort studies.

Study; study duration	Sluik et al., 2014[25]; 10 years[a]
Study design	Pooled analysis of 15 cohorts
Cohort name	EPIC
Exposure	Consumption of milk or milk products; yoghurt consumption; cheese consumption
Dietary assessment method	Self-administered, validated, country-specific dietary questionnaire at baseline, either quantitative dietary questionnaires, semi-quantitative FFQs, or combined dietary methods of food records and questionnaires
Number of participants; number of cases	6384 participants; All-cause mortality: 830
Strength of the association for all-cause mortality: HR (95%CI)	Milk consumption, per 50 g/d higher intake: 1.01 (0.99-1.04)[b] Yoghurt consumption, per 10 g/d higher intake: 1.01 (1.00-1.02)[b] Cheese consumption, per 10 g/d higher intake: 0.99 (0.94-1.05)[b]
Study population	Participants with a confirmed diagnosis of diabetes (type 1 or 2); BMI[c]: 29 ± 5 kg/m^2; diabetes duration: NR; diabetes medication: NR; men and women; Europe

BMI: body mass index; CI: confidence interval; d: day; EPIC: European Prospective Investigation into Cancer and Nutrition; FFQ: food frequency questionnaire; HR: hazard ratio; NR: not reported.

[a] Median.

[b] Associations were stratified by age and centre, and adjusted for sex, prevalence of heart disease, cancer or stroke, educational attainment, diabetes medication, and the following when there were no exposure variables: alcohol consumption, smoking behaviour, physical activity and underlying dietary patterns.

[c] Mean ± standard deviation.

The Committee concluded the following:

There is too little research to draw conclusions regarding the associations of milk consumption, yoghurt consumption or cheese 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:

1. There are no MAs of prospective cohort studies that address associations of milk consumption, yoghurt consumption or cheese consumption with the risk of all-cause mortality. There is one pooled analysis of 15 cohorts, with more than 500 cases, that addresses this topic. This is the first step required to mark the evidence as strong. However, there were other considerations leading to the conclusion of ‘too little research’, as described below.
2. The level of heterogeneity in the pooled analysis is unknown.
3. The pooled analysis shows no association for all three types of dairy products (i.e. milk, yoghurt and cheese). To conclude that an association is ‘unlikely’, the result of a pooled analysis should be supported by the result of another study. However, no additional study was available, and thus the Committee judged the evidence as limited, which impedes a conclusion of ‘unlikely’. Therefore, the Committee downgraded its conclusion and concluded that there is too little research.

Explanation

The Committee included one pooled analysis of 15 cohorts, by Sluik et al.[25], in the evaluation of associations of specific types of dairy products with the risk of all-cause mortality in people with type 2 diabetes. This study was conducted within the European Prospective Investigation into Cancer and Nutrition (EPIC) consortium, covering six European countries. Almost 6400 participants with confirmed diabetes (either type 1 or 2 diabetes) were included and 830 cases of mortality were reported during a median follow-up of 10 years. Median (interquartile range) intakes of milk, yoghurt and cheese at baseline were 137 (64-238), 31 (24-39) and 32 (3-71) g/d, respectively. Multivariable analyses showed no associations of milk consumption, yoghurt consumption or cheese consumption with the risk of all-cause mortality in people with diabetes.

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

05 summary of conclusions

The Committee's conclusions regarding relationships of the consumption of dairy products with health outcomes in people with type 2 diabetes are summarised in Table 8.

Table 8 Overview of conclusions regarding the relationship of increased dairy consumption with health outcomes in people with type 2 diabetes, based on randomised controlled trials and prospective cohort studies.

Dietary exposure	Type of studies	Health outcome[a]	Conclusion
Total dairy	RCT	HbA1c	Too little research
Total dairy	RCT	Fasting blood glucose	Too little research
Total dairy	RCT	Body weight	Too little research
Total dairy	RCT	LDL cholesterol	Too little research
Total dairy	RCT	Systolic blood pressure	Too little research
Total dairy	Prospective cohort studies	All-cause mortality	Too little research
Camel milk	RCT	Fasting blood glucose	Too little research
Camel milk	RCT	LDL cholesterol	Too little research
Camel milk	RCT	Systolic blood pressure	Too little research
Milk (total)	Prospective cohort studies	All-cause mortality	Too little research
Yoghurt (total)	Prospective cohort studies	All-cause mortality	Too little research
Cheese (total)	Prospective cohort studies	All-cause mortality	Too little research

HbA1c: glycated haemoglobin; LDL: low-density lipoprotein; RCT: randomised controlled trial.

[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.

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annex A
search strategy, study selection and flow diagrams

Systematic reviews including meta-analyses

The Committee performed a literature search to identify relevant SRs including MAs on the relationship of dairy consumption with health outcomes in people with type 2 diabetes. Literature searches were performed in PubMed and Scopus on 4th February 2021 using the following search strategies:

PubMed

("diabetes mellitus, type 2"[MeSH] OR Diabet*[tiab] OR T2DM[tiab] OR NIDDM[tiab]) AND ("dairy products"[MeSH Terms] OR dairy[tiab] OR milk*[tiab] OR "Yogurt"[Mesh] OR yogurt[tiab] OR yoghurt[tiab] OR cheese*[tiab] OR butter[tiab] OR buttermilk[tiab] OR cream[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

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("dairy products") OR TITLE-ABS(dairy) OR TITLE-ABS(milk*) OR TITLE-ABS(yogurt) OR TITLE-ABS(yoghurt) OR TITLE-ABS(cheese*) OR TITLE-ABS(butter) OR TITLE-ABS(buttermilk) OR TITLE-ABS(cream)) AND (TITLE-ABS-KEY ("Systematic review") OR TITLE-ABS-KEY ("Meta-analysis") OR TITLE-ABS (review) OR TITLE-ABS (meta-analysis) OR TITLE-ABS (metaanalysis) 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

In total, 428 publications were found in PubMed and 607 publications in Scopus, including 359 duplicates. Via hand-searching of reference lists, three additional publications were identified, leading to a total of 679 publications which were screened for title and abstract. A total of 130 publications remained for full-text assessment, of which 5 publications were included.

The Committee selected the following SRs for the evaluation of dairy consumption. Three of those focused on probiotic yoghurt:

- Ejtahed et al., 2020[26]
- He et al., 2017[27]
- Hendijani et al., 2019[28]

Two of those focused on camel milk:

- Mihic et al., 2016[14]
- Mirmiran et al., 2017[15]

Probiotic yoghurt

The Committee found the umbrella review of SRs by Ejtahed et al. (2020)[26], which refers to two SRs of RCTs addressing the effect of probiotic yoghurt consumption on surrogate outcomes in people with type 2 diabetes: He et al. (2017)[27] and Hendijani et al. (2018).[28] No relevant RCTs were retrieved from those SRs.

Camel milk

The Committee found two SRs addressing the effect of camel milk consumption on surrogate outcomes in persons with type 2 diabetes.[14,15] One relevant RCT was retrieved from those SRs: Ejtahed et al. (2015).[16] This RCT addressed the outcomes of fasting blood glucose, LDL cholesterol and systolic blood pressure.

Recent individual randomised controlled trials

The Committee performed one additional literature search to identify relevant individual RCTs that were published after the inclusion date of the retrieved SR. Specifically, the Committee searched for RCTs into camel milk consumption in relation to fasting blood glucose, LDL cholesterol and blood pressure (published since 2016) in people with type 2 diabetes. Only the selected outcomes were considered since the Committee focuses only on the health outcomes that were already covered in the selected SR. The literature search was performed on 18th May 2021 in PubMed and Scopus using the following search strategy:

Camel milk and fasting blood glucose, LDL cholesterol and blood pressure

PubMed

(“diabetes mellitus, type 2”[MeSH] OR Diabet*[TIAB] OR T2DM[TIAB] OR NIDDM[TIAB]) AND (camel milk[TIAB] OR camel’s milk[TIAB] OR (camel[TIAB] AND dairy[TIAB])) AND (glucose[tiab] OR glycemic control[tiab] OR glycaemic control[tiab] OR glycemia[tiab] OR glycaemia[tiab] OR “Cholesterol”[Mesh] OR cholesterol[tiab] OR LDL[tiab] OR (blood[tiab] AND (“lipids”[MeSH] OR lipid*[tiab])) OR “Blood Pressure”[Mesh] OR blood pressure[tiab] OR Diastolic Pressure[tiab] OR Systolic Pressure[tiab] OR pulse pressure[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 2016

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(Camel milk) OR TITLE-ABS-KEY (camel’s milk) OR TITLE-ABS-KEY (camel) AND TITLE-ABS-KEY (dairy)) AND (TITLE-ABS-KEY(glucose) OR TITLE-ABS-KEY(“glycemic control”) OR TITLE-ABS-KEY(“glycaemic control”) OR TITLE-ABS-KEY(glycemia) OR TITLE-ABS-KEY(glycaemia) TITLE-ABS-KEY(cholesterol) OR TITLE-ABS-KEY(ldl) OR TITLE-ABS-KEY(hdl) OR TITLE-ABS-KEY (“blood lipids”) OR TITLE-ABS-KEY(“blood Pressure”) OR TITLE-ABS-KEY(“diastolic Pressure”) OR TITLE-ABS-KEY(“systolic Pressure”) OR TITLE-ABS-KEY(“pulse pressure”)) AND (TITLE-ABS-KEY (“clinical trial”) OR TITLE-ABS-KEY (“cross-over studies”) OR TITLE-ABS-KEY (“double-blind method”) OR TITLE-ABS-KEY (“single-blind method”) OR TITLE-ABS-KEY (“controlled before-after studies”) OR TITLE-ABS-KEY (“historically controlled study”) OR TITLE-ABS (randomized) OR TITLE-ABS (randomised) OR TITLE-ABS (rct) OR TITLE-ABS (controlled*) OR TITLE-ABS (placebo) OR TITLE-ABS (“clinical trial”) OR TITLE-ABS (trial) OR TITLE-ABS(intervention))

Limit: from 2016

In total, 3 publications were found in PubMed and 0 publications in Scopus, who were screened for title and abstract. None were considered relevant.

Total dairy
The Committee found one relevant recent RCT via the dietary guidelines for diabetes of the Dutch Diabetes Federation: the RCT by Mitri et al. (2020).[17]

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 dairy consumption with health outcomes in people with type 2 diabetes in the retrieved SR and in external dietary guidelines for diabetes of the following organizations:

- Dutch Diabetes Federation (Nederlandse Diabetes Federatie (NDF)), 2020[18];
- European Association for the Study of Diabetes (EASD) & European Society of Cardiology (ESC), 2020[19];
- American Diabetes Association (ADA), 2019[20];
- Diabetes UK, 2018[21];
- Diabetes Canada, 2018[22];
- Swedish Council, 2010.[23]

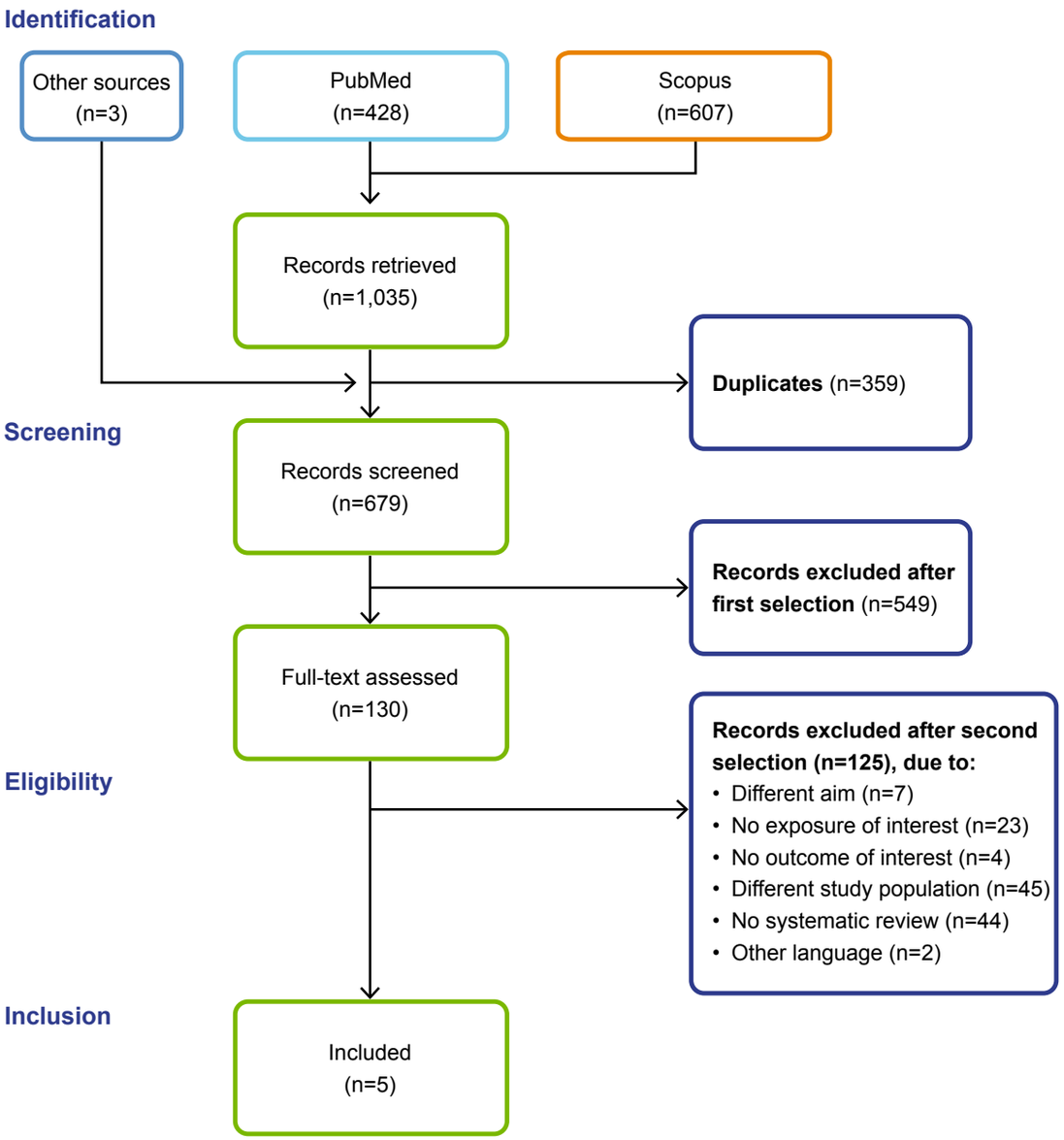
One prospective cohort study[24] was retrieved via the dietary guidelines of the Swedish Council.[23] Articles citing this study were searched in PubMed. This yielded one additional relevant (pooled analysis of) prospective cohort studies.[25]

The Committee selected the following prospective cohort studies for its evaluation of consumption of dairy products:

- Sluik et al., 2014[25] (pooled analysis of prospective cohort studies);
- Trichopoulou et al., 2006.[24]

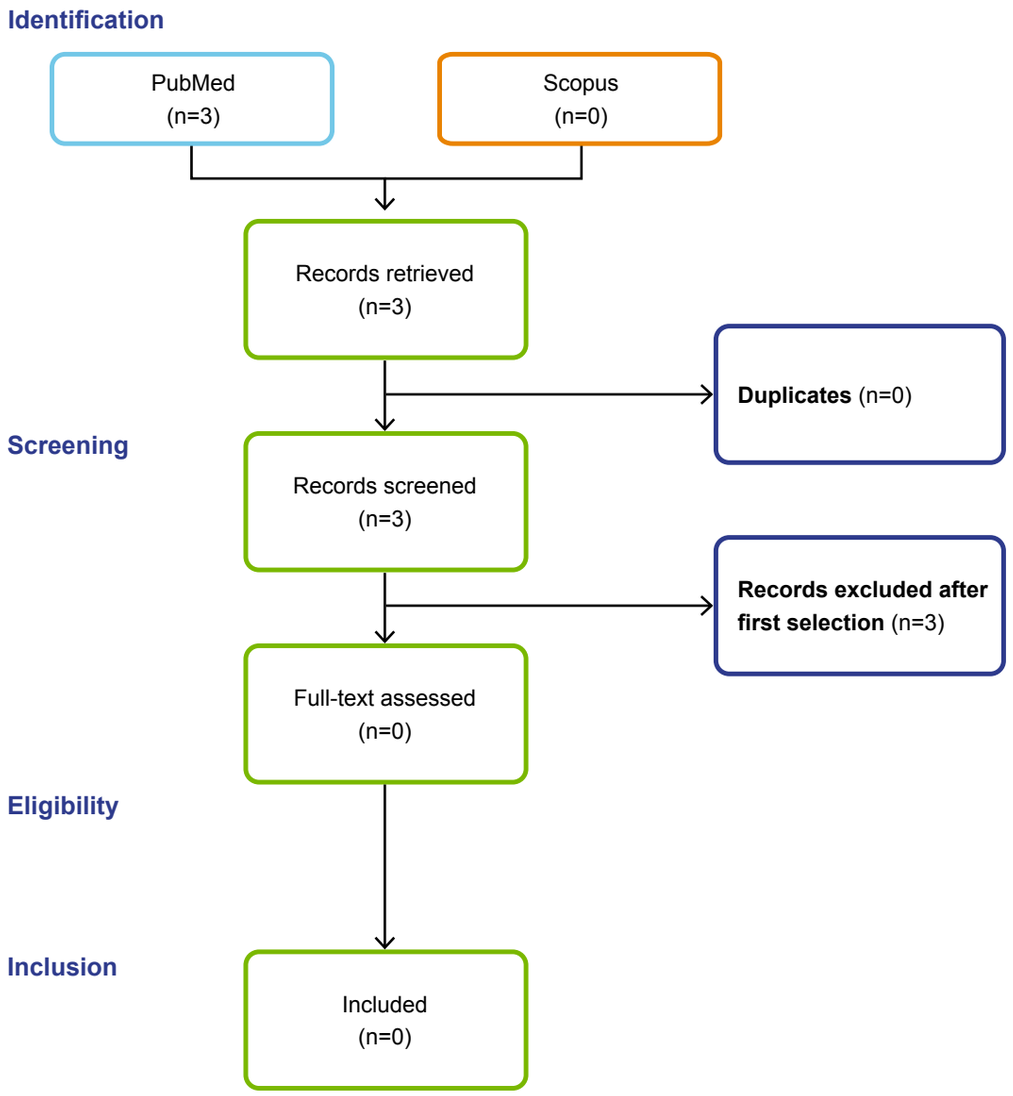
Flow diagram for the selection of systematic reviews including meta-analyses

Dairy



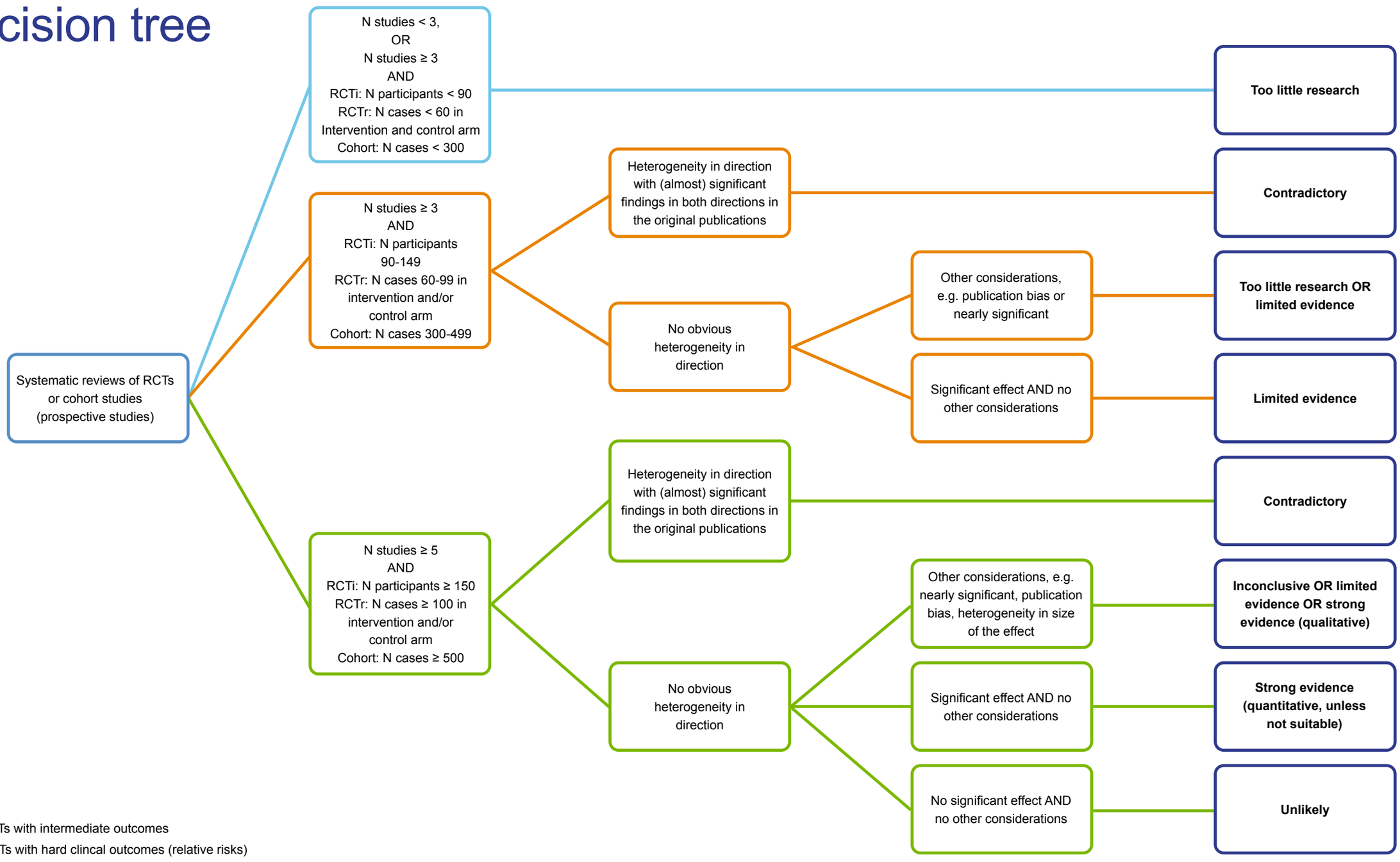
Flow diagram for the selection of recent individual randomised controlled trials

Camel milk and fasting blood glucose, LDL cholesterol or blood pressure



annex B

decision tree



RCTi: RCTs with intermediate outcomes

RCTr: RCTs with hard clincal outcomes (relative risks)

annex C

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

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

Study's first author, year	Funding of the work	Conflicts of interest of authors
Ejtahed, 2015[16]	The study was funded by the Research Institute for Endocrine Sciences of the Shahid Beheshti University of Medical Sciences.	
Mitri, 2020[17]	The study was supported by the National Dairy Council and the NIH/National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK).	One author declared to consult for Novo Nordisk, to receiving support from the National Dairy Council, KOWA Inc., the NIH and the Juvenile Diabetes Research Foundation (JDRF), and to have spoken on dietary patterns for local Dairy Councils. Another author declared to receiving support from the National Dairy Council, to consult for Merck, Sanofi-Aventis and Abbott Nutrition, to be on the advisory board of Astra Zeneca and to be shareholder of Healthimation.
Sluik, 2014[25]	The study was supported by a European Foundation for the Study of Diabetes (EFSD)/Sanofi-Aventis grant.	The authors declared to have no conflicts of interests.
Trichopoulou, 2006[24]	This study was supported by the European Commission, the Greek Ministries of Health and Education and the University of Athens.	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).
The Health Council receives most requests for advice from the Ministers of Health, Welfare and Sport, Infrastructure and Water Management, Social Affairs and Employment, and Agriculture, Nature and Food Quality. The Council can publish advisory reports on its own initiative. It usually does this in order to ask attention for developments or trends that are thought to be relevant to government policy.
Most Health Council reports are prepared by multidisciplinary committees of Dutch or, sometimes, foreign experts, appointed in a personal capacity.
The reports are available to the public.

This publication can be downloaded from www.healthcouncil.nl.

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