eSupplement

Neubewertung der DGE-Position zu veganer Ernährung

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Content

eSupplement to the article:
Klug A, Barbaresko J, Alexy U, et al. on behalf of the German Nutrition Society (DGE): Update of the DGE position on vegan diet – Position statement of the German Nutrition Society (DGE). Ernahrungs Umschau 2024; 71(7): 60–84. DOI 10.4455/eu.2024.22

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Table e1: Detailed search strategies for the umbrella review on vegan diet for all databases (according to (1))

PubMed			**Results**
#1	Vegan diet	Diet, Vegan [MeSH] OR Vegans [MeSH] OR Diet, Vegetarian [MeSH] OR vegan* OR (plant-based AND (diet OR diets OR dietary OR nutrition)) OR (“plant based” AND (diet OR diets OR dietary OR nutrition))	8,568
#2	Study design	Systematic Review [Publication Type] OR "systematic review" OR “systematic reviews” OR Meta-Analysis [Publication Type] OR meta-analysis OR meta-analyses	447,997
#3	#1 AND #2		333
Web of Science			
#1	Vegan diet	(vegan* OR (plant-based AND (diet OR diets OR dietary OR nutrition)) OR (“plant based” AND (diet OR diets OR dietary OR nutrition)))	8,864
#2	Study design	"Systematic review" OR Meta-Analysis OR “systematic reviews” OR meta-analyses	472,239
#3	#1 AND #2		303
Epistemonikos			
#1	Vegan diet	Vegan* OR (plant-based AND (diet OR diets OR dietary OR nutrition)) OR (“plant based” AND (diet OR diets OR dietary OR nutrition))	1,105
#2	Study design	"Systematic review" OR meta-analysis OR “systematic reviews” OR meta-analyses	413,645
#3	#1 AND #2		166
Cochrane library			
#1	Vegan diet	Vegan* OR (“plant-based AND (diet OR diets OR dietary OR nutrition)) OR (“plant based AND (diet OR diets OR dietary OR nutrition)) OR (MeSH descriptor: [Diet, Vegan] explore all trees) OR (MeSH descriptor: [Vegans] in all MeSH products) OR (MeSH descriptor: [Diet, Vegetarian] explore all trees)	985
#2	Study design	"systematic review" OR "systematic reviews" OR “meta-analysis” OR “meta-analyses” OR (“systematic review”):pt OR (“meta analysis”):pt	35,496
#3	#1 AND #2		51

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Table e2: Detailed search strategies for the systematic review on vegan diet in vulnerable groups for all databases

PubMed			**Results**
#1	Vegan diet	Diet, Vegan [MeSH] OR Vegans [MeSH] OR vegan* OR (plant-based AND (diet OR diets OR dietary OR nutrition)) OR ("plant based" AND (diet OR diets OR dietary OR nutrition))	6,379
#2	Elderly	Aged [tiab] OR geriatric* [tiab] OR geriatrics [MesH] OR elder* [tiab] OR old [tiab] OR older [tiab] OR ageing [tiab] OR aging [MesH] OR "frail elderly" [MesH]	2,656,661
#3	Pregnancy and breast feeding	Pregnan* [tiab] OR Pregnancy [MeSH] OR "Pregnant Women" [MeSH] OR gestation* [tiab] OR "breast feeding" [tiab] OR "breastfeeding" [tiab] OR "Milk, Human" [MeSH] OR "breast feeding" [MeSH] OR lactation [tiab] OR lactation [MeSH]	1,268,919
#4	Study design	Review [Publication Type] OR Systematic Review [Publication Type]	3,269,031
#5	(#1 AND (#2 OR #3)) NOT #4		948
#6	#5 AND (2020:2023[pdat])		495
Web of Science			
#1	Vegan diet	(vegan* OR (plant-based AND (diet OR diets OR dietary OR nutrition)) OR ("plant based" AND (diet OR diets OR dietary OR nutrition)))	8,241
#2	Elderly	Aged OR geriatric* OR geriatrics OR elder* OR old* OR ageing OR aging OR "frail elderly"	5,120,664
#3	Pregnancy and breast feeding	Pregnan* OR Pregnancy OR "Pregnant Women" OR gestation* OR "breast feeding" OR "breastfeeding" OR lactation	233,300
#4	Study design	DT=("review")	na
#5	(#1 AND (#2 OR #3)) NOT #4		1,645
#6	#5 AND (2020 or 2021 or 2022 or 2023 (Publication Years))		862
Epistemonikos			
#1	Vegan diet	Vegan* OR (plant-based AND (diet OR diets OR dietary OR nutrition)) OR ("plant based" AND (diet OR diets OR dietary OR nutrition))	828
#2	Elderly	Aged OR geriatric* OR geriatrics OR elder* OR old* OR ageing OR aging OR "frail elderly"	340,218
#3	Pregnancy and breast feeding	Pregnan* OR Pregnancy OR "Pregnant Women" OR gestation* OR "breast feeding" OR "breastfeeding" OR lactation	136,149
#4	Study design	title:("systematic review" OR "meta-analysis" OR "systematic reviews" OR "meta-analyses")	349,085
#5	(#1 AND (#2 OR #3)) NOT #4		140

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#6	#5 AND 2020-2023		56

Cochrane library			
#1	Vegan diet	Vegan* OR (“plant-based AND (diet OR diets OR dietary OR nutrition)) OR (“plant based AND (diet OR diets OR dietary OR nutrition)) OR (MeSH descriptor: [Diet, Vegan] explore all trees) OR (MeSH descriptor: [Vegans] in all MeSH products) OR (MeSH descriptor: [Diet, Vegetarian] explore all trees)	848
#2	Elderly	Aged OR geriatric* OR geriatrics OR elder* OR old* OR ageing OR aging OR “frail elderly” OR (MeSH descriptor: [Aging] explode all trees) OR (MeSH descriptor: [Frail Elderly] explode all trees)	706,252
#3	Pregnancy and breast feeding	Pregnan* OR Pregnancy OR “Pregnant Women” OR gestation* OR “breast feeding” OR “breastfeeding” OR (MeSH descriptor: [Breast Feeding] explode all trees) OR lactation OR (MeSH descriptor: [Lactates] explode all trees)	3,539
#4	Study design	(MeSH descriptor: [Systematic Review] explode all trees) OR (MeSH descriptor: [Meta-Analysis] explode all trees)	426
#5	(#1 AND (#2 OR #3)) NOT #4		na
#6	#5 AND 2020-2023		186

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Table e3: PICOS for the umbrella review on vegan diet

	Inclusion criteria	Exclusion criteria
Population	All age groups, general populations	High risk populations (such as people with obesity and/or diabetes mellitus)
Intervention	Vegan diet	Non-vegan diets including consumption of animal foods
Comparison	Omnivores or other non-vegan diets	-
Outcome	Nutrient profiles, nutrition-related diseases	Other diseases not primarily related to nutrition (e.g. pain, depression)
Study design	Systematic reviews with and without meta-analyses	Non-systematic reviews, primary studies, conference abstracts, comments, letters, editorials

Table e4: PICOS for the systematic review on vegan diet in vulnerable groups

	Inclusion criteria	Exclusion criteria
Population	Elderly (≥60 years), Pregnant and breast feeding women	Children, adolescents, adults aged <60 years
Intervention	Vegan diet	Non-vegan diets including consumption of animal foods
Comparison	Omnivores or other non-vegan diets	-
Outcome	Nutrient profiles, nutrition-related diseases	Other diseases not primarily related to nutrition (e.g. pain, depression)
Study design	Primary studies (interventional and observational studies)	Reviews, conference abstracts, comments, editorials

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Figure e1: PRISMA flow chart for the umbrella review on vegan diet

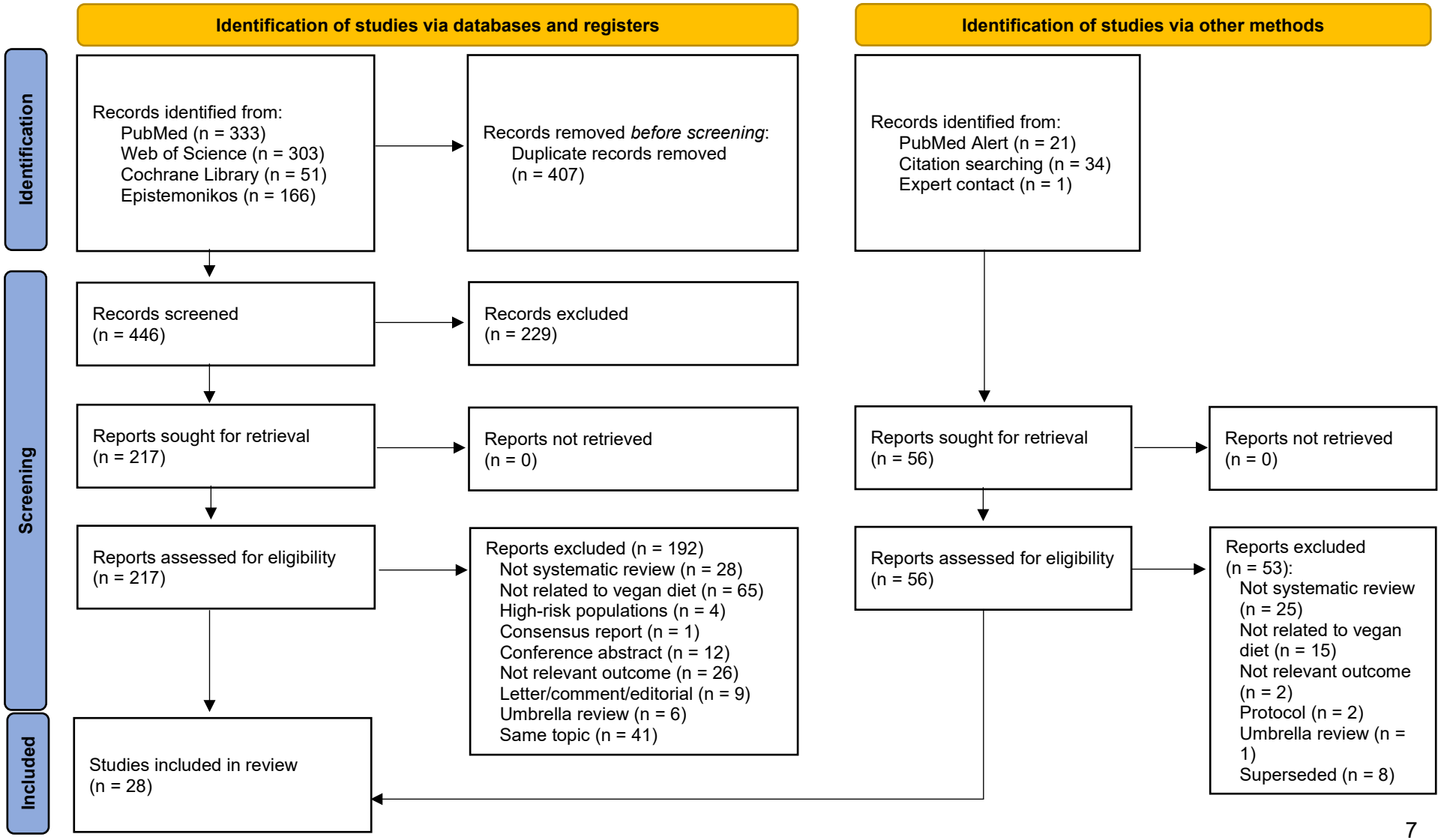

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Table e5: List of excluded studies with reasons (umbrella review)

Exclusion reason	**References**
Not systematic review	(2-29)
Not related to vegan diet	(30-94)
High-risk populations	(95-98)
Consensus report	(99)
Conference abstract	(100-111)
Not relevant outcome	(112-137)
Letter/comment/editorial	(138-146)
Umbrella review	(1, 147-151)
Same topic	(152-192)

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Figure e2: PRISMA flow chart for the systematic review on vegan diet in vulnerable groups

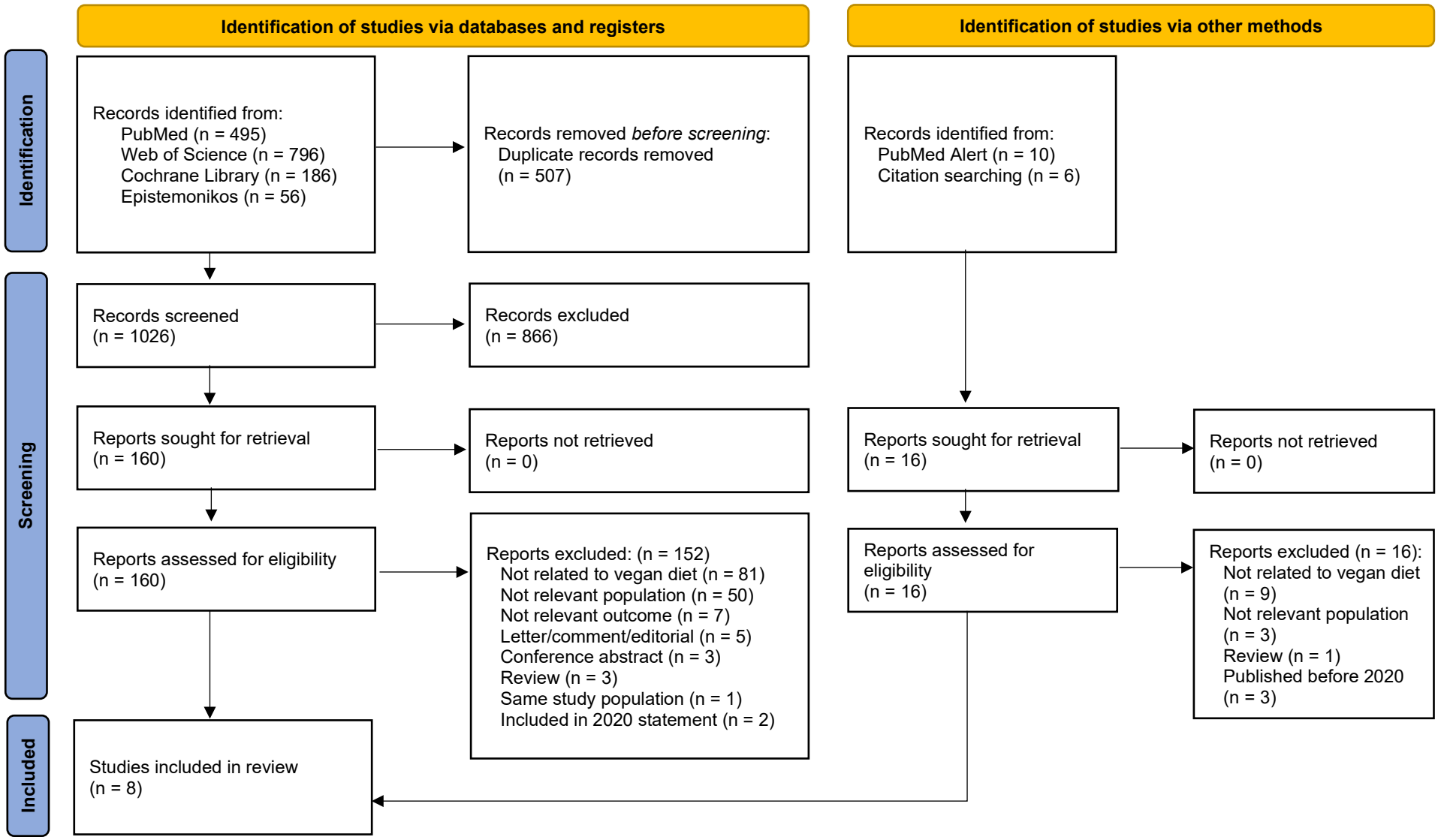

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Table e6: List of excluded studies with reasons (systematic review on vulnerable groups)

Exclusion reason	**References**
Not related to vegan diet	(193-273)
Not relevant population	(274-323)
Not relevant outcome	(324-330)
Letter/comment/editorial	(331-335)
Conference abstract	(336-338)
Review	(339-341)
Same study population	(342)
Included in 2020 statement	(343, 344)

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Table e7: Characteristics of the included systematic reviews with meta-analyses on vegan diet with regard to nutritional status and dietary intake in general populations (modified according to (1))

Outcome (unit)	Reference	No. of primary studies	Study type of primary studies	Comparison	No. of participants	Summary effect (95% CI)	I^2	Certainty of evidence[1]
Energy and nutrients								
Total energy (MJ/d)	Benatar 2018 (345)	17	Cross-sectional studies	Omnivore diet	131,664	MD: -0.94 (-1.28, -0.59)	97%	⊕◯◯◯ VERY LOW
Protein (g/d)	Benatar 2018 (345)	13	Cross-sectional studies	Omnivore diet	90,621	MD: -22.32 (-27.84, -16.80)	97%	⊕◯◯◯ VERY LOW
Total fat (g/d)	Benatar 2018 (345)	16	Cross-sectional studies	Omnivore diet	90,757	MD: -16.40 (-22.45, -10.35)	97%	⊕◯◯◯ VERY LOW[1]
Saturated fatty acids (g/d)	Benatar 2018 (345)	13	Cross-sectional studies	Omnivore diet	90,599	MD: -15.92 (-19.90, -11.94)	98%	⊕◯◯◯ VERY LOW
Monounsaturated fatty acids (g/d)	Benatar 2018 (345)	9	Cross-sectional studies	Omnivore diet	55,535	MD: -6.29 (-10.27, -2.31)	92%	⊕◯◯◯ VERY LOW
Polyunsaturated fatty acids (g/d)	Benatar 2018 (345)	13	Cross-sectional studies	Omnivore diet	61,390	MD: 3.60 (1.50, 5.69)	90%	⊕◯◯◯ VERY LOW
Carbohydrates (g/d)	Benatar 2018 (345)	13	Cross-sectional studies	Omnivore diet	65,170	MD: 25.60 (9.64, 41.56)	97%	⊕◯◯◯ VERY LOW
Calcium intake	Bickelmann 2022 (346)	21	Cross-sectional studies	Omnivore diet	64,804	SMD: -0.70 (-0.85, -0.55)	89%	⊕◯◯◯ VERY LOW
Calcium intake	Bickelmann 2022 (346)	12	Cross-sectional studies	Vegetarian diet	36,324	SMD: -0.57 (-0.83, -0.32)	95%	⊕◯◯◯ VERY LOW
Iodine (µg/day)	Eveleigh 2023 (347)	6	Cross-sectional studies	Omnivore diet	1,995	MD: -62.30 (-93.88, -30.73)	89%	⊕◯◯◯ VERY LOW
Iodine, urine (µg/L)	Eveleigh 2023 (347)	4	Cross-sectional studies	Omnivore diet	333	MD: -46.52 (-94.08, 1.04)	97%	⊕◯◯◯ VERY LOW
Zinc (mg/d)	Foster 2013 (348)	8	Cross-sectional studies	Omnivore diet	36,791	MD: -1.16 (-2.16, -0.16)	93%	⊕◯◯◯ VERY LOW

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Zinc, serum (µmol/L)	Foster 2013 (348)	4	Cross-sectional studies	Omnivore diet	259	MD: -1.06 (-2.09, -0.03)	94%	⊕◯◯◯ VERY LOW
Vitamin B12, serum (pmol/L)	Obersby 2013 (349)	9	Cross-sectional studies	Omnivore and vegetarian diet	1,018	Mean vegans: 172 (SD: 59) Mean vegetarians: 209 (SD: 47) Mean omnivores: 303 (SD: 72)	NA	⊕◯◯◯ VERY LOW

CI, confidence interval; MD, mean difference; SD, standard deviation; SMD, standardized mean difference

[1] Certainty of evidence was evaluated by the GRADE approach

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Table e8: Characteristics of the included systematic reviews on vegan diet with regard to nutritional status and dietary intake in general populations

Outcome	Reference	No. of primary studies	Study type of primary studies	Comparison	Results[1]	Certainty of evidence
n-3 fatty acid intake	Neufingerl 2022 (350)	8	Cross-sectional data	Omnivore and vegetarian diet	Across all studies, mean intake of total n-3 fatty acids tended to be higher in vegans (2.69 g/d) compared to vegetarians (1.36 g/d) and omnivores (1.08 g/d). The higher intake of n-3 fatty acids in plant-based dietary patterns was mainly due to higher intakes of ALA in vegans (2.01 g/d) compared to vegetarians (1.78 g/d) and omnivores (1.38 g/d). Intakes of EPA and DHA were considerably lower in vegans (27 and 4 mg/d) and vegetarians (16 and 31 mg/d) compared to omnivores (94 and 172 mg/d). While mean intake of ALA was above the AI for vegetarians and vegans, average combined intakes of EPA and DHA were below the lower AMDR (i.e., 250 mg/d).	⊕◯◯◯ VERY LOW[2]
PUFA status	Neufingerl 2022 (350)	5	Cross-sectional data	Omnivore and vegetarian diet	Most studies showed significantly higher PUFA status in vegans (3/5 studies) and vegetarians (3/3 studies) compared to omnivores. For ALA status, there was a higher status in vegans (4/9 studies) and vegetarians (3/8 studies) compared to omnivores. Most studies reported lower EPA and DHA status in vegans (7/8 and 8/9 studies) and vegetarians (5/7 and 7/7 studies) compared to omnivores. Vegans also mostly had lower EPA and DHA status than vegetarians (5/6 and 5/6 studies).	⊕◯◯◯ VERY LOW[2]
Fiber intake	Neufingerl 2022 (350)	19	Cross-sectional data	Omnivore and vegetarian diet	Across all studies, average fiber intake was highest in vegans (44 g/d), followed by vegetarians (28 g/d) and lowest in omnivores (21 g/d). The average fiber intake of vegans met the AI, while for omnivores it was below the AI. Looking at individual studies, 74 % (14/19 studies) reported fiber intakes of vegans met the AI compared to 29 % (10/35 studies) in vegetarians and 6 % (2/33 studies) in omnivores.	⊕◯◯◯ VERY LOW[2]
Vitamin A intake	Neufingerl 2022 (350)	11	Cross-sectional data	Omnivore and vegetarian diet	Across all studies, average vitamin A intake was similar across vegans, vegetarians and omnivores. Vitamin A intakes were well above the EAR (i.e., 500/625 µg RE for women/men). Only two studies (both considering intake from foods only) reported vitamin A intake below the EAR in omnivores in the US and vegans in the UK.	⊕◯◯◯ VERY LOW[2]
Vitamin A status	Neufingerl 2022 (350)	2	Cross-sectional data	Omnivore and vegetarian diet	Average beta-carotene-status tended to be higher in vegans (0.8 µmol/L) compared to vegetarians (0.4 µmol/L) and similar to omnivores (0.8 µmol/L). Vitamin A status based on serum/plasma retinol levels, was similar across all dietary patterns (2.5/2.2/2.1 µmol/L in respectively meat-eaters, vegetarians, and vegans). Status data were well above the cut-off for vitamin A deficiency (i.e., retinol < 0.7 µmol/L).	⊕◯◯◯ VERY LOW[2]

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Vitamin B1 intake	Neufingerl 2022 (350)	11	Cross-sectional data	Omnivore and vegetarian diet	Vegans tended to have a higher average vitamin B1 intake (1.97 mg/d) than vegetarians (1.47 mg/d) and omnivores (1.34 mg/d). This was even more pronounced in studies that assessed intake from foods and supplements. Average vitamin B1 intake was above the EAR (i.e., 0.9/1.0 mg/d for women/men) for all dietary patterns.	⊕◯◯◯ VERY LOW[2]
Vitamin B1 status	Neufingerl 2022 (350)	2	Cross-sectional data	Omnivore and vegetarian diet	A study from Switzerland assessed vitamin B1 status based on plasma levels, reporting somewhat higher levels in vegans (36.4 nmol/L) than in vegetarians (29.4 nmol/L) and omnivores (30.7 nmol/L). Another study from Austria reported a zero prevalence of vitamin B1 deficiency (>25% Thiamine pyrophosphate effect) in vegans and vegetarians compared to 2.5% prevalence in omnivores.	⊕◯◯◯ VERY LOW[2]
Vitamin B2 intake	Neufingerl 2022 (350)	10	Cross-sectional data	Omnivore and vegetarian diet	Average vitamin B2 intake was similar for vegan, vegetarian and omnivores. In studies that assessed intake from foods and supplements, vegans and omnivores had slightly higher vitamin B2 intakes than vegetarians. For all dietary patterns, mean intake across all studies was above the EAR (i.e., 0.9/1.1 mg/d for women/men).	⊕◯◯◯ VERY LOW[2]
Vitamin B2 status	Neufingerl 2022 (350)	2	Cross-sectional data	Omnivore and vegetarian diet	One study from Switzerland assessed vitamin B2 status based on plasma levels, reporting lower levels in vegans (79.8 nmol/L) and vegetarians (82.4 nmol/L) than in omnivores (92.0 nmol/L). Another study from Austria reported on vitamin B2 deficiency (erythrocyte glutathione reductase activity coefficient >1.4), with prevalence of 33%, 12.5% and 10% in vegans, omnivores and vegetarians.	⊕◯◯◯ VERY LOW[2]
Niacin intake	Neufingerl 2022 (350)	9	Cross-sectional data	Omnivore and vegetarian diet	On average, vegans (24.3 mg/d) had slightly higher niacin intake compared to vegetarians (18.8 mg/d) and similar intake compared to omnivores (25.2 mg/d). Mean intakes of niacin were higher in studies that assessed intake from foods and supplements, especially for omnivores and vegetarians. Mean intake across studies was above the EAR (i.e., 11/12 mg/d for women/men).	⊕◯◯◯ VERY LOW[2]
Niacin status	Neufingerl 2022 (350)	1	Cross-sectional data	Omnivore and vegetarian diet	One study from Switzerland assessed niacin status based on plasma levels, reporting lower levels in vegans (464 nmol/L) than in vegetarians (580 nmol/L) and omnivores (579 nmol/L).	⊕◯◯◯ VERY LOW[2]
Vitamin B6 intake	Neufingerl 2022 (350)	14	Cross-sectional data	Omnivore and vegetarian diet	Average vitamin B6 intake tended to be higher in vegans (2.81 mg/d) compared to vegetarians and omnivores (1.82 mg/d), irrespective of whether studies assessed intake from supplements. Mean intakes were well above the EAR (i.e., 1.1 mg/d).	⊕◯◯◯ VERY LOW[2]
Vitamin B6 status	Neufingerl 2022 (350)	5	Cross-sectional data	Omnivore and vegetarian diet	Average vitamin B6 levels were similar for vegans, vegetarians and omnivores	⊕◯◯◯ VERY LOW[2]

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Folate intake	Neufingerl 2022 (350)	14	Cross-sectional data	Omnivore and vegetarian diet	Vegans tended to have higher average folate intake (490 µg/d) than vegetarians (403 µg/d) and omnivores (331 µg/d), irrespective of whether intake from supplements was assessed. Mean intakes were just above the EAR (i.e., 320 µg/d) in omnivores. While for vegetarians and vegans, 93–100% of individual studies (27/29 and 15/15 studies) reported folate intakes above the EAR, for omnivores 9 out of 24 studies (38%) found intakes below the EAR.	⊕◯◯◯ VERY LOW[2]
Folate status	Neufingerl 2022 (350)	17	Cross-sectional data	Omnivore and vegetarian diet	Folate status tended to be higher in vegans (29 nmol/L) and in vegetarians (24 nmol/L) as compared to omnivores (19 nmol/L), with highest levels. This order was similar in studies that included and excluded supplement users. Three quarter of studies (9/12 studies) comparing vegans with omnivores, showed that omnivores had lower folate levels. Eight studies assessed folate deficiency (<10 nmol/L in plasma/serum or <340 nmol/L in red blood cells) with average prevalence of 1.5 % in vegans, 0 % in vegetarians and 11 % in omnivores.	⊕◯◯◯ VERY LOW[2]
Vitamin B12 intake	Neufingerl 2022 (350)	16	Cross-sectional data	Omnivore and vegetarian diet	Across all studies, average vitamin B12 intake was higher in omnivores (5.6 µg/d) compared to vegetarians (2.1 µg/d) and vegans (1.5 µg/d). In studies that assessed intake from foods and supplements, all dietary patterns had a mean vitamin B12 intake above the EAR, though the median vitamin B12 intake of vegans was below the EAR (i.e., 2.0 µg/d). In studies that assessed intake from foods only, mean and median vitamin B12 intake of vegans was well below the EAR. Most individual studies that assessed intake from foods only (10/13 studies) reported a vitamin B12 intake below the EAR for vegans, and half of the studies did so for vegetarians. This indicates that vegans and vegetarians are at high risk of inadequate vitamin B12 intake when supplements are not considered.	⊕◯◯◯ VERY LOW[2]
Vitamin C intake	Neufingerl 2022 (350)	12	Cross-sectional data	Omnivore and vegetarian diet	Average vitamin C intake was highest in vegans (213 mg/d), followed by vegetarians (166 mg/d) and then omnivores (137 mg/d), irrespective of whether studies assessed intake from supplements. Average vitamin C intake was above the EAR. No single study reported intakes below the EAR (i.e., 60/75 mg for women/men).	⊕◯◯◯ VERY LOW[2]
Vitamin C status	Neufingerl 2022 (350)	3	Cross-sectional data	Omnivore and vegetarian diet	Across all studies, average vitamin C levels were higher in vegans (61.9 µmol/L) and vegetarians (62.7 µmol/L) compared to omnivores (44.9 µmol/L). This was similar for studies including and excluding supplement users. All or most individual studies showed a significant higher vitamin C status in vegans (3/3 studies) compared to omnivores. Vegans as compared to vegetarians had similar (2/3 studies) or higher vitamin C status.	⊕◯◯◯ VERY LOW[2]
Vitamin D intake	Bakaloudi 2021 (351)	11	Cross-sectional data	Any other diet	In 10 out of 11 studies, a vegan diet was characterized by a lower intake of vitamin D when compared to other diets, or lower than the intake reference	⊕◯◯◯ VERY LOW[2]

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					value (5 mg/d for 19–50 years, 10 mg/d for 51–61 years and 15 mg/d for 65+ years).	
Vitamin D status	Neufingerl 2022 (350)	8	Cross-sectional data	Omnivore and vegetarian diet	Across all studies, average vitamin D levels tended to be slightly lower in vegans (21.9 µg/L) and vegetarians (22.8 µg/L) than in omnivores (26.2 µg/L). Among studies that compared vitamin D status between dietary patterns, three showed lower vitamin D status in vegetarians or vegans compared to omnivores. Vegans had similar vitamin D status as vegetarians in 5 out of 6 studies. Vitamin D deficiency was much more prevalent in vegans (ranging between 3% and 67% across studies) compared to omnivores and pesco-vegetarians (ranging between 0 and 6% across studies) and vegetarians (ranging between 0 and 33%). Insufficiency was 15% in omnivores and 25% in vegetarians and vegans. One study of Adventists in the USA/Canada also reported a high prevalence of vitamin D insufficiency in semi-vegetarians.	⊕◯◯◯ VERY LOW[2]
Vitamin E intake	Neufingerl 2022 (350)	10	Cross-sectional data	Omnivore and vegetarian diet	Average vitamin E intake tended to be higher in vegans (19.2 mg/d) compared to vegetarians (12.6 mg/d) and omnivores (10.8 mg/d), irrespective of whether intake from supplements was assessed. Only for vegans, average vitamin E intake was well above the EAR (i.e., 12 mg/d), and all individual studies reported intakes above the EAR.	⊕◯◯◯ VERY LOW[2]
Vitamin E status	Neufingerl 2022 (350)	3	Cross-sectional data	Omnivore and vegetarian diet	Vitamin E status was similar across vegans (20.5 µmol/L), vegetarians (25.5 µmol/L) and omnivores (25.4 µmol/L). One study assessed vitamin E deficiency (defined as plasma α-tocopherol < 13 µmol/L), reporting zero prevalence among omnivores and vegetarians and 3.8% among vegans.	⊕◯◯◯ VERY LOW[2]
Iron intake	Neufingerl 2022 (350)	14	Cross-sectional data	Omnivore and vegetarian diet	Average iron intake tended to be higher in vegans (21.0 mg/d) compared to vegetarians (15.3 mg/d) and omnivores (13.9 mg/d), independent of whether intake from supplements was assessed. Mean iron intakes were above the (bioavailability-adjusted) EAR in all diet groups.	⊕◯◯◯ VERY LOW[2]
Iron status	Neufingerl 2022 (350)	9	Cross-sectional data	Omnivore and vegetarian diet	Iron status tended to be higher in omnivores (55.5 µg/L) than in vegans (31.3 µg/L) and vegetarians (33.8 µg/L). Two out of three studies comparing omnivores and vegans, showed that omnivores had a higher iron status. Studies showed a prevalence of iron deficiency (ferritin <15 µg/L) of 15% in vegans, 11% in vegetarians and 7% in omnivores.	⊕◯◯◯ VERY LOW[2]
Phosphorus intake	Neufingerl 2022 (350)	6	Cross-sectional data	Omnivore and vegetarian diet	Average phosphorus intake was similar between vegans, vegetarians and omnivores. Average phosphorus intake was somewhat higher in studies that assessed intake from foods and supplements, especially among vegetarians. Average phosphorus intake was well above the EAR (i.e., 580 mg/d) for all diets.	⊕◯◯◯ VERY LOW[2]

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Potassium intake	Bakaloudi 2021 (351)	8	Cross-sectional data	Any other diet	Several studies showed that potassium intake was above the RNI among vegans.	⊕◯◯◯ VERY LOW[2]
Sodium intake	Bakaloudi 2021 (351)	8	Cross-sectional data	Any other diet	Several studies showed that sodium intake was above the RNI among vegans. In some studies, vegans had the lowest intake of sodium (2.5–2.8 g/d) in comparison with vegetarian and omnivores (2.7–3.0 g/d), whereas other studies reported higher sodium intake in the vegan group than in omnivores and lacto-ovo vegetarians. One study did not find any difference between vegans and other diet groups. An upward trend was found for studies published from 2016 onwards.	⊕◯◯◯ VERY LOW[2]
Magnesium intake	Neufingerl 2022 (350)	10	Cross-sectional data	Omnivore and vegetarian diet	Average magnesium intake was higher in vegans (503 mg/d) than in vegetarians (373 mg/d) and omnivores (302 mg/d). In studies that assessed intake from foods only, magnesium intake was somewhat lower across all groups than in studies that assessed intake from foods and supplements, but vegans had still the highest intake. Average magnesium intake of vegans and vegetarians was above the EAR (307.5 md/g), while for omnivores, intake did not meet the EAR for men. More than half of individual studies reported magnesium intake of omnivores to be below the EAR, while for vegetarians and vegans most studies intakes above the EAR.	⊕◯◯◯ VERY LOW[2]
Magnesium status	Neufingerl 2022 (350)	3	Cross-sectional data	Omnivore and vegetarian diet	No differences shown between vegans, vegetarians and omnivores.	⊕◯◯◯ VERY LOW[2]
Selenium intake	Bakaloudi 2021 (351)	5	Cross-sectional data	Any other diet	Studies suggest that vegans are more likely to have a low selenium intake, though this might not be significantly different compared to non-vegans. One study found that vegans had the lowest selenium intake, which was close to the WHO RNI.	⊕◯◯◯ VERY LOW[2]
Copper intake	Bakaloudi 2021 (351)	3	Cross-Sectional data	Any other diet	Vegans were shown to have the highest intake of copper compared to other diet types in some studies.	⊕◯◯◯ VERY LOW[2]

AI, adequate intake; ALA, alpha linolenic acid; AMDR, acceptable macronutrient distribution range; DHA, docosahexaenoic acid; EAR, estimated average requirement; EPA, eicosapentaenoic acid; PUFA, polyunsaturated fatty acids; RE, retinol equivalent; RNI, reference nutrient intake; WHO, World Health Organization

[1] As reported in the systematic reviews.

[2] Very low certainty of evidence due to small number of studies, small sample sizes, study design, high risk of bias, and/or confounding.

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Table e9: Characteristics of the included meta-analyses on vegan diet with regard to health outcomes, nutritional status and dietary intake in children and adolescents

Outcome (unit)	Reference	No. of primary studies	Study type of primary studies	Comparison	No. of participants	Ratio of Means (95% CI)	I^2	Certainty of evidence[1]
Nutrient intake								
Energy intake	Koller 2023 (352)	5	Cross-sectional studies	Omnivore Diet	762	0.99 (0.91, 1.08)	79%	⊕◯◯◯ VERY LOW
Protein intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	393	0.78 (0.68, 0.89)	94%	⊕◯◯◯ VERY LOW
Fat intake	Koller 2023 (352)	4	Cross-sectional studies	Omnivore Diet	638	0.94 (0.87, 1.02)	81%	⊕◯◯◯ VERY LOW
SFA intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	578	0.57 (0.48, 0.67)	83%	⊕◯◯◯ VERY LOW
MUFA intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	548	0.99 (0.76, 1.28)	95%	⊕◯◯◯ VERY LOW
PUFA intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	548	1.86 (1.76, 1.96)	7%	⊕◯◯◯ VERY LOW
Carbohydrate intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	608	1.09 (1.01, 1.18)	92%	⊕◯◯◯ VERY LOW
Sucrose intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	184	0.75 (0.53, 1.07)	88%	⊕◯◯◯ VERY LOW
Fiber intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	184	1.87 (1.57, 2.24)	71%	⊕◯◯◯ VERY LOW
Vitamin B1 intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	363	1.08 (0.81, 1.46)	88%	⊕◯◯◯ VERY LOW
Vitamin B2 intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	363	0.59 (0.42, 0.82)	88%	⊕◯◯◯ VERY LOW
Vitamin B6 intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	363	1.10 (0.93, 1.30)	73%	⊕◯◯◯ VERY LOW

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Folate intake	Koller 2023 (352)	4	Cross-sectional studies	Omnivore Diet	517	1.96 (1.44, 2.67)	95%	⊕◯◯◯ VERY LOW
Folate, blood	Koller 2023 (352)	4	Cross-sectional studies	Omnivore Diet	398	0.97 (0.57, 1.65)	98%	⊕◯◯◯ VERY LOW
Vitamin B12 intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	363	0.91 (0, 7322.95)	100%	⊕◯◯◯ VERY LOW
Vitamin B12, blood	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	121	1.21 (1.03, 1.42)	0%	⊕◯◯◯ VERY LOW
Holotranscobalamin	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	368	1.14 (0.95, 1.36)	38%	⊕◯◯◯ VERY LOW
Vitamin C intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	487	1.57 (1.33, 1.84)	64%	⊕◯◯◯ VERY LOW
Vitamin A intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	393	0.92 (0.83, 1.02)	0%	⊕◯◯◯ VERY LOW
ß-carotene intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	427	1.30 (0.85, 2.01)	82%	⊕◯◯◯ VERY LOW
Vitamin D intake	Koller 2023 (352)	4	Cross-sectional studies	Omnivore Diet	517	0.89 (0.35, 2.22)	92%	⊕◯◯◯ VERY LOW
Vitamin D, blood	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	401	0.85 (0.64, 1.13)	94%	⊕◯◯◯ VERY LOW
Vitamin E intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	363	1.67 (1.36, 2.07)	76%	⊕◯◯◯ VERY LOW
Calcium intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	487	0.60 (0.36, 1.00)	96%	⊕◯◯◯ VERY LOW
Magnesium intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	487	1.55 (1.23, 1.96)	93%	⊕◯◯◯ VERY LOW
Potassium intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	363	1.08 (1.02, 1.15)	0%	⊕◯◯◯ VERY LOW
Iron intake	Koller 2023 (352)	4	Cross-sectional studies	Omnivore Diet	517	1.54 (1.39, 1.70)	62%	⊕◯◯◯ VERY LOW

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Ferritin, blood	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	401	0.82 (0.74, 0.90)	5%	⊕◯◯◯ VERY LOW
Iodine intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	417	0.48 (0.17, 1.34)	79%	⊕◯◯◯ VERY LOW
Selenium intake	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	363	0.54 (0.20, 1.45)	89%	⊕◯◯◯ VERY LOW
Zinc intake	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	393	0.96 (0.64, 1.44)	95%	⊕◯◯◯ VERY LOW
Metabolic markers								
Total cholesterol	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	154	0.74 (0.64, 0.86)	88%	⊕◯◯◯ VERY LOW
HDL cholesterol	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	401	0.87 (0.76, 1.00)	90%	⊕◯◯◯ VERY LOW
LDL cholesterol	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	401	0.72 (0.56, 0.92)	90%	⊕◯◯◯ VERY LOW
Triglycerides	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	371	1.04 (0.97, 1.11)	0%	⊕◯◯◯ VERY LOW
Anthropometric parameters								
BMI	Koller 2023 (352)	3	Cross-sectional studies	Omnivore Diet	8.175	1.03 (0.98, 1.08)	30%	⊕⊕◯◯ LOW
Height	Koller 2023 (352)	5	Cross-sectional studies	Omnivore Diet	8.670	0.97 (0.96, 0.99)	0%	⊕⊕◯◯ LOW
Weight	Koller 2023 (352)	5	Cross-sectional studies	Omnivore Diet	8.670	0.95 (0.91, 1.00)	73%	⊕◯◯◯ VERY LOW
Birth weight (vegan diet of the mother during pregnancy)	Koller 2023 (352)	2	Cross-sectional studies	Omnivore Diet	465	1.07 (1.03, 1.11)	0%	⊕◯◯◯ VERY LOW

BMI, body mass index; CI, confidence interval; HDL, high-density lipoprotein; LDL, low-density lipoprotein; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids

[1] Certainty of Evidence as reported by Koller et al. 2023, using the GRADE approach

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Table e10: Characteristics of the included systematic reviews on vegan diet with regard to nutritional status and dietary intake in vulnerable groups

Outcome	Reference	No. of primary studies	Study type of primary studies	Population	Comparison	Results[1]	Certainty of evidence
Energy and nutrient intake in vegan children and adolescents							
Disaccharides, free sugars, added sugar intake	Koller 2023 (352)	3	Cross-sectional studies	Children and adolescents	Omnivore Diet	Lower in vegans	⊕◯◯◯ VERY LOW[2]
Fatty acid intake	Koller 2023 (352)	2	Cross-sectional studies	Children and adolescents	Omnivore Diet	EPA, AA, DHA intake were lower in vegans, LA:ALA showed no differences in vegans compared to omnivores, LA and ALA intake were higher in vegans	⊕◯◯◯ VERY LOW[2]
Blood fatty acid levels	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents	Omnivore Diet	No difference in ALA levels, DHA levels were lower in vegans	⊕◯◯◯ VERY LOW[2]
Vitamin A status	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents	Omnivore Diet	Lower levels in vegans	⊕◯◯◯ VERY LOW[2]
Vitamin B2 status	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents	Omnivore Diet	Lower levels in vegans	⊕◯◯◯ VERY LOW[2]
Niacin intake	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents (males only)	Omnivore Diet	Lower in male vegans	⊕◯◯◯ VERY LOW[2]
Biotin excretion	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents	Omnivore Diet	Higher in vegans	⊕◯◯◯ VERY LOW[2]
Zinc status	Koller 2023 (352)	2	Cross-sectional studies	Children and adolescents	Omnivore Diet	No difference	⊕◯◯◯ VERY LOW[2]
Iodine status	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents	Omnivore Diet	No difference	⊕◯◯◯ VERY LOW[2]
Phosphorus intake	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents	Omnivore Diet	Lower among vegans	⊕◯◯◯ VERY LOW[2]
Sodium intake	Koller 2023 (352)	1	Cross-sectional study	Children and adolescents (males only)	Omnivore Diet	Lower among vegans	⊕◯◯◯ VERY LOW[2]

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Nutrient intake	Koller 2023 (352)	1	RCT	Obese children with elevated cholesterol	AHA diet or Mediterranean diet	The group of vegan children showed a greater reduction in protein, vitamin B12 and vitamin D intake	⊕◯◯◯ VERY LOW[2]
Breast milk composition							
Total breast milk fat	Karcz 2021 (353)	1	Cross-sectional study	Vegan lactating women	Vegetarians and omnivores	Vegans: 3.0 ± 1.7 g/dl Vegetarians: 4.0 ± 2.9 g/dl Omnivores: 4.0 ± 2.9 g/dl Difference in dietary groups significant (p = 0.041)	⊕◯◯◯ VERY LOW[2]
Fatty acids	Karcz 2021 (353)	2	Cross-sectional study	Vegan lactating women	Omnivores	Lower amount of C16:0, C16:1, C18:0 and C20:4 n3 and higher amount of C18:2 n6, C18:3 n3, C20:2 n6 in vegans' breast milk. Tendency to lower proportions of C20:5 n3 and C22:6 n3 in vegans' breast milk.	⊕◯◯◯ VERY LOW[2]
			Cross-sectional study	Vegan lactating women (6 weeks postpartum)	Vegetarians and omnivores	Vegans' breastmilk contained higher proportions of short chain FA (C10-C14) and lower proportions of medium chain FA (C16-C18) in comparison to omnivores' breast milk. The proportions of dihomo-gamma-linolenic acid (20:3 n6) and arachidonic acid (22:4 n6) were comparable in all groups. The proportion of breast milk DHA (22:6 n3) was lower in vegans than in omnivores and vegetarians. The n6/n3 FA ratio was higher in the vegans than in the other groups.	⊕◯◯◯ VERY LOW[2]
Trans fatty acids	Karcz 2021 (353)	1	Cross-sectional study	Vegan lactating women	Vegetarians and omnivore	The mean breast milk trans-fat concentrations were below 1.1% in all study groups, with the lowest levels in vegans."	⊕◯◯◯ VERY LOW[2]
Vitamin B12	Baroni 2021 (354)	1	Cross-sectional study	Vegan lactating women	Lacto-ovo-vegetarian, Omnivore Diet	No significant differences in vitamin B12 milk concentration among groups. Positive correlation between Vit B12 supplementation and milk vitamin B12 concentration (standardized β: 0.263). No correlation between B-complex supplement intake and milk vitamin B12 concentration. Higher vitamin B12 supplement usage among vegans compared to lacto-ovo-vegetarians and lacto-ovo-vegetarians to omnivores (46.2 %, 27.3 %, 3.9 %). Vitamin B12 supplement usage ranged from 4 to 5000 µg/d.	⊕◯◯◯ VERY LOW[2]

AA, arachidonic acid; AHA, American Heart Association; ALA, alpha linolenic acid; DHA, docosahexaenoic acid; EPA, eicosapentaenoic acid; FA, fatty acids; LA, linolenic acid; RCT, randomized controlled trial

[1] As reported in the systematic reviews.

[2] Very low certainty of evidence due to small number of studies, small sample sizes, study design, high risk of bias, and/or confounding

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Table e11: Characteristics of the included systematic reviews with meta-analyses on vegan diet with regard to health outcomes in general populations (modified according to (1))

Outcome (unit)	Reference	No. of primary studies	Study type of primary studies	Comparison	No. of participants / No. of cases	Summary effect (95% CI)	I^2	Certainty of evidence[1]
Binary outcomes								
All-cause mortality	Dinu 2017 (355)	2	Prospective cohort studies	Omnivore diet	6,301 / 265	RR: 0.87 (0.75, 1.01)	0%	⊕⊕◯◯ LOW
Cancer incidence	Dinu 2017 (355)	2	Prospective cohort studies	Omnivore diet	7,168 / 295	RR: 0.84 (0.75, 0.95)	0%	⊕⊕◯◯ LOW
Cardiovascular disease incidence	Dybvik 2023 (356)	3	Prospective cohort studies	Omnivore diet	197,668 / 8,052	RR: 0.92 (0.79, 1.06)	0%	⊕⊕◯◯ LOW
Ischemic heart disease incidence	Dybvik 2023 (356)	3	Prospective cohort studies	Omnivore diet	197,668 / 5,456	RR: 0.82 (0.68, 1.00)	0%	⊕◯◯◯ VERY LOW
Stroke incidence	Dybvik 2023 (356)	2	Prospective cohort studies	Omnivore diet	109,938 / ≥39	RR: 1.17 (0.69, 1.99)	28%	⊕◯◯◯ VERY LOW
Diabetes prevalence	Lee 2017 (357)	4	Cross-sectional studies	Omnivore diet	15,665 / na	OR: 0.79 (0.51, 1.22)	85%	⊕◯◯◯ VERY LOW
Fracture incidence	Iguacel 2019 (358)	3	Prospective cohort studies	Omnivore diet	40,863 / 1,350	RR: 1.46 (1.03, 2.07)	56%	⊕⊕◯◯ LOW
Anthropometric markers								
Weight loss (kg)	Huang 2016 (359)	8	RCTs	Omnivore diet; 55-60% of calories from carbohydrates, <30% fat; high fat, high protein, low carbohydrate, <30%; NCEP diet; Calories from carbohydrates, protein, fat split 40/30/30; Diabetes Diet; habitual diet	836	MD: -2.52 (-3.06, -1.98)	3%	⊕⊕⊕◯ MODERATE
Weight (kg)	Li 2020 (360)	3	Cross-sectional studies	Lacto-vegetarian diet; omnivore diet	479	MD: -5.45 (-12.23, 1.33)	94%	⊕◯◯◯ VERY LOW

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Height (cm)	Li 2020 (360)	3	Cross-sectional studies	Lacto-vegetarian diet; omnivore diet	479	MD: -1.90 (-3.45, -0.34)	41%	⊕◯◯◯ VERY LOW
BMI (kg/m^2)	Benatar 2018 (345)	27	Cross-sectional studies	Omnivore diet	175,897	MD: -1.99 (-2.73, -1.25)	98%	⊕◯◯◯ VERY LOW
Waist circumference (cm)	Benatar 2018 (345)	5	Cross-sectional studies	Omnivore diet	49,965	MD: -3.10 (-5.51, -0.69)	85%	⊕◯◯◯ VERY LOW
Cardiovascular markers								
Systolic blood pressure (mmHg) - all	Lopez 2019 (361)	11	RCT	Society-recommended diet; portion-controlled diet; non-supervised diet; Lacto-ovo-vegetarian diet	1,078	MD: -1.33 (-3.50; 0.84)	30%	⊕⊕◯◯ LOW
Diastolic blood pressure (mmHg) - all	Lopez 2019 (361)	11	RCT	Society-recommended diet; portion-controlled diet; non-supervised diet; Lacto-ovo-vegetarian diet	1,078	MD: -1.20 (-3.06; 0.65)	54%	⊕⊕◯◯ LOW
Systolic blood pressure (mmHg) – healthy	Lopez 2019 (361)	2	RCT	Society-recommended diet; portion-controlled diet	63	MD: -2.09 (-8.53, 4.35)	0%	⊕◯◯◯ VERY LOW
Diastolic blood pressure (mmHg) - healthy	Lopez 2019 (361)	2	RCT	Society-recommended diet; portion-controlled diet	63	MD: -2.87 (-7.87, 2.13)	0%	⊕◯◯◯ VERY LOW
Systolic blood pressure (mmHg)	Picasso 2019 (362)	3	Cross-sectional studies	Omnivore diet	132	MD: -2.19 (-10.77, 6.39)	76%	⊕◯◯◯ VERY LOW
Diastolic blood pressure (mmHg)	Picasso 2019 (362)	3	Cross-sectional studies	Omnivore diet	132	MD: -2.00 (-7.22, 3.22)	75%	⊕◯◯◯ VERY LOW
Triglycerides (mmol/L)	Yokoyama 2017 (363)	9	RCTs	Omnivore diet, ADA diet	690	MD: 0.03 (-0.07, 0.13)	22%	⊕⊕◯◯ LOW
Triglycerides (mmol/L)	Benatar 2018 (345)	19	Cross-sectional studies	Omnivore diet	51,043	MD: -0.20 (-0.32, -0.08)	91%	⊕◯◯◯ VERY LOW
Total cholesterol (mmol/L)	Yokoyama 2017 (363)	9	RCTs	Omnivore diet, ADA diet	690	MD: -0.42 (-0.61, -0.22)	59%	⊕◯◯◯ VERY LOW

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LDL cholesterol (mmol/L)	Yokoyama 2017 (363)	8	RCTs	Omnivore diet, ADA diet	679	MD: -0.48 (-0.75, -0.21)	87%	⊕◯◯◯ VERY LOW
LDL cholesterol (mmol/L)	Benatar 2018 (345)	22	Cross-sectional studies	Omnivore diet	53,032	MD: -0.51 (-0.65, -0.36)	91%	⊕◯◯◯ VERY LOW
HDL cholesterol (mmol/L)	Yokoyama 2017 (363)	9	RCTs	Omnivore diet, ADA diet	690	MD: -0.10 (-0.20, -0.00)	31%	⊕⊕◯◯ LOW
HDL cholesterol (mmol/L)	Picasso 2019 (362)	3	Cross-sectional studies	Omnivore diet	138	MD: -0.10 (-0.18, -0.02)	0%	⊕◯◯◯ VERY LOW
Apo B (µmol/L)	Chiavaroli 2018 (364)	7	RCTs	NCEP Step II diet	609	MD: -0.19 (-0.23, -0.15)	61%	⊕⊕◯◯ LOW
Fasting glucose (mmol/L)	Benatar 2018 (345)	10	Cross-sectional studies	Omnivore diet	50,823	MD: -0.25 (-0.39, -0.11)	61%	⊕◯◯◯ VERY LOW[1]
HOMA-IR	Benatar 2018 (345)	3	Cross-sectional studies	Omnivore diet	153	MD: -0.04 (-0.36, 0.28)	0%	⊕◯◯◯ VERY LOW
10-year CHD risk (Framingham score)	Chiavaroli 2018 (364)	5	RCTs	NCEP Step II diet	537	MD: -1.34 (-2.19, -0.49)	54%	⊕◯◯◯ VERY LOW
Bone mass measurements								
BMD lumbar spine (g/cm^2)	Iguacel 2019 (358)	6	Cross-sectional studies	Omnivore diet	630	MD: -0.07 (-0.12, -0.03)	69%	⊕◯◯◯ VERY LOW
BMD femoral neck (g/cm^2)	Iguacel 2019 (358)	5	Cross-sectional studies	Omnivore diet	600	MD: -0.06 (-0.09, -0.02)	73%	⊕◯◯◯ VERY LOW
BMD whole body (g/cm^2)	Iguacel 2019 (358)	3	Cross-sectional studies	Omnivore diet	301	MD: -0.05 (-0.10, -0.00)	68%	⊕◯◯◯ VERY LOW

ADA, American Diabetes Association; BMD, bone mass density; BMI, body mass index; CHD, coronary heart disease; HDL, high-density lipoprotein; LDL, low-density lipoprotein; MD, mean difference; NCEP, National Cholesterol Education Program; OR, odds ratio; RCT, randomized controlled trial; RR, relative risk; SMD, standardized mean difference

[1] Certainty of evidence was evaluated by the GRADE approach

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Table e12: Characteristics of the included systematic reviews on vegan diet with regard to health outcomes in general populations

Outcome	Reference	No. of primary studies	Study type of primary studies	Comparison	Results[1]	Certainty of evidence
Chronic diseases						
Prostate Cancer incidence	Gupta 2022 (105)	2	Prospective cohort studies	Omnivore diet	Adventist-Health Study-2: RR: 0.65 (95% CI: 0.49, 0.85) EPIC-Oxford and Oxford Vegetarian studies: RR: 0.62 (95% CI: 0.31, 1.22) for vegans compared to meat eaters	⊕◯◯◯ VERY LOW[2]
Colorectal Cancer	Zhao 2022 (365)	1	Prospective cohort study	Omnivore diet	Adventist Health Study-2: HR: 0.84 (95% CI: 0.59, 1.19)	⊕◯◯◯ VERY LOW[2]
Diabetes incidence	Pollakova 2021 (366)	2	Prospective cohort studies	Omnivore diet (regular meat eaters)	Adventist Health Study-2: vegan diet was inversely associated with the development of T2D in both non-Black (OR: 0.43, 95% CI: 0.25, 0.74) and Black participants (OR: 0.38, 95% CI: 0.24, 0.62) EPIC-Oxford study: HR: 0.53 (95% CI 0.36, 0.79)	⊕◯◯◯ VERY LOW[2]
Metabolic syndrome incidence	Turner-McGrievy 2014 (367)	1	Retrospective cohort study	Omnivore and vegetarian diet	Vegetarians and omnivores had a lower risk of metabolic syndrome than vegans	⊕◯◯◯ VERY LOW[2]
Eating disorders						
Disordered eating	McLean 2022 (368)	13	Cross-sectional studies	Omnivore diet	Most studies (8 of 13) reported no association between veganism and disordered eating Six studies reported lower disordered eating in the vegan sample Two studies reported greater disordered eating in the vegan sample	⊕◯◯◯ VERY LOW[2]
Orthorexia nervosa	McLean 2022 (368)	12	Cross-sectional studies	Omnivore diet	Nine of 12 studies reported a positive association between veganism and orthorexia nervosa pathology. One study reported an inverse association with orthorexia nervosa pathology while two studies reported no association between veganism and orthorexia nervosa pathology.	⊕◯◯◯ VERY LOW[2]
Anthropometry						
Lean mass	Chan 2021 (369)	2	RCT	Control (National Cholesterol Education Program guidelines)	Change in lean mass (-0.8 kg) compared to control (-0.2 kg)	⊕◯◯◯ VERY LOW[2]

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			Cross-sectional study	Omnivore	Women: 43.2 kg (95% CI 42.5, 43.8) compared to omnivores: 44.8 kg (95% CI 44.8, 44.9) Men: 60.6 kg (95% CI 59.5, 61.8) compared to omnivores: 64.1 kg (95% CI 64.0, 64.1)	⊕◯◯◯ VERY LOW[2]
Grip strength	Chan 2021 (369)	1	Cross-sectional study	Omnivore	Women 24.5 kg (95% CI 23.7, 25.3) compared to omnivores: 25.3 kg (95% CI 25.3, 25.3) Men 40.3 kg (95% CI 39.0, 41.7) compared to omnivores: 42.2 kg (95% CI 41.2, 42.2)	⊕◯◯◯ VERY LOW[2]
Oral health						
Oral hygiene	Azzola 2023 (370)	2	Cross-sectional study, RCT with fluoride supplementation	Omnivore diet	Subjects on a vegan diet compared to an omnivore diet had good oral health conditions. Plaque index: SMD 0.00 (-0.39, 0.39) Gingival index: SMD 0.26 (-0.93, 0.91)	⊕◯◯◯ VERY LOW[2]
		1	Cross-sectional study	Omnivore diet	Bleeding on probing (%): SMD -0.45 (-0.81, -0.08)	⊕◯◯◯ VERY LOW[2]
Periodontal health	Azzola 2023 (370)	1	Cross-sectional study	Omnivore diet	Subjects on a vegan diet compared to an omnivore diet had good oral health conditions. Probing depth: SMD -0.37 (-0.74, -0.01) Recession SMD 0.04 (-0.33, 0.40) Attachment loss SMD 0.00 (-0.36, 0.36) Tooth mobility SMD -0.14 (-0.50, 0.22)	⊕◯◯◯ VERY LOW[2]
Dental status	Azzola 2023 (370)	1	Cross-sectional study	Omnivore diet	Decayed missing filled teeth index: SMD -0.15 (-0.51, 0.21) Decayed missing filled surfaces index: SMD -0.00 (-0.37, 0.36)	⊕◯◯◯ VERY LOW[2]
		1	RCT with fluoride supplementation	Omnivore diet	Decayed missing filled teeth index: SMD 1.40 (0.97, 1.84)	⊕◯◯◯ VERY LOW[2]

CI, confidence interval; EPIC, European prospective investigation into cancer and nutrition; HR, hazard ratio; OR, odds ratio; RCT, randomized controlled trial; RR, relative risk; SMD, standardised mean difference; T2D, type 2 diabetes mellitus

[1] As reported in the systematic reviews.

[2] Very low certainty of evidence due to small number of studies, small sample sizes, study design, high risk of bias, and/or confounding.

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Table e13: Characteristics of the included systematic reviews on vegan diet with regard to health outcomes in vulnerable groups

Outcome	Reference	No. of primary studies	Study type of primary studies	Population	Comparison	Results[1]	Certainty of evidence
Multiple health outcomes in children of vegan mothers							
Preeclampsia	Baroni 2021 (354)	1	Retrospective study	Vegan mothers (in a vegan community)	None	Incidence: 0.13% incidence (study published in 1987)	⊕◯◯◯ VERY LOW[2]
Preterm delivery	Baroni 2021 (354)	1	Cross-sectional study	Pregnant woman	Vegetarian, Omnivore Diet	There was no clear difference between diet groups in terms of prematurely or post-term births. Among children born to vegan mothers 6.4% were born prematurely and 12.8% were born post-term. For children born to vegetarian and omnivore mothers the percentage of those born prematurely was 11.6% and 10.3%, respectively. 10.6% and 9.1%, respectively, were born post-term.	⊕◯◯◯ VERY LOW[2]
Physical development of vegan children							
Growth	Koller 2023 (352)	3	Cross-sectional study	Children and adolescents	Omnivore Diet	Length after 12 months, weight 6 and 12 months, fat mass index, suprailiac skinfold, triceps skinfold, tight girth, as well as hip girth were lower among vegans, Birth length, length after 6 months, weight for height, weight for age, lean mass index, biceps skinfold thickness, subscapular skinfold thickness, waist girth, head circumference after 6 months, after 12 months showed no differences.	⊕◯◯◯ VERY LOW[2]
Health outcomes in vegan children							
Total body less head bone mineral content	Koller 2023 (352)	1	Cross-sectional study	Children	Omnivore Diet	Lower in vegans: –3.7 (95% CI: –7.0, –0.4)%	⊕◯◯◯ VERY LOW[2]
Glycemic markers, insulin	Koller 2023 (352)	1	RCT	Obese children with elevated cholesterol	AHA diet or Mediterranean diet	Decrease of fasting glucose in all groups, no reduction in insulin levels.	⊕◯◯◯ VERY LOW[2]

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		1	Cross-sectional study	Children and adolescents	Omnivore Diet	No difference in blood glucose, insulin, higher HOMA levels in vegans	⊕◯◯◯ VERY LOW[2]
Blood pressure	Koller 2023 (352)	1	RCT	Obese children with elevated cholesterol	AHA diet or Mediterranean diet	In all three groups decrease in systolic and diastolic blood pressure	⊕◯◯◯ VERY LOW[2]
HDL cholesterol	Koller 2023 (352)	1	RCT	Obese children with elevated cholesterol	AHA diet or Mediterranean diet	No reduction.	⊕◯◯◯ VERY LOW[2]
Anthropometric parameters	Koller 2023 (352)	1	RCT	Obese children with elevated cholesterol	AHA diet or Mediterranean diet	In all three groups decrease in waist circumference, no reduction in BMI.	⊕◯◯◯ VERY LOW[2]

AHA, American Heart Association; BMI, body mass index; HDL, high-density lipoprotein; HOMA, Homeostasis Model Assessment; RCT, randomized controlled trial

[1] As reported in the systematic reviews.

[2] Very low certainty of evidence due to small number of studies, small sample sizes, study design, high risk of bias, and/or confounding.

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Table e14: Characteristics of the included primary studies on vegan diet with regard to nutritional status, dietary intake and health outcomes in vulnerable groups

Outcome	Reference	Study design, country	Total population (n vegans)	Comparison	Age (y)	Results[1]	Certainty of evidence
Pregnancy							
Status of Vitamin B12, Folic acid, Iron	Avnon 2020 (371)	Prospective observational study, Israel	273 (n = 60)	LOV (n = 64) PC (n = 37) OM (n = 112)	≥ 18	No differences in vitamin B12, folic acid, and ferritin levels or prevalence of deficiencies based on blood measurements between the diet groups. Umbilical B12 was lower in pregnant vegan women who did not take any vitamin supplementation than in vegan women taking multivitamins (442.57 ± 151.30 pg/ml vs. 1002.63 ± 608.56 pg/ml).	⊕◯◯◯ VERY LOW[2]
Gestational weight gain	Avnon 2021 (372)	Prospective observational study, Israel	273 (n = 60)	LOV (n = 64) PC (n = 37) OM (n = 112)	≥ 18	Vegans had lower pre-gestational BMI in comparison to other diet groups and lower mean gestational weight gain compared to OM (11.6 ± 4.2 kg vs. 14.3 ± 4.6 kg, 95% CI: 1.13, 4.10), but not to PC or LOV.	⊕◯◯◯ VERY LOW[2]
	Kesary 2020 (373)	Retrospective web-based study, Israel	1,419 (n = 234)	VG (n = 133) OM (n = 1,052)	Mean maternal age: 31.8	Vegan diet was associated with lower mean absolute maternal weight gain (12.2 ± 5.7 kg vs. 13.8 ± 5.8 kg in OM) and lower proportion of excessive weight gain (OR: 0.61; 95% CI: 0.44, 0.86).	
Gestational diabetes mellitus	Avnon 2021 (372)	Prospective observational study, Israel	273 (n = 60)	LOV (n = 64) PC (n = 37) OM (n = 112)	≥ 18	No difference between diet groups: Vegans: 8.3% LOV: 7.8% PC: 16.2% OM: 8.9%	⊕◯◯◯ VERY LOW[2]
	Kesary 2020 (373)	Retrospective web-based study, Israel	1,419 (n = 234)	VG (n = 133) OM (n = 1,052)	Mean maternal age: 31.8	Vegan diet tended to be inversely associated with gestational diabetes (OR: 0.54; 95% CI: 0.28, 1.03) compared to OM, which was further attenuated by adjustment for pre-pregnancy BMI.	
Hypertensive complications	Avnon 2021 (372)	Prospective observational study, Israel	273 (n = 60)	LOV (n = 64) PC (n = 37) OM (n = 112)	≥ 18	No difference between diet groups: Vegans: 3.3% LOV: 3.1% PC: 2.7% OM: 1.8%	⊕◯◯◯ VERY LOW[2]

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Small for gestational age, large for gestational age	Avnon 2021 (372)	Prospective observational study, Israel	273 (n = 60)	LOV (n = 64) PC (n = 37) OM (n = 112)	≥ 18	Highest incidence of small for gestational age in vegans (11.7%, RR: 5.93; 95 % CI: 1.20, 21.83), mainly compared to OM, no difference compared to LOV or PC.	⊕◯◯◯ VERY LOW[2]
	Kesary 2020 (373)	Retrospective web-based study, Israel	1,419 (n = 234)	VG (n = 133) OM (n = 1,052)	Mean maternal age: 31.8	Higher risk of small for gestational age in vegans (OR: 1.74; 95% CI: 1.05, 2.86) compared to OM, association somewhat attenuated when further adjusted for BMI of the mother (OR: 1.59; 95% CI: 0.95, 2.65), no difference in large for gestational age between diet groups.	
Preterm Birth	Avnon 2021 (372)	Prospective observational study, Israel	273 (n = 60)	LOV (n = 64) PC (n = 37) OM (n = 112)	≥ 18	Incidence was similar in all groups: Vegans: 5.0% LOV: 4.7% PC: 5.4% OM: 3.6%	⊕◯◯◯ VERY LOW[2]
	Kesary 2020 (373)	Retrospective web-based study, Israel	1,419 (n = 234)	VG (n = 133) OM (n = 1,052)	Mean maternal age: 31.8	No difference between diet groups. Vegans: 2.6% LOV: 3.8% OM: 4.4%	⊕◯◯◯ VERY LOW[2]
Lactating women							
Mineral and contaminant concentrations in breast milk	Perrin 2022 (374)	Cross-sectional study, USA	63 (n = 23)	VG (n = 19) OM (n = 21)	18–46	Higher concentrations of selenium in breast milk from vegans (19 µg/l) and VG (21 µg/l) compared to OM (17 µg/l). No differences in concentrations of calcium, copper, iron, iodine, potassium, magnesium, manganese, sodium, phosphorus, lead, and zinc.	⊕◯◯◯ VERY LOW[2]
Iodine in breast milk	Pawlak 2023 (375)	Cross-sectional study, USA	30 (n = 12)	VG (n = 6) OM (n = 12)	18–46	Lower mean (range) breast milk iodine concentration in vegans (65 µg/l (32–194 µg/l)) compared to VG (116 µg/l (62–189 µg/l)) and OM (276 µg/l (62–1,719 µg/l)). No differences in median iodine concentrations. No difference in incidence of inadequate breast milk iodine concentrations by maternal diet (75% vegan, 67% VG, and 58% OM).	⊕◯◯◯ VERY LOW[2]
Human Milk Oligosaccharide (HMO) composition	Neville 2022 (376)	Cross-sectional study, USA	74 (n = 26)	VG (n = 22) OM (n = 26)	18–46	No difference in individual HMO composition, total HMO-bound fructose and HMO-bound sialic acid or diversity and evenness scores.	⊕◯◯◯ VERY LOW[2]
Elderly people							

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Anthropometric parameters	Baleato 2022 (377)	Cross-sectional study, Australia	9,102 women (n = 8)	LOV (n = 48) SV (n = 45) PC (n = 74) OM (n = 8,927)	62–67	Vegans (and LOV, SV, PC) were less likely to be overweight or obese compared to OM: mean BMI for vegans (24.1 ± 3.1) vs OM (27.8 ± 5.7). Vegan group had a lower mean weight compared to LOV, SV and OM (63.7 ± 9.7 kg vs. 66.4 ± 15.3 vs. 71.0 ± 13.4 kg vs. 73.8 ± 15.6 kg). Vegan group had a smaller mean waist circumference (79.9 ± 12.6 cm) compared to LOV (87.3 ± 13.7 cm), PC (83.0 ± 11.8), SV (89.0 ± 13.2 cm) and OM (91.4 ± 13.7 cm).	⊕◯◯◯ VERY LOW[2]
Impaired glucose tolerance, diabetes mellitus	Baleato 2022 (377)	Cross-sectional study, Australia	9,102 women (n = 8)	LOV (n = 48) SV (n = 45) PC (n = 74) OM (n = 8,927)	62–67	Vegans (and LOV, SV, PC) had lower rates of diagnosis and treatment for impaired glucose tolerance compared to OM. No respondent diagnosed with diabetes in the vegan group.	⊕◯◯◯ VERY LOW[2]
Intake of medications	DosSantos 2021 (378)	Cross-sectional study, USA	328 men and women (n = 35)	LOV (n = 71) PC (n = 35) OM (n = 187)	≥ 60	Vegans had a reduced number of medications compared to OM (IRR: 0.42; 95% CI: 0.25, 0.70).	⊕◯◯◯ VERY LOW[2]

AI, adequate intake; BMI, body mass index; CI, confidence interval; HMO, human milk oligosaccharide; IRR, incidence rate ratio; LOV, lacto-ovo-vegetarian; RR, risk ratio; SV, semi-vegetarian; VG, vegetarian; PC, pescetarian; OM, omnivore; y, years

[1] As reported in the systematic reviews.

[2] Very low certainty of evidence due to small sample sizes, study design, high risk of bias, and/or confounding

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Table e15: Assessment of the certainty of evidence for newly identified meta-analyses in the umbrella-review on vegan diet using GRADEpro (379)

Certainty assessment							№ of patients	Effect estimate (95% CI)	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations			
Cardiovascular disease incidence									
3	prospective cohort studies	not serious	not serious	not serious	not serious	none	197,668	**RR 0.92** (0.79 to 1.06)	⊕⊕◯◯ LOW
Ischemic heart disease incidence									
3	prospective cohort studies	not serious	not serious	not serious	serious[a]	none	197,668	**RR 0.82** (0.68 to 1.00)	⊕◯◯◯ VERY LOW
Stroke incidence									
2	prospective cohort studies	not serious	serious[b]	not serious	serious[a]	none	109,938	**RR 1.17** (0.69 to 1.99)	⊕◯◯◯ VERY LOW
Calcium intake (compared to omnivores)									
21	cross-sectional studies	serious[c]	serious[d]	not serious	not serious	none	64,804	**SMD 0.70 lower** (0.85 lower to 0.55 lower)	⊕◯◯◯ VERY LOW
Calcium intake (compared to vegetarian diet)									
12	cross-sectional studies	serious[c]	serious[d]	not serious	not serious	none	36,324	**SMD 0.57 lower** (0.83 lower to 0.32 lower)	⊕◯◯◯ VERY LOW
Iodine (µg/day)									
6	cross-sectional studies	not serious	serious[d]	not serious	not serious	none	1,995	**MD 62.3 µg/d lower** (93.88 lower to 30.73 lower)	⊕◯◯◯ VERY LOW

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Certainty assessment							№ of patients	Effect estimate (95% CI)	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations			
Iodine, urine (µg/L)									
4	cross-sectional studies	not serious	serious[e]	not serious	serious[f]	none	333	**MD 46.52 µg/d lower** (94.08 lower to 1.04 lower)	⊕◯◯◯ VERY LOW

CI, Confidence interval; MD, mean difference; RR, risk ratio; SMD, standardised mean difference
Explanations:

a. Downgraded by one level for imprecision since effect estimate overlaps null effect and 95% CI includes important benefit/harm (SRR <0.75 and/or >1.25).
b. Downgraded by one level for inconsistency since effect estimates point in opposite directions.
c. Downgraded by one level for risk of bias since study quality has not been assessed and due to insufficient adjustments.
d. Downgraded by one level for inconsistency since some 95% CI did not fully overlap between studies.
e. Downgraded by one level for inconsistency since effect estimates point in opposite directions and some 95% CIs did not fully overlap between studies.
f. Downgraded by one level for imprecision due to small sample size (<400).

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