Ernährung bei chronischer Nierenerkrankung (CKD)

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Heidelberger Nephrologisches Seminar

07-03-2024

Interessenkonflikte

- Keine Interessenkonflikte in Verbindung mit dem Thema
- Keine Erwähnung von Medikamenten

Ernährungstherapie in der Nephrologie

- Niereninsuffizienz ist eine metabolische Erkrankung
- Vor der Entwicklung der Dialyse war eine diätetische Therapie die einzige Möglichkeit der (moderaten) Lebensverlängerung bei Niereninsuffizienz
- In der Bevölkerung sind Nierenerkrankungen und Diät immer noch eng miteinander verknüpft
- Nierenerkrankte sind daher empfänglich für Ernährungsempfehlungen

Ernährungstherapie bei CKD

Ziele

- Progressionshemmung
- Hinauszögern der Dialyseeinleitung
- Reduktion kardiovaskulärer Morbidität und Mortalität
- Aufrechterhaltung eines guten Ernährungszustandes

Ernährungskonzepte

- Eiweißrestriktion
  - Low Potein Diet
  - Very Low Protein Diet + Supplements
- Kochsalzrestriktion
- Pflanzen-basierte Ernährung
  - Mediterrane Kost
  - DASH-Diet
  - Vegetarische/vegane Ernährung

Eiweißzufuhr bei CKD

Diskussion kreist seit Jahrzehnten um die *Quantität* (g/kg KG/d) der Eiweißzufuhr

0,28 – 0,43

0,55 – 0,60

0,8 – 1,00

0,6 – 0,80

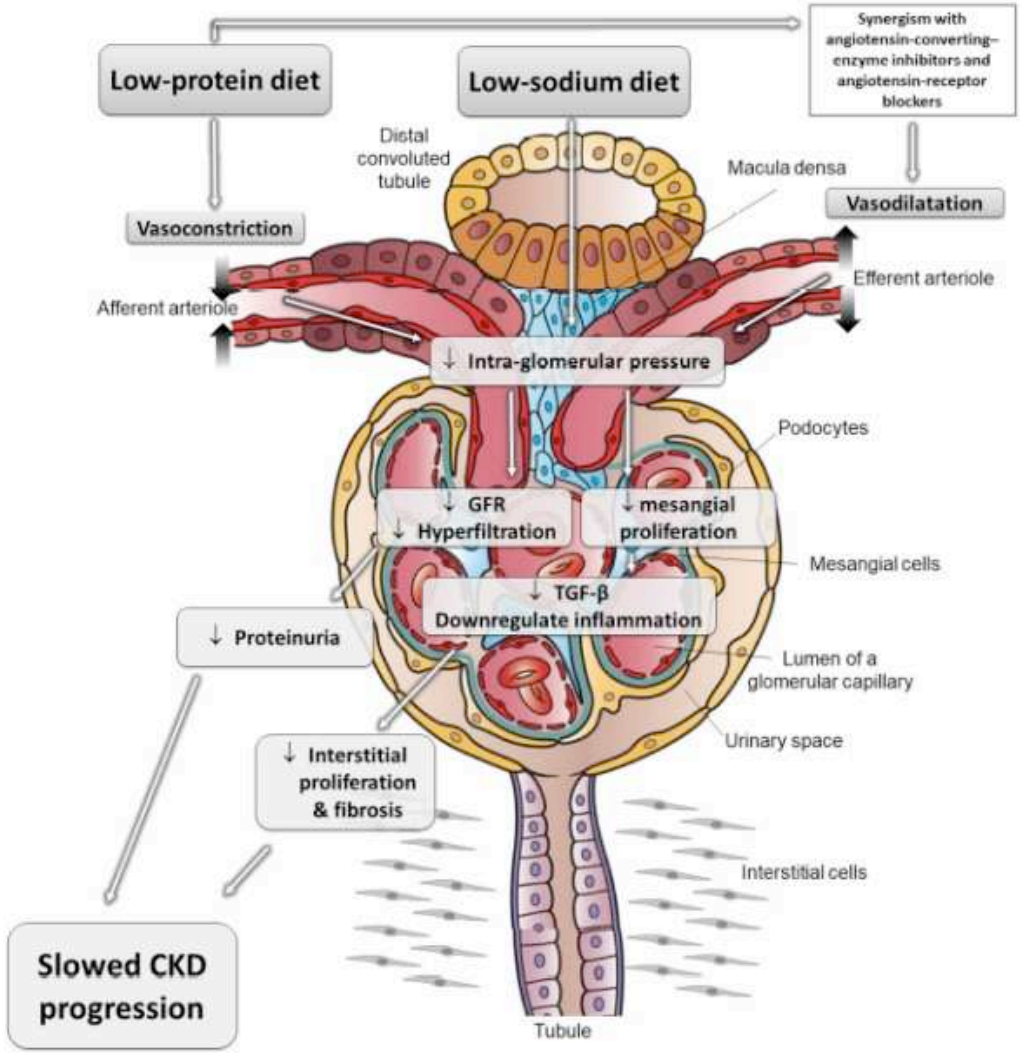
1,0 – 1,2

Qualität der Eiweiße bleibt in Empfehlungen meist unerwähnt

Eiweißarme Diät – Definition

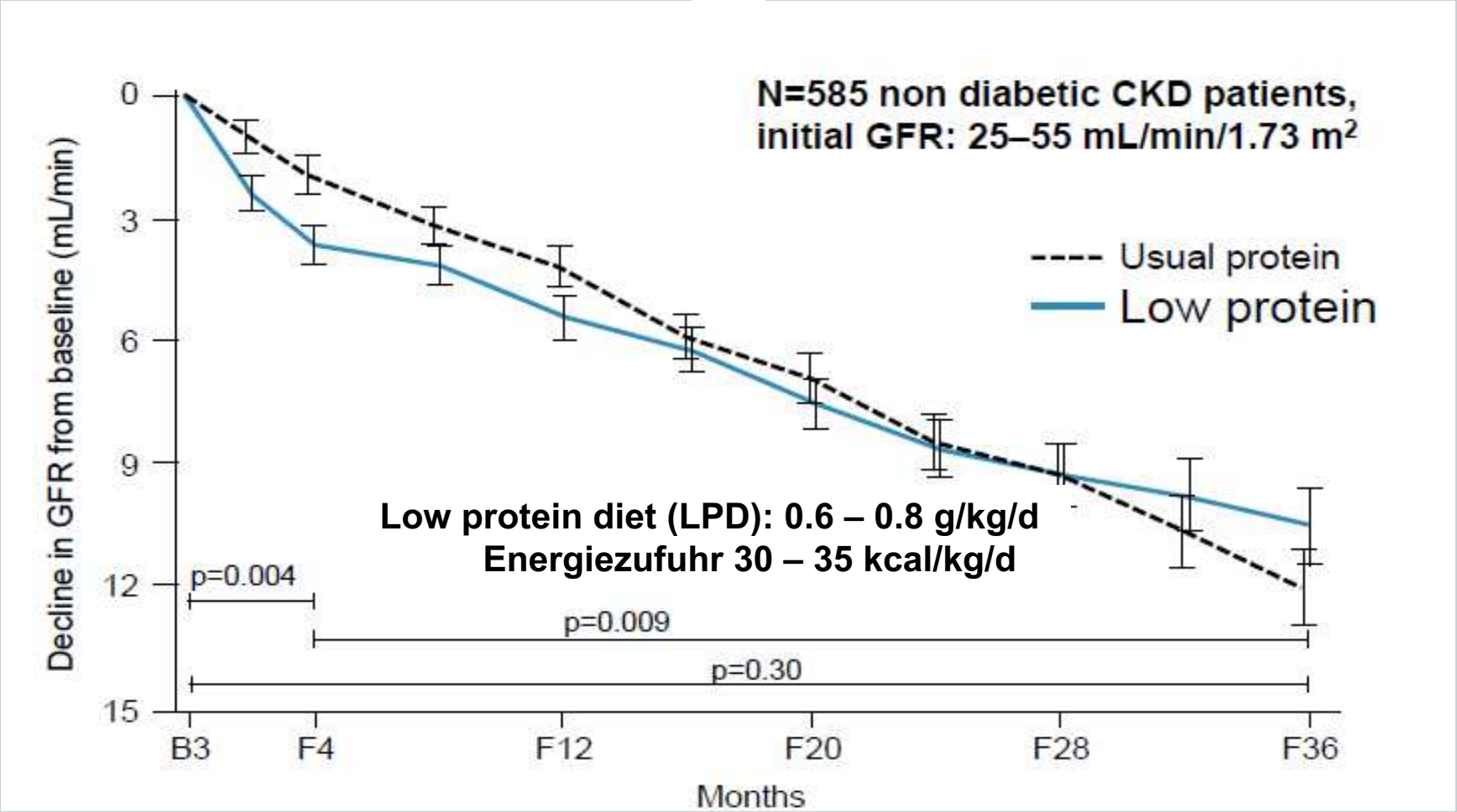
- Mittlere Eiweißzufuhr: 1.1 – 1.35 g/kg KG/d
- WHO-Empfehlung: 0.8 – 1.0 g/kg/d
- Mindestzufuhr für neutrale Stickstoffbilanz bei metabolischer Stabilität: 0.6 g/kg/d
  - Bei Energiezufuhr von 30-35 kcal/kg/d
- Low protein diet (LPD): 0.6 – 0.8 g/kg/d
  - Energiezufuhr 30 – 35 kcal/kg/d
- Very low protein diet (vLPD): 0.3 g/kg/d
  - vLPD muss supplementiert werden mit essentiellen Aminosäuren oder Ketosäuren

LPD reduziert glomeruläre Hyperfiltration



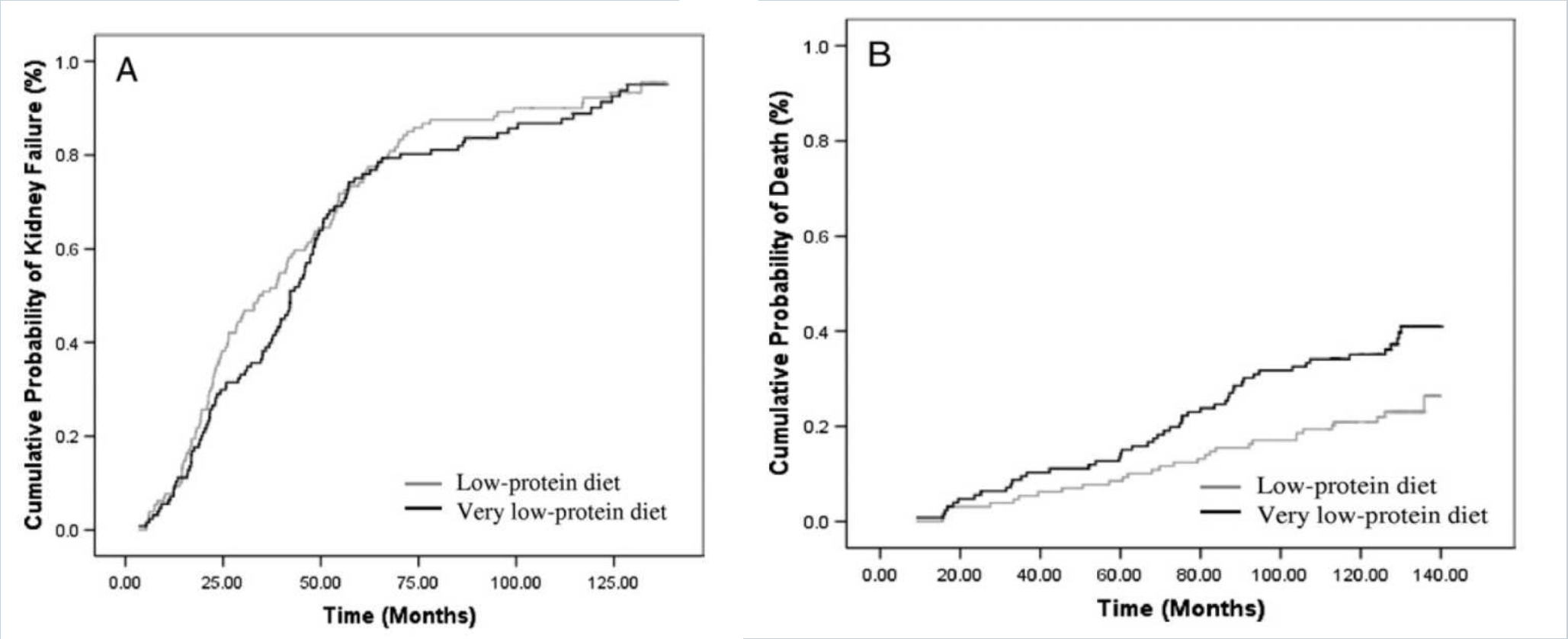
Molina P et al. Front Med 2021; 8

MDRD-Studie: RCT zu Progressionshemmung durch diätetische Eiweißreduktion bei CKD



Klahr S et al. NEJM 330:877-884, 1994

vLPD: Langfristig gesteigerte Mortalität!



Very low protein diet (vLPD): 0.3 g/kg/d + Ketoanaloga essentieller AS

Menon V et al. AJKD 53:208-217, 2009

Aktuelle KDIGO – Empfehlungen 2020

KDOQI CLINICAL PRACTICE GUIDELINE FOR NUTRITION IN CKD: 2020 UPDATE

T. Alp Ikizler, Jerrilynn D. Burrowes, Laura D. Byham-Gray, Katrina L. Campbell, Juan-Jesus Carrero, Winnie Chan, Denis Fouque, Allon N. Friedman, Sana Ghaddar, D. Jordi Goldstein-Fuchs, George A. Kaysen, Joel D. Kopple, Daniel Teta, Angela Yee-Moon Wang, and Lilian Cuppari

Protein Restriction, CKD Patients Not on Dialysis and Without Diabetes

3.0.1 In adults with CKD 3-5 who are metabolically stable, we recommend, under close clinical supervision, protein restriction with or without keto acid analogs, to reduce risk for end-stage kidney disease (ESKD)/death (*1A*) and improve quality of life (QoL) (*2C*):

- a low-protein diet providing 0.55–0.60 g dietary protein/kg body weight/day, or
- a very low-protein diet providing 0.28–0.43 g dietary protein/kg body weight/day with additional keto acid/amino acid analogs to meet protein requirements (0.55–0.60 g/kg body weight/day)

4.1.1 Patients CKD G3-5D „at risk or with protein-energy-wasting“: Minimum 3 months trial of oral supplements

Weak Recommendation (level 2 = we suggest)

Low (C)	Our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.

CKD G3-5

- **Energie**: 25-35kcal/kg KG/d
- **Protein:** 0,55 - 0,60 g/kg KG/d
  Low Protein Diet (LPD)
- ABER: „metabolisch stabil“
- **Ballaststoffe**: Mediterrane Kost (LDL)
- CKD G1-4: viel Obst und Gemüse

CKD 5D

- **Protein:** 1-1,2g/kg KG/d
- Bei PEW: >1,2 g/kg KG/d

Ikizler, T. A. *et al.* KDOQI Clinical Practice Guideline for Nutrition in CKD: 2020 Update. *Am J Kidney Dis* **76**, S1-S107, doi:10.1053/j.ajkd.2020.05.006 (2020).

Cochrane Library

Cochrane Database of Systematic Reviews

Low protein diets for non-diabetic adults with chronic kidney disease (Review)

Hahn D, Hodson EM, Fouque D

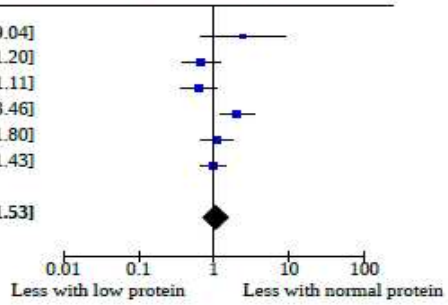
Analysis 1.2. Comparison 1: Low protein diet versus normal protein diet, Outcome 2: ESKD

Study or Subgroup	Low protein diet Events	Total	Normal protein diet Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Rosman 1 1984	7	74	3	77	6.3%	2.43 [0.65 , 9.04]
MDRD 1 1989	18	291	27	294	17.0%	0.67 [0.38 , 1.20]
Locatelli 1989	19	230	29	226	17.7%	0.64 [0.37 , 1.11]
ESGCMCRF 1 1990	28	64	15	70	18.2%	2.04 [1.20 , 3.46]
Williams 1991	17	33	15	32	19.0%	1.10 [0.67 , 1.80]
Cianciaruso 2008a	41	212	42	211	21.9%	0.97 [0.66 , 1.43]
Total (95% CI)		**904**		**910**	**100.0%**	**1.05 [0.73 , 1.53]**
Total events:	130		131			

Heterogeneity: $Tau^2 = 0.13$; $Chi^2 = 13.23$, df = 5 (P = 0.02); $I^2 = 62\%$

Test for overall effect: Z = 0.27 (P = 0.78)

Test for subgroup differences: Not applicable



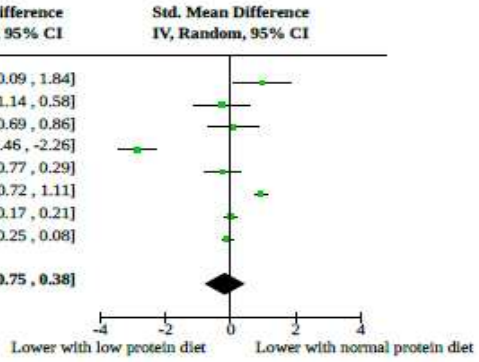
Analysis 1.3. Comparison 1: Low protein diet versus normal protein diet, Outcome 3: End or change in GFR

Study or Subgroup	Low protein diet Mean	SD	Total	Normal protein diet Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Bergstrom 1986	0.013	0.002	11	0.011	0.002	12	10.7%	0.96 [0.09 , 1.84]
MDRD Feasibility A 1989	0.045	1.0088	10	0.321	0.8822	11	10.7%	-0.28 [-1.14 , 0.58]
Milovanov 2009	23.1	3.3	18	22.8	4	10	11.3%	0.08 [-0.69 , 0.86]
Meloni 2004	3.47	0.26	44	6.05	1.23	45	12.3%	-2.86 [-3.46 , -2.26]
Williams 1991	13.9	10	28	16.5	11	27	12.7%	-0.24 [-0.77 , 0.29]
Locatelli 1989	0.51	0.48	230	0.08	0.46	226	14.1%	0.91 [0.72 , 1.11]
Cianciaruso 2008a	0.19	0.48	212	0.18	0.46	211	14.1%	0.02 [-0.17 , 0.21]
MDRD 1 1989	10.9	14.6	291	12.1	13.9	294	14.1%	-0.08 [-0.25 , 0.08]
Total (95% CI)			**844**			**836**	**100.0%**	**-0.18 [-0.75 , 0.38]**

Heterogeneity: $Tau^2 = 0.58$; $Chi^2 = 173.63$, df = 7 (P < 0.00001); $I^2 = 96\%$

Test for overall effect: Z = 0.63 (P = 0.53)

Test for subgroup differences: Not applicable



- This review found that low protein diets (LPD) may make little difference to the number of people who progress to ESKD.
- Very low protein diets (VLPD) probably reduce the number of people with CKD 4 or 5, who progress to ESKD.
- LPD or VLPD probably do not influence death.
- There are limited data on adverse effects such as weight differences and protein energy wasting.
- There are no data on whether quality of life is impacted by difficulties in adhering to protein restriction.
- Studies evaluating the adverse effects and the impact on quality of life of dietary protein restriction are required before these dietary approaches can be recommended for widespread use.

Cochrane Database of Systematic Reviews 2020, Issue 10. Art. No.: CD001892. DOI: 10.1002/14651858.CD001892.pub5.

KDOQI 2020: LPD nur beim „metabolisch stabilen“ Patienten

„metabolisch stabil“ =

- keine aktive Inflammation oder Infektion
- kein Krankenhausaufenthalt in den vergangenen 14d
- kein unkontrollierter Diabetes Mellitus
- keine Tumorerkrankung
- keine Immunsuppression
- keine antibiotische Therapie
- kein Gewichtsverlust
- kein Untergewicht

nur für wenige Patienten sicher

proteinarme Diät (0,6g/kg/d) - hohe Kalorienzufuhr (>30 Kcal/kg/d) (Risiko Mangelernährung)

„very low protein“ Diät (0,28-0,43 g/kg/d) nur unter Substitution von Ketoanaloga

Erhalt Muskelmasse wichtig

Ikizler, T. A. *et al.* KDOQI Clinical Practice Guideline for Nutrition in CKD: 2020 Update. *Am J Kidney Dis* **76**, S1-S107, doi:10.1053/j.ajkd.2020.05.006 (2020).

Potentielle Vorteile einer diätetischen Proteinrestriktion

- Verminderte glomeruläre Hyperfiltration
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- Verbesserung des Lipidprofils durch verminderte Zufuhr gesättigter Fette aus tierischem Eiweiß
- Günstiger Effekt auf SBH (geringere Azidose)
- Besserung der Insulinresistenz (Urämietoxine?)

ABER:
Proteinrestriktion hat *keinen Effekt* auf kardiovaskuläres Outcome

Red Meat Intake and Risk of ESRD

Quan-Lan Jasmine Lew,* Tazeen Hasan Jafar,[†‡] Hiromi Wai Ling Koh,[§] Aizhen Jin,[‖] Khuan Yew Chow,[‖] Jian-Min Yuan,[¶**] and Woon-Puay Koh[†§]

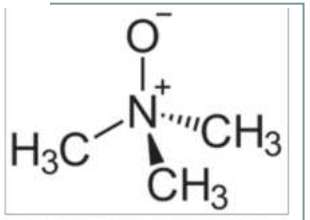
Table 3. Hazard ratios (95% CI) for risk of ESRD according to food sources of protein (n=60,198)

Food Sources of Protein (g/d)	Quartiles of Energy-Adjusted Food Intake				*P* for Trend[a]
	Q1	Q2	Q3	Q4	
Red meat					
Cases	194	220	267	270	
Person-years	236,141	236,256	230,243	230,006	
Multivariate model 1	1.00	1.11 (0.91–1.35)	1.39 (1.16–1.68)	1.47 (1.22–1.77)	<0.001
Multivariate model 2	1.00	1.01 (0.83–1.24)	1.29 (1.06–1.56)	1.36 (1.13–1.64)	<0.001
Multivariate model 3	1.00	1.03 (0.84–1.26)	1.32 (1.07–1.61)	1.40 (1.15–1.71)	<0.001
Poultry					
Cases	232	243	253	223	
Person-years	230,852	232,599	232,016	237,180	
Multivariate model 1	1.00	1.02 (0.85–1.22)	1.14 (0.95–1.36)	1.07 (0.89–1.29)	0.37
Multivariate model 2	1.00	0.92 (0.77–1.12)	1.04 (0.86–1.26)	0.99 (0.82–1.20)	0.77
Multivariate model 3	1.00	0.88 (0.72–1.06)	0.95 (0.78–1.16)	0.90 (0.74–1.09)	0.49
Fish and shellfish					
Cases	204	251	237	259	
Person-years	229,112	231,006	235,816	236,713	
Multivariate model 1	1.00	1.21 (1.01–1.46)	1.14 (0.94–1.37)	1.27 (1.06–1.53)	0.03
Multivariate model 2	1.00	1.16 (0.96–1.39)	1.06 (0.87–1.27)	1.12 (0.93–1.34)	0.44
Multivariate model 3	1.00	1.12 (0.93–1.35)	1.01 (0.84–1.23)	1.07 (0.89–1.30)	0.71

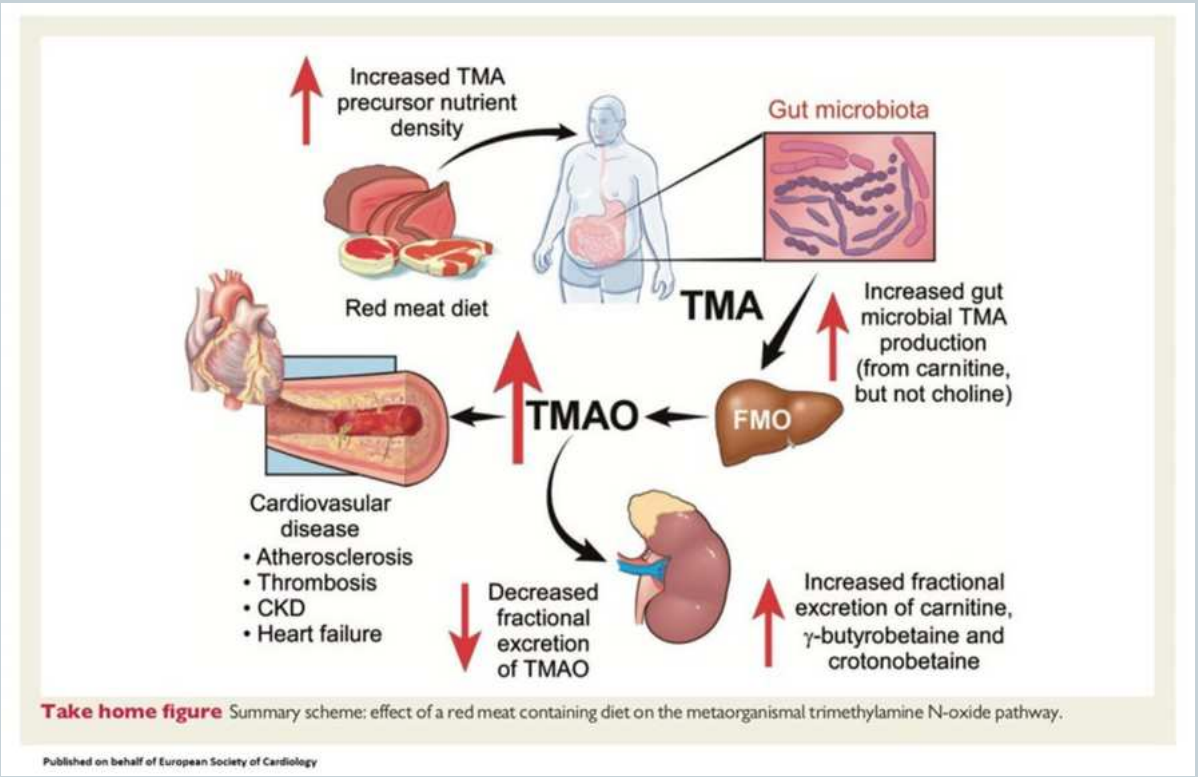
J Am Soc Nephrol 28: 304–312, 2017

The role of trimethylamine N-oxide as a mediator of cardiovascular complications in chronic kidney disease

James A.P. Tomlinson[1,2] and David C. Wheeler[3]



TMAO = Trimethylamin N-Oxid



Take home figure Summary scheme: effect of a red meat containing diet on the metaorganismal trimethylamine N-oxide pathway.

Published on behalf of European Society of Cardiology

Surprising Sources of TMAO

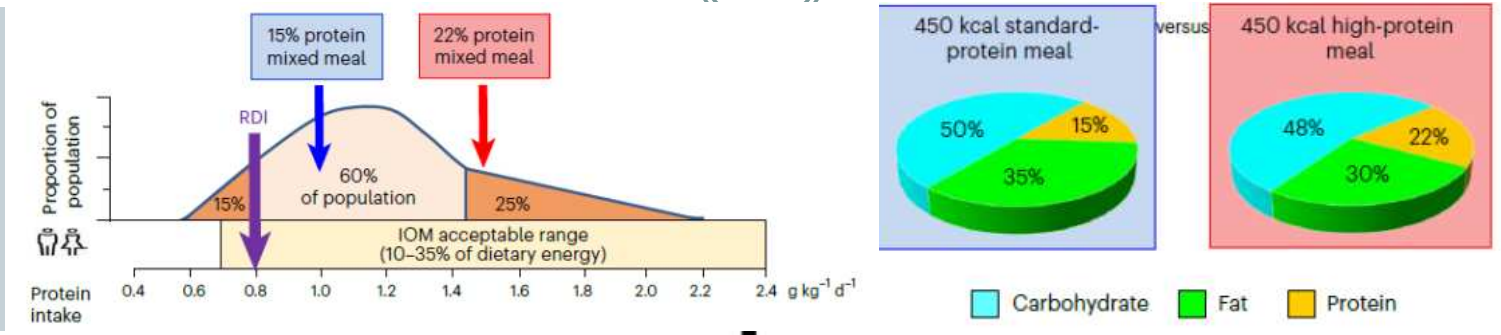
Animal products and dietary supplements are well-known sources of choline and L-carnitine, but the TMAO-precursors can also show up in these unexpected places:

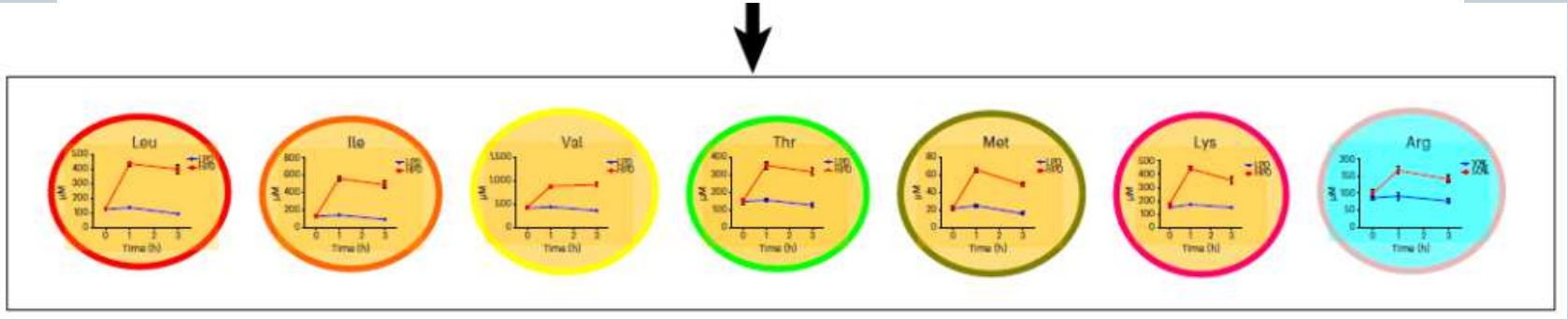
- Processed foods that contain phosphatidylcholine, also known as lecithin
- Energy drinks
- Protein supplementation products
- Some fruits and vegetables

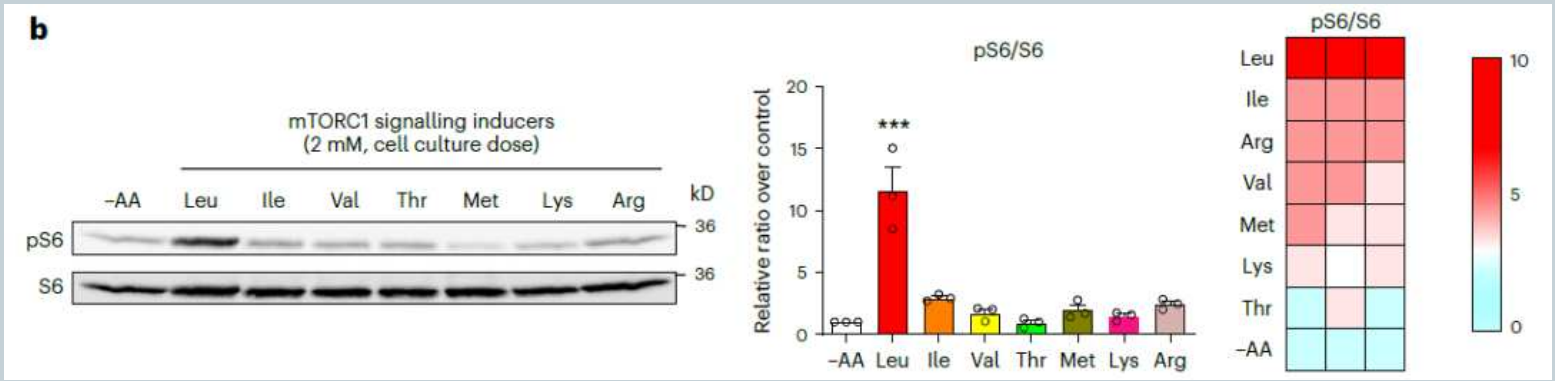
FMO = Flavin Mono-oxygenase

Kidney International (2017) **92,** 809–815

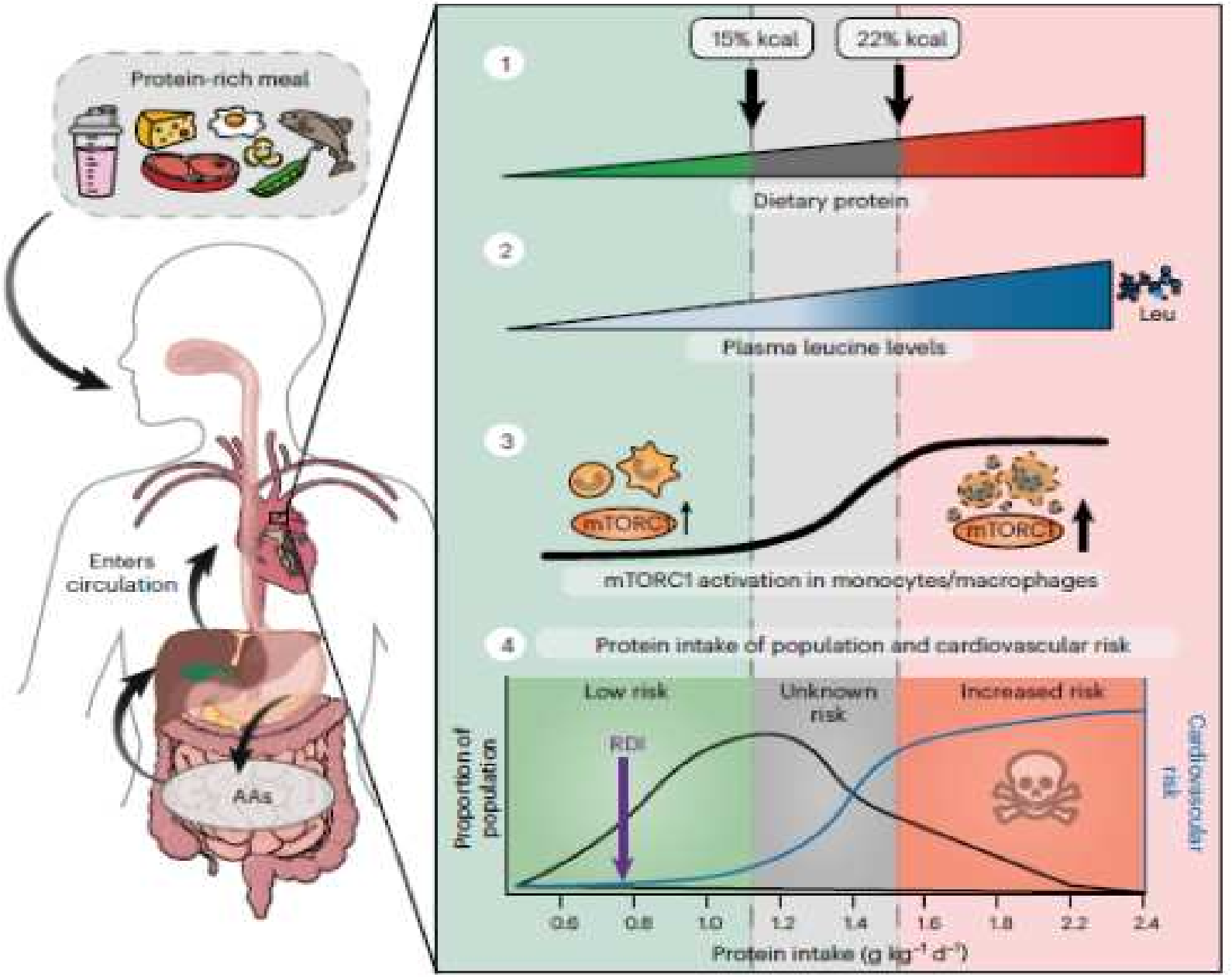
Identification of a leucine-mediated threshold effect governing macrophage mTOR signalling and cardiovascular risk







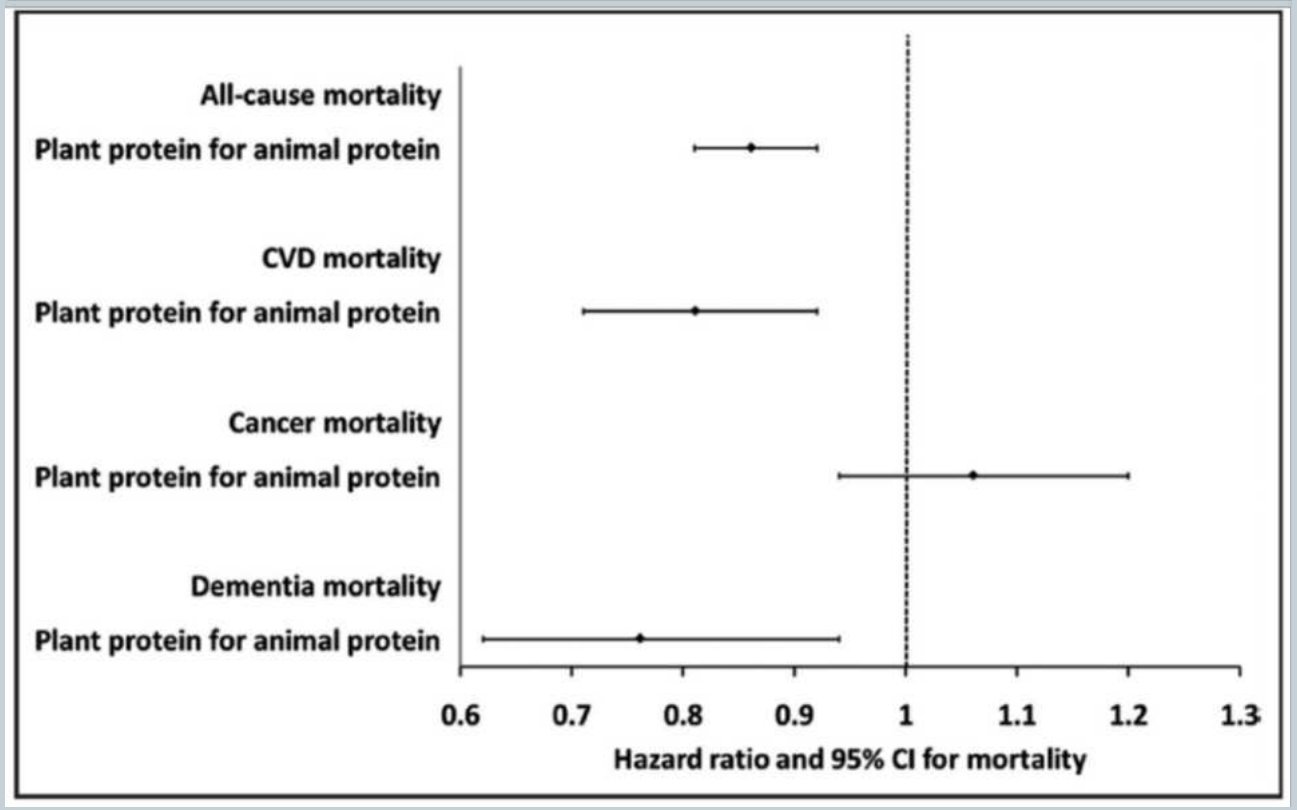
Nature Metabolism | Volume 6 | February 2024 | 359–377


Protein-rich meal
Enters circulation
AAs
15% kcal
22% kcal
1
Dietary protein
2
Leu
Plasma leucine levels
3
mTORC1
mTORC1
mTORC1 activation in monocytes/macrophages
4
Protein intake of population and cardiovascular risk
Low risk
Unknown risk
Increased risk
RDI
Proportion of population
Cardiovascular risk
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.2
2.4
Protein intake (g kg⁻¹ d⁻¹)

Association of Major Dietary Protein Sources With All-Cause and Cause-Specific Mortality: Prospective Cohort Study

Yangbo Sun, MD, PhD; Buyun Liu, MD, PhD; Linda G. Snetselaar, PhD; Robert B. Wallace, MD;

Figure 1. Hazard ratios of all-cause and cause-specific mortality associated with replacement of 5% energy of animal protein with plant protein.



CLINICAL PERSPECTIVE

What Is New?

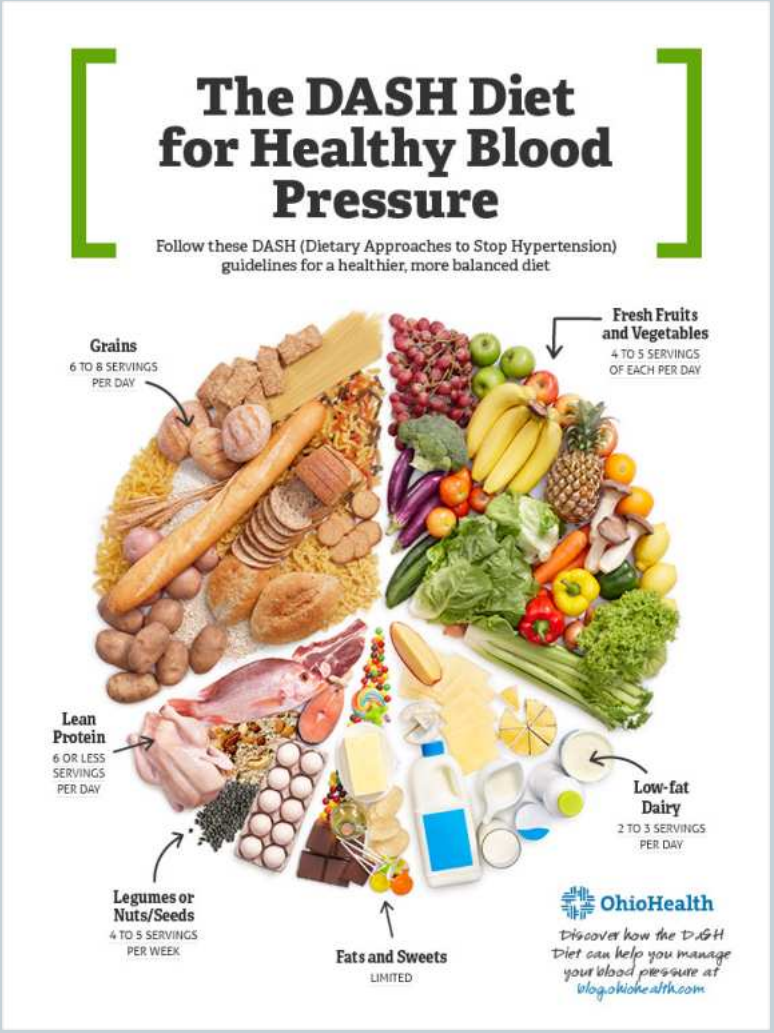
- Different dietary protein sources have varying associations with all-cause mortality, cardiovascular disease mortality, and dementia mortality.
- Higher plant protein intake and substitution of animal protein with plant protein were associated with lower risk of all-cause mortality, cardiovascular disease mortality, and dementia mortality.

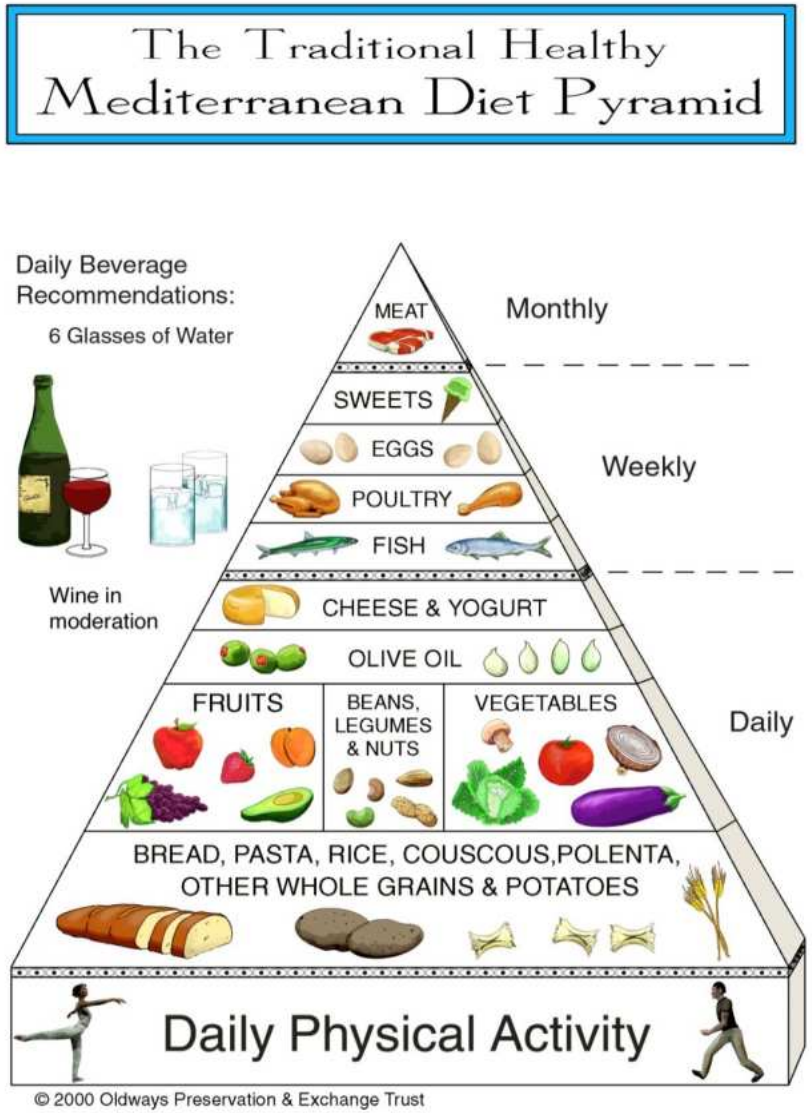
What Are the Clinical Implications?

- Our findings support the need for consideration of protein sources, in addition to the amount of protein intake, in future dietary guidelines.

J Am Heart Assoc. 2021;10

Pflanzen-basierte Ernährung





- **Ungesättigte FS (Fisch, Olivenöl)**
- **Komplexe Kohlenhydrate (Hülsenfrüchte)**
- **Hoher Ballaststoffgehalt (Gemüse, Früchte)**
- **Hoher Gehalt an Vitamin B6, B12, C, E und Polyphenolen (Gemüse, Früchte, Cerealien, Olivenöl)**

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JUNE 26, 2003 VOL. 348 NO. 26

Adherence to a Mediterranean Diet and Survival in a Greek Population

Table 4. Hazard Ratios for Death Associated with a Two-Point Increment in the Mediterranean-Diet Score.*

Variable	No. of Deaths/ No. of Participants	Hazard Ratio for Death (95% CI)		
		Crude	Age- and Sex-Adjusted	Fully Adjusted
Death from any cause	275/22,043	0.74 (0.65–0.86)	0.79 (0.69–0.91)	0.75 (0.64–0.87)
Death from coronary heart disease	54/22,043	0.68 (0.50–0.94)	0.74 (0.54–1.02)	0.67 (0.47–0.94)
Death from cancer	97/22,043	0.81 (0.64–1.03)	0.85 (0.67–1.08)	0.76 (0.59–0.98)

Mediterrane Diät senkt kardiovaskuläre Mortalität in Gesamtpopulation

Trichopoulou A, NEJM 348:2599, 2003

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 APRIL 4, 2013 VOL. 368 NO. 14

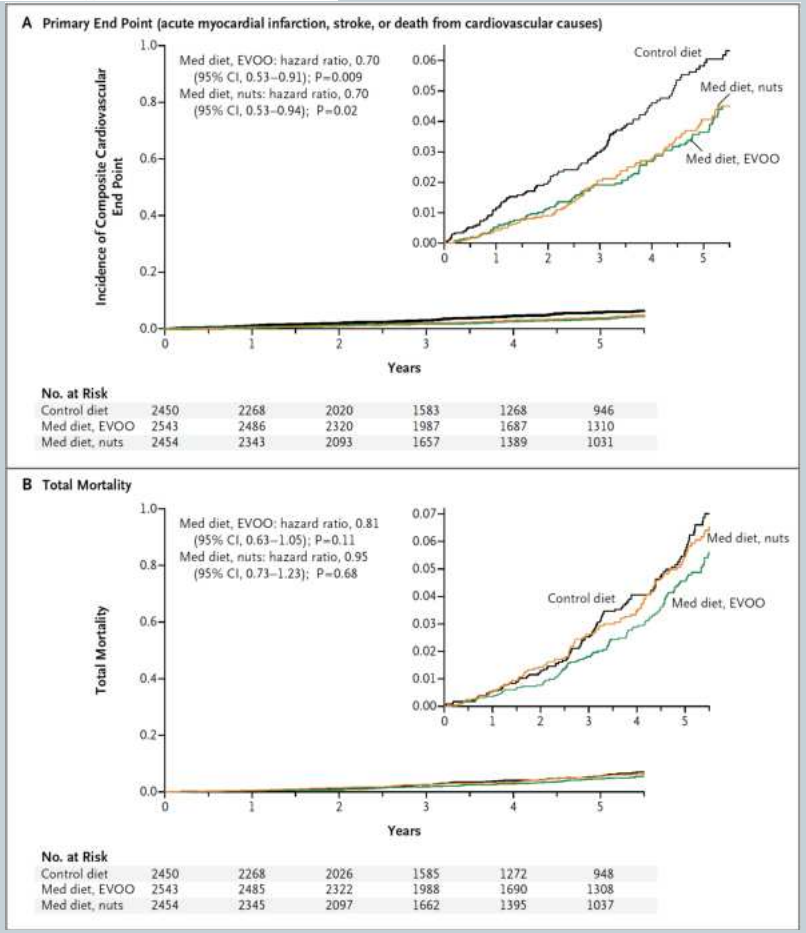
Primary Prevention of Cardiovascular Disease with a Mediterranean Diet

Ramón Estruch, M.D., Ph.D., Emilio Ros, M.D., Ph.D., Jordi Salas-Salvadó, M.D., Ph.D.,

- Multicenter RCT in Spain
- 7447 participants at high cardiovascular risk but free of cardiovascular disease
  - Mediterranean diet + extra-virgin olive oil (n = 2543)
  - Mediterranean diet + mixed nuts (n = 2454)
  - Fat reduced control diet (n = 2450)
- After interim analysis the trial was stopped (median FU of 4.8 yrs)

CONCLUSIONS

Among persons at high cardiovascular risk, a Mediterranean diet supplemented with extra-virgin olive oil or nuts reduced the incidence of major cardiovascular events. (Funded by the Spanish government's Instituto de Salud Carlos III and others; Controlled-Trials.com number, ISRCTN35739639.)



JAMA Internal Medicine | Original Investigation

Association Between Plant and Animal Protein Intake and Overall and Cause-Specific Mortality

Jiaqi Huang, PhD; Linda M. Liao, PhD, MPH; Stephanie J. Weinstein, PhD; Rashmi Sinha, PhD; Barry I. Graubard, PhD; Demetrius Albanes, MD

DESIGN, SETTING, AND PARTICIPANTS This prospective cohort study analyzed data from 416 104 men and women in the US National Institutes of Health–AARP Diet and Health Study from 1995 to 2011. Data were analyzed from October 2018 through April 2020.

Figure. Risk of Overall Mortality Associated With Intake of Plant Protein According to Subgroups Among 237 036 Men and 179 068 Women

Subgroup	Men HR (95% CI)	s increased lity	*P* for interaction
Age at baseline, y			
<60	0.93 (0.90-0.96)		<.001[a]
60-65	0.95 (0.92-0.98)		
≥65	0.97 (0.95-0.99)		
Smoking status			
Never	0.97 (0.94-1.00)		.009
Former	0.96 (0.94-0.98)		
Current	0.94 (0.91-0.97)		
Diabetes			
No	0.96 (0.94-0.97)		.006
Yes	0.93 (0.90-0.97)	–	
BMI			
<18.5	1.10 (0.96-1.27)	—	<.001[a]
18.5 to <25	0.94 (0.91-0.96)		
25 to <30	0.96 (0.94-0.99)		
30 to <35	0.95 (0.92-0.99)		
≥35	0.99 (0.93-1.05)	———	
Alcoholic drinks/d			
≤1	0.97 (0.96-0.99)		.006
>1 to 3	0.93 (0.89-0.97)	0.91 (0.85-0.97)	
>3	0.89 (0.85-0.93)	0.85 (0.77-0.94)	
Fruit consumption			

Key Points

Question Does an association exist between dietary protein choice, particularly from various food sources, and long-term overall mortality or cause-specific mortality in the US population?

Findings In this cohort of 237 036 men and 179 068 women with 16 years of observation and nearly 78 000 deaths, greater intake of plant protein was significantly associated with lower overall mortality and cardiovascular disease mortality independent of several other risk factors.

Meaning This study provides evidence for public health recommendations regarding dietary modifications in choice of protein sources that may promote health and longevity.

Plant-Based Diets and Incident CKD and Kidney Function

Hyunju Kim,[1,2] Laura E. Caulfield,[1] Vanessa Garcia-Larsen,[1] Lyn M. Steffen,[3] Morgan E. Grams,[2,4] Josef Coresh,[2,4] and Casey M. Rebholz[2,4]

Design, setting, participants, & measurements Analyses were conducted in a sample of 14,686 middle-aged adults enrolled in the Atherosclerosis Risk in Communities study. Diets were characterized using four plant-based diet indices. In the overall plant-based diet index, all plant foods were positively scored; in the healthy plant-based diet index, only healthful plant foods were positively scored; in the provegetarian diet, selected plant foods were positively scored. In the less healthy plant-based diet index, only less healthful plant foods were positively scored. All indices negatively scored animal foods. We used Cox proportional hazards models to study the association with incident CKD and linear mixed models to examine decline in eGFR, adjusting for confounders.

Results During a median follow-up of 24 years, 4343 incident CKD cases occurred. Higher adherence to a healthy plant-based diet (HR comparing quintile 5 versus quintile 1 [$HR_{Q5\ versus\ Q1}$], 0.86; 95% confidence interval [95% CI], 0.78 to 0.96; *P* for trend =0.001) and a provegetarian diet ($HR_{Q5\ versus\ Q1}$, 0.90; 95% CI, 0.82 to 0.99; *P* for trend =0.03) were associated with a lower risk of CKD, whereas higher adherence to a less healthy plant-based diet ($HR_{Q5\ versus\ Q1}$, 1.11; 95% CI, 1.01 to 1.21; *P* for trend =0.04) was associated with an elevated risk. Higher adherence to an overall plant-based diet and a healthy plant-based diet was associated with slower eGFR decline. The proportion of CKD attributable to lower adherence to healthy plant-based diets was 4.1% (95% CI, 0.6% to 8.3%).

Conclusions Higher adherence to healthy plant-based diets and a vegetarian diet was associated with favorable kidney disease outcomes.

Clin J Am Soc Nephrol 14: 682–691, 2019

Healthy Dietary Patterns and Risk of Mortality and ESRD in CKD: A Meta-Analysis of Cohort Studies

Jaimon T. Kelly, Suetonia C. Palmer,† Shu Ning Wai,* Marinella Ruospo,‡§ Juan-Jesus Carrero,‖ Katrina L. Campbell,* and Giovanni F. M. Strippoli§¶***

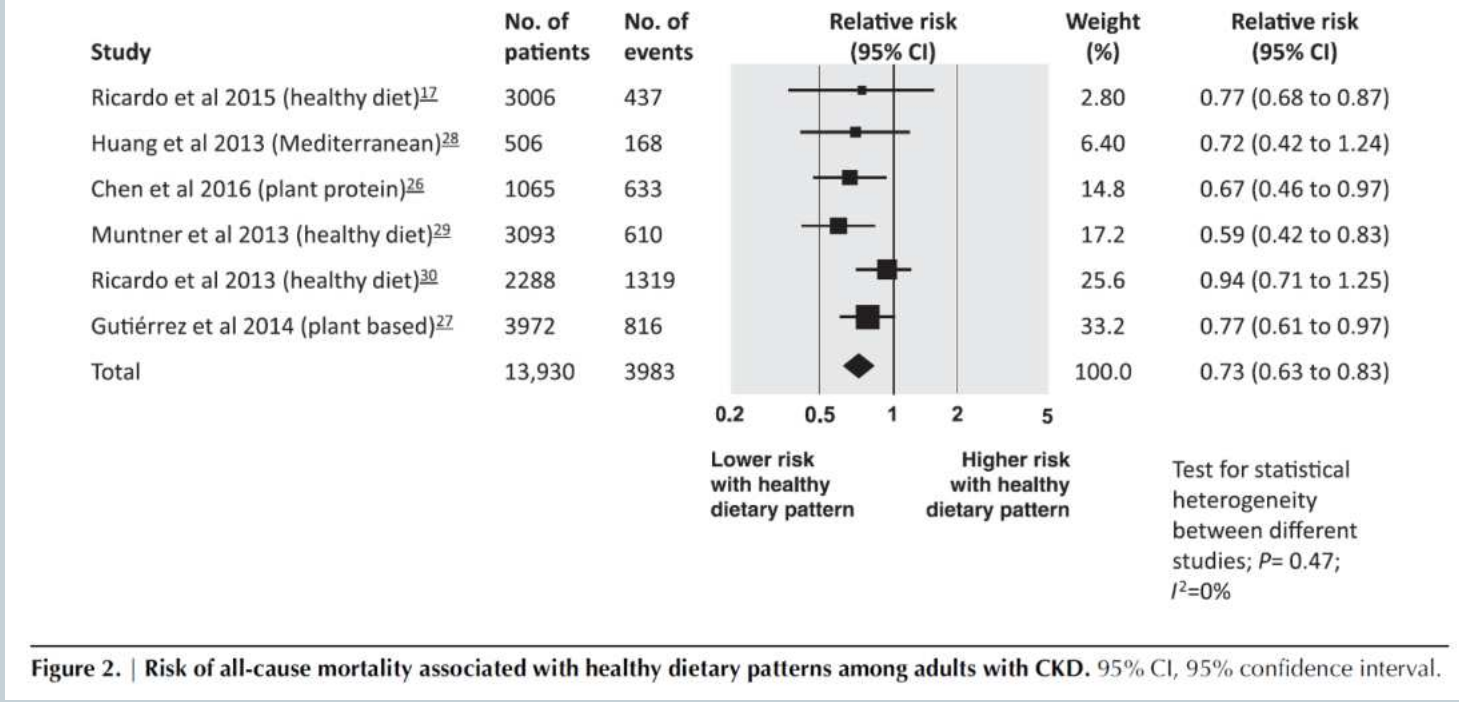


Figure 2. | **Risk of all-cause mortality associated with healthy dietary patterns among adults with CKD.** 95% CI, 95% confidence interval.

Conclusions Healthy dietary patterns are associated with lower mortality in people with kidney disease. Interventions to support adherence to increased fruit and vegetable, fish, legume, whole grain, and fiber intake, and reduced red meat, sodium, and refined sugar intake could be effective tools to lower mortality in people with kidney disease.

Kelly JT et al. CJASN 2017; 12: 272-279

Ballaststoffreiche Ernährung assoziiert mit weniger Inflammation und niedrigerer Mortalität bei CKD-Patienten

- Empfohlene Ballaststoffeinnahme: 30g/Tag[1]
- CKD-Patienten: im Schnitt nur 15g/d[2,3]
- Obst, Gemüse, Vollkorn wichtige Quellen
- Mehr Ballaststoffe = weniger Inflammation (CRP↓) [2,3]
- Mehr Ballaststoffe = niedrigere Mortalität bei CKD[2,3]
- Fermentierbare Ballaststoffe → kurzkettige Fettsäuren (SCFA)
- Nicht-fermentierbare Ballaststoffe
  → kürzere Darmpassagezeit, höheres Stuhlvolumen

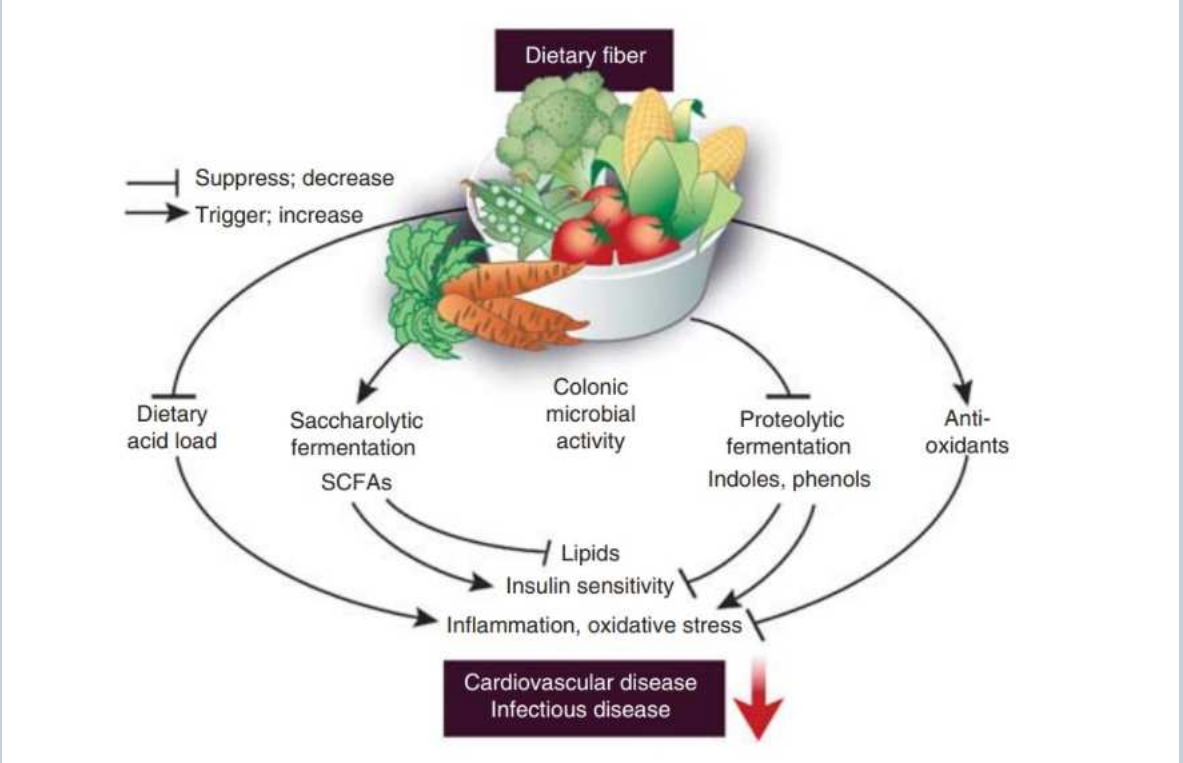
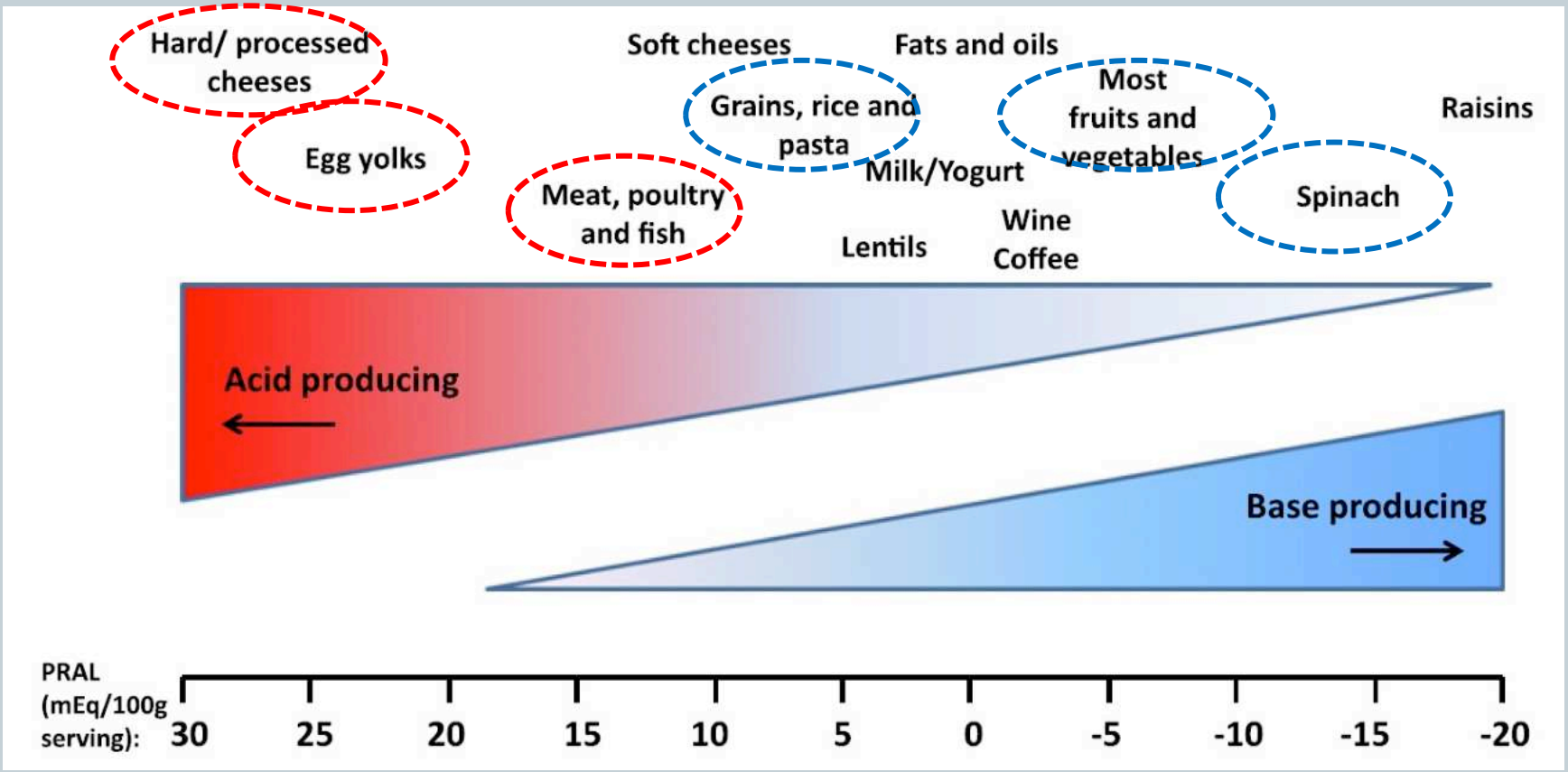


Abbildung aus [3]

1 https://www.dge.de/gesunde-ernaehrung/dge-ernaehrungsempfehlungen/
2 **Krishnamurthy, V. M., et al.** (2012). "High dietary fiber intake is associated with decreased inflammation and all-cause mortality in patients with chronic kidney disease." Kidney Int **81**(3): 300-306.
3 **Evenepoel, P.** and B. K. Meijers (2012). "Dietary fiber and protein: nutritional therapy in chronic kidney disease and beyond." Kidney Int **81**(3): 227-229.

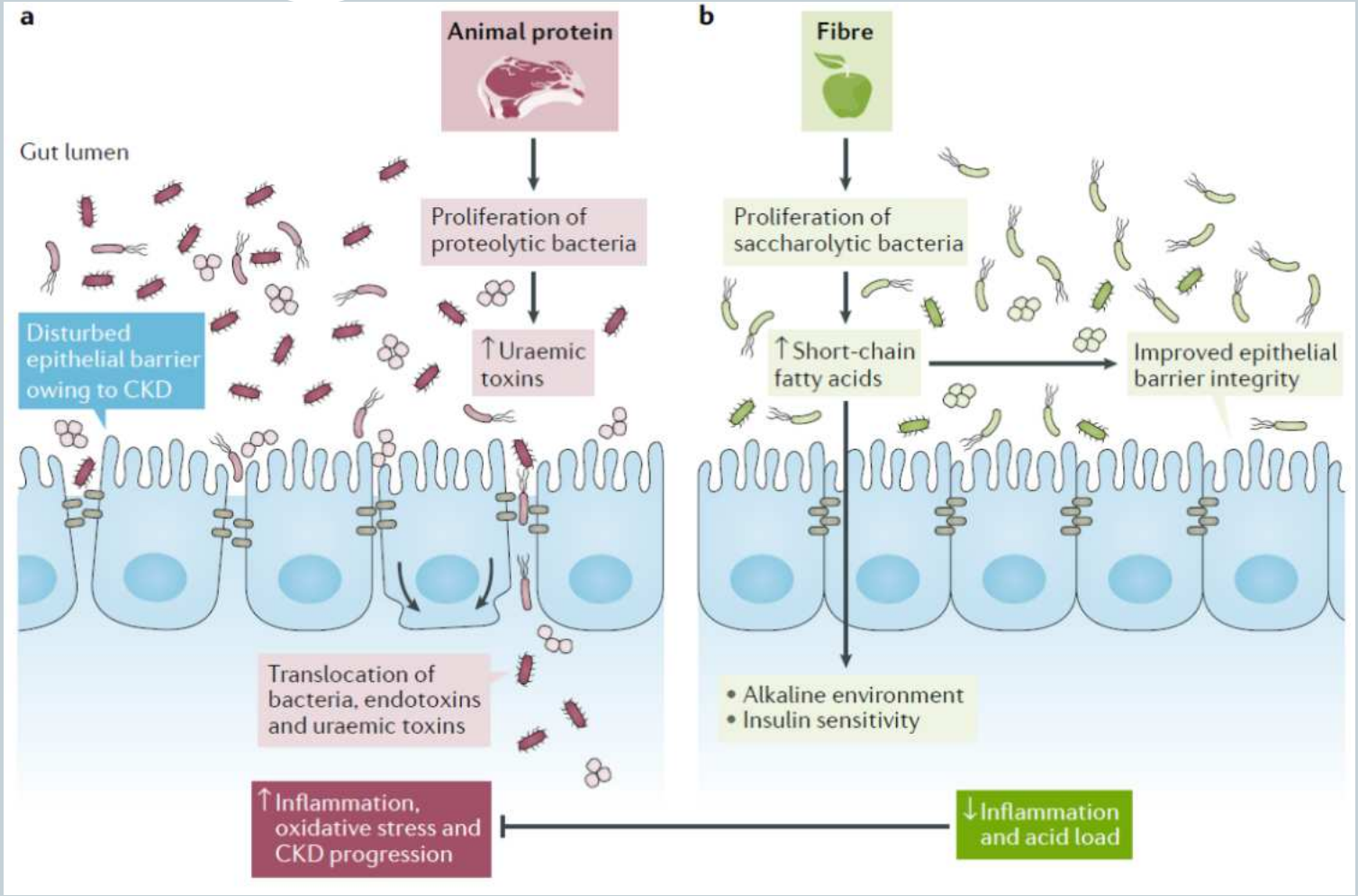
Pflanzen-basierte Kost verringert die endogene Säurebelastung



Advances in Chronic Kidney Disease, Vol 20, No 2 (March), 2013: pp 141-149

Ballaststoffe stimulieren das Darm-Microbiom zur Produktion von anti-inflammatorischen Substanzen und weniger Urämietoxinen

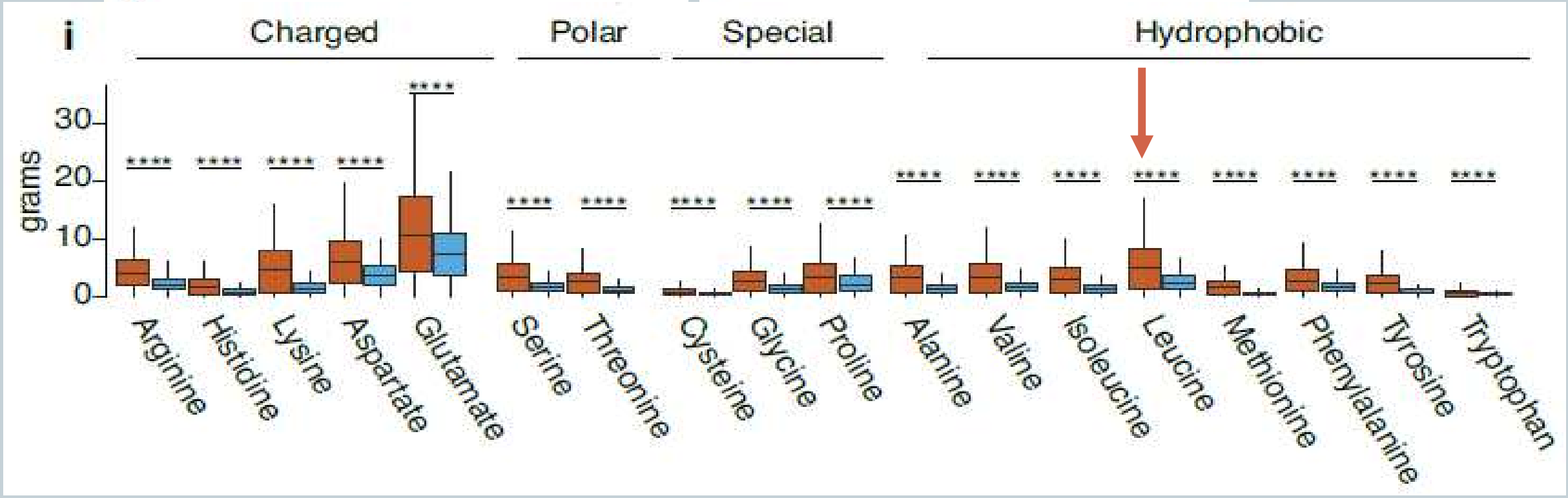
- Urämietoxine entstehen im Darm durch bakteriellen Abbau von Proteinen (proteolytische Bakterien)
- bei CKD vermehrt wg. Malabsorption = mehr Protein im Colon
- Urämietoxine (u.a. TMAO, P-cresyl-sulfat, Indoxylsulfat) fördern Atherosklerose und endotheliale Dysfunktion → höheres kardiovaskuläres Risiko
- Kurzkettige Fettsäuren entstehen durch mikrobielle Fermentation von Ballaststoffen (symbiotische Saccharolytische Bakterien) →Integrität Darmepithel
- Pflanzliche Proteine = immer gemeinsam mit Ballaststoffen



Carrero, J. J., et al. (2020). "Plant-based diets to manage the risks and complications of chronic kidney disease." Nat Rev Nephrol **16**(9): 525-542.

Effect of a plant-based, low-fat diet versus an animal-based, ketogenic diet on ad libitum energy intake

Kevin D. Hall[1]✉, Juen Guo[1], Amber B. Courville[1], James Boring[2], Robert Brychta[1],



Nature Medicine 2024; doi 10.1038/s41591-023-02761-2

NATURE MEDICINE | VOL 27 | FEBRUARY 2021 | 344–353

Risikostratifizierung bei CKD

CKD-assoziiertes kardiovaskuläres* und renales** Risiko (KDIGO 2012)			Albuminurie-Kategorien Albumin/Kreatinin-Quotient i. U. mg/g Kreatinin		
			A1	A2	A3
			< 30	30 - 300	> 300
GFR-Kategorien ml/min/1,73 m²	G1	> 90	niedrig	moderat	hoch
	G2	60 - 89	niedrig	moderat	hoch
	G3a	45 - 59	moderat	hoch	sehr hoch
	G3b	30 - 44	hoch	sehr hoch	sehr hoch
	G4	15 - 29	sehr hoch	sehr hoch	sehr hoch
	G5	< 15	sehr hoch	sehr hoch	sehr hoch

*Kardiovaskuläre Mortalität, Gesamtmortalität

**Progression der Niereninsuffizienz, Dialysepflicht

Nutrition in CKD by KDIGO Risk Categories

Cardiovascular and Renal Risk	*low*	*moderately increased*	*high*	*very high*
CKD-Stages	G1A1, G2A1	G1A2, G2A2, G3aA1	G1A3, G2A3, G3aA2, G3bA1	G3aA3,G3bA2/A3 G4Ax, G5Ax
Fraction of CKD-Population§	63,1%	23.6%	8,2%	5,1%
Protein Intake	No protein restriction 0,8 - 1,2 g/kg ibw*/d adjusted for physical activity level	No protein restriction 0,8 - 1,2 g/kg ibw*/d adjusted for physical activity level	Moderate protein restriction 0,6 - 0,8 g/kg ibw/d monitor nutritional status	0,6 - 1,0 g/kg ibw/d cave: risk of malnutrition with inadequate protein intake
Energy Intake	25 - 35 kcal/kg ibw/d adjusted for physical activity level	25 - 35 kcal/kg ibw/d adjusted for physical activity level	30 - 35 kcal/kg ibw/d adjusted for physical activity level	30 - 35 kcal/kg ibw/d adjusted for physical activity level
Alkali	No need for substitution	No need for substitution	Plant-based protein as alkali source	Plant-based protein HCO_3^--substitution in acidotic pts.
Nutritional concept	Plant-based nutrition	Plant-based nutrition	Plant-based nutrition	Plant-based nutrition + regular dietary counceling

§Rheinberger M, Jung B, Segiet T et al. Poor risk factor control in outpatients with diabetes mellitus type 2 in Germany: The DIAbetes COhoRtE (DIACORE) study. PLoS ONE 2019; 14(3): e0213157

Vielen Dank für die Aufmerksamkeit

Vielen Dank für die Aufmerksamkeit

Cochrane Library

Cochrane Database of Systematic Reviews

Altered dietary salt intake for people with chronic kidney disease (Review)

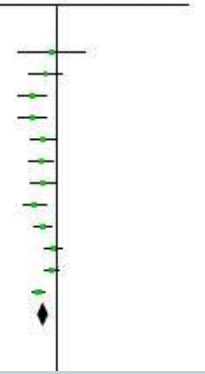
McMahon EJ, Campbell KL, Bauer JD, Mudge DW, Kelly JT

Analysis 1.2. Comparison 1: CKD stage, Outcome 2: Systolic blood pressure

Study or Subgroup	Low salt Mean [mm Hg]	Low salt SD [mm Hg]	Low salt Total	High salt Mean [mm Hg]	High salt SD [mm Hg]	High salt Total	Weight	Mean Difference IV, Random, 95% CI [mm Hg]
1.2.1 CKD								
Ruilope 1992a	146.1	20.2	14	148	21.2	14	1.4%	-1.90 [-17.24 , 13.44]
Mulhauser 1996	-1.7	8.3132	8	3.2	6.9376	8	4.3%	-4.90 [-12.40 , 2.60]
DUAAAL 2011	123	16.3975	52	134	16.3975	52	5.3%	-11.00 [-17.30 , -4.70]
Saran 2017	137	15.7468	49	147.8	15.7468	49	5.3%	-10.80 [-17.04 , -4.56]
Vogt 2008	137	11.9197	33	143	11.9197	33	5.8%	-6.00 [-11.75 , -0.25]
Konishi 2001	115	11.2	38	121.6	13.1	38	6.1%	-6.60 [-12.08 , -1.12]
ViRTUE-CKD 2016	123	12	43	129	14	44	6.1%	-6.00 [-11.48 , -0.52]
LowSALT CKD 2012	144.9	8.2285	20	154.6	8.2285	20	6.6%	-9.70 [-14.80 , -4.60]
Kwakernaak 2014	141	10.4869	45	147	10.4869	45	7.6%	-6.00 [-10.33 , -1.67]
ESPECIAL 2014	-1.7	14.6	119	-0.6	15.1	126	8.4%	-1.10 [-4.82 , 2.62]
ESMO 2017	125	9.8	67	127	10.1	71	9.0%	-2.00 [-5.32 , 1.32]
de Brito-Ashurst 2013	-8.6	5.2977	25	-0.6	5.2977	23	9.5%	-8.00 [-11.00 , -5.00]
Subtotal (95% CI)			**513**			**523**	**75.5%**	**-6.10 [-8.11 , -4.08]**

Heterogeneity: Tau² = 5.51; Chi² = 20.96, df = 11 (P = 0.03); I² = 48%

Test for overall effect: Z = 5.93 (P < 0.00001)

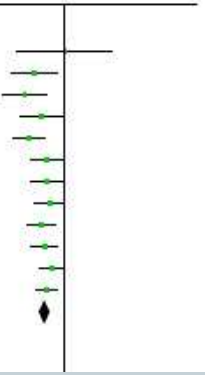


Analysis 1.3. Comparison 1: CKD stage, Outcome 3: Diastolic blood pressure

Study or Subgroup	Low salt Mean [mm Hg]	Low salt SD [mm Hg]	Low salt Total	High salt Mean [mm Hg]	High salt SD [mm Hg]	High salt Total	Weight	Mean Difference IV, Random, 95% CI [mm Hg]
1.3.1 CKD								
Ruilope 1992a	90.3	11.3	14	90.1	12.1	14	1.0%	0.20 [-8.47 , 8.87]
Mulhauser 1996	-3.1	3.2894	8	2.2	4.7846	8	4.1%	-5.30 [-9.32 , -1.28]
DUAAAL 2011	73	10.4348	52	80	10.4348	52	4.1%	-7.00 [-11.01 , -2.99]
Konishi 2001	75	8	38	79	9	38	4.5%	-4.00 [-7.83 , -0.17]
Saran 2017	70.8	7.4201	47	77	7.4201	47	6.6%	-6.20 [-9.20 , -3.20]
ViRTUE-CKD 2016	74	7.0049	43	77	7.0049	44	6.8%	-3.00 [-5.94 , -0.06]
Vogt 2008	83	6.093	33	86	6.093	33	6.8%	-3.00 [-5.94 , -0.06]
ESPECIAL 2014	73.6	10.7768	119	76	10.7768	126	7.7%	-2.40 [-5.10 , 0.30]
LowSALT CKD 2012	79.4	4.0336	20	83.3	4.0336	20	8.6%	-3.90 [-6.40 , -1.40]
Kwakernaak 2014	78.6	5.8084	45	82	5.8084	45	9.1%	-3.40 [-5.80 , -1.00]
ESMO 2017	74	6.5	67	76	6.7	71	10.1%	-2.00 [-4.20 , 0.20]
de Brito-Ashurst 2013	-4	4.4	25	-1	2.1	23	11.9%	-3.00 [-4.93 , -1.07]
Subtotal (95% CI)			**511**			**521**	**81.3%**	**-3.47 [-4.28 , -2.65]**

Heterogeneity: Tau² = 0.00; Chi² = 10.57, df = 11 (P = 0.48); I² = 0%

Test for overall effect: Z = 8.30 (P < 0.00001)

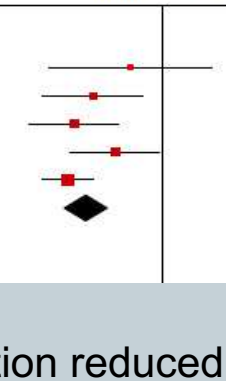


Analysis 1.5. Comparison 1: CKD stage, Outcome 5: Albuminuria [ln mg/d]

Study or Subgroup	MD	SE	Weight	Mean Difference IV, Random, 95% CI
1.5.1 CKD				
Saran 2017	-0.2	0.2551	7.1%	-0.20 [-0.70 , 0.30]
ESPECIAL 2014	-0.43	0.158224	15.5%	-0.43 [-0.74 , -0.12]
Kwakernaak 2014	-0.5447	0.1379	18.9%	-0.54 [-0.81 , -0.27]
ViRTUE-CKD 2016	-0.293	0.1376	18.9%	-0.29 [-0.56 , -0.02]
LowSALT CKD 2012	-0.5798769	0.0798343	34.3%	-0.58 [-0.74 , -0.42]
Subtotal (95% CI)			**94.8%**	**-0.47 [-0.60 , -0.34]**

Heterogeneity: Tau² = 0.00; Chi² = 4.91, df = 4 (P = 0.30); I² = 19%

Test for overall effect: Z = 7.17 (P < 0.00001)



- High certainty evidence that salt reduction reduced blood pressure in people with CKD, and albuminuria in people with earlier stage CKD in the short-term.
- If such reductions could be maintained long-term, this effect may translate to clinically significant reductions in CKD progression and cardiovascular events.
- Research into the long-term effects of sodium-restricted diet for people with CKD is warranted.

Cochrane Database of Systematic Reviews 2021, Issue 6.

Nutrition in CKD by KDIGO Risk Categories

	KDIGO Risk-Category I	KDIGO Risk-Category II	KDIGO Risk-Category III	KDIGO Risk-Category IV
Cardiovascular and Renal Risk	*low*	*moderately increased*	*high*	*very high*
CKD-Stages	G1A1, G2A1	G1A2, G2A2, G3aA1	G1A3, G2A3, G3aA2, G3bA1	G3aA3,G3bA2/A3 G4Ax, G5Ax
Fraction of CKD-Population§	63,1%	23.6%	8,2%	5,1%
Protein Intake	No protein restriction 0,8 - 1,2 g/kg ibw*/d adjusted for physical activity level	No protein restriction 0,8 - 1,2 g/kg ibw*/d adjusted for physical activity level	Moderate protein restriction 0,6 - 0,8 g/kg ibw/d monitor nutritional status	0,6 - 1,0 g/kg ibw/d cave: risk of malnutrition with inadequate protein intake
Energy Intake	25 - 35 kcal/kg ibw/d adjusted for physical activity level	25 - 35 kcal/kg ibw/d adjusted for physical activity level	30 - 35 kcal/kg ibw/d adjusted for physical activity level	30 - 35 kcal/kg ibw/d adjusted for physical activity level
Sodium/Salt	In pts w/arterial hypertension < 3-4 g Na^+/d, < 6-8 g salt/d	< 2-3 g Na^+/d, < 5-6 g salt/d	< 2-3 g Na^+/d, < 5-6 g salt/d	< 2 g Na^+/d, < 5 g salt/d
Potassium	No restriction	No restriction	Rarely K^+-restriction	Dietary K+-restriction or potassium binders in pts with increased risk for hyperkalemia
Calcium	1000 - 2000 mg/d	1000 - 2000 mg/d	1000 mg/d, maximum 1500 mg/d	1000 mg/d, maximum 1500 mg/d avoid Ca^{++}-containing phosphate binders
Phosphate	No restriction	10 - 15 mg/kg bw/d	10 - 15 mg/kg bw/d avoid phosphate containing food additives	10 - 15 mg/kg bw/d avoid PO-containing food additives consider phosphate binders
Vitamines	No special requirements	No special requirements	Substitution for specific hypovitaminosis	Substitution in malnutrition and/or specific hypovitaminosis
Fluid intake	No restriction no minimum requirement	No restriction no minimum requirement	Dependent on volume status and comorbidities	Dependent on volume status, comorbidities and RRF
Alkali	No need for substitution	No need for substitution	Plant-based protein as alkali source	Plant-based protein HCO_3^--substitution in acidotic pts.
Nutritional concept	Mediterranean Diet	Mediterranean Diet	Mediterranean Diet	Mediterranean Diet + regular dietary counceling

§Rheinberger M, Jung B, Segiet T et al. Poor risk factor control in outpatients with diabetes mellitus type 2 in Germany: The DIAbetes COhoRtE (DIACORE) study. PLoS ONE 2019; 14(3): e0213157