Nutritional Factors Impacting Muscle, Fat, and Bone

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Aging Affects Food Intake

- Compared with younger adults older adults had:
  - 16%–20% lower energy intake
  - 25% to 39% lower hunger
  - 37% greater fullness

- Calcium
- Vitamin D
- Protein
- Antioxidants
  - Vitamin C
  - Carotenoids
- Omega-3 fatty acids
- B-vitamins
- Fiber
- Hydration

Giezenaar et al. Nutrients 2016, 8, 28

Calcium and Vitamin D

Table 1. Dietary reference intakes for calcium, vitamin D and protein in women over the age of 50 years.

Age	IOM†		European Guidance for the Diagnosis and Management of Osteoporosis in Postmenopausal Women‡		
	Calcium RDA (mg/day)	Vitamin D RDA (IU/day)	Calcium RDI (mg/day)	Vitamin D RDI (IU/day)	Protein RDI (g/kg body weight)
51–70 years	1000/1200	400/600	1000–1300	800	1
51–70 years with serum levels of vitamin D <50 nmol/l or <75 nmol/l in those with a high risk of falls and fractures	1000/1200	400/600	1000–1300	800–1000	1
70+ years	1000/1200	400/800	1000–1300	800–1000	1

†Data taken from [58].
‡Data taken from [1].
IOM: Institute of Medicine; RDA: Recommended daily allowance; RDI: Recommended daily intake.

Rizzoli et al. Women's Health 2014, 10 (6)

Dietary Protein and Bone Health

- Meta-analysis of prospective cohort and RCT studies
  - Dietary protein alone and with calcium, with or without vitamin D
  - Fracture outcomes, BMD, BMC, and select bone turnover markers
- No adverse effects of high dietary protein
- Positive trends for BMD at most bone sites. Moderate evidence for a protective effect on lumbar spine BMD
- Heterogeneity (variety of designs, doses, durations, outcomes)
- Limited duration to see effects on BMD, BMC, and fractures
- Larger long term RCTs are needed

Shams-White MM et al. AJCN 2017; 105 (6): 1528-43

Dietary Protein and Muscle Health

- Dietary protein and exercise are the only recommendation for age-related muscle loss
- Meta-analysis of 49 RCTs on protein supplementation and resistance exercise training showed that protein supplementation increased fat free mass, muscle strength and muscle fiber cross-sectional area
  - Protein's effect reduced with age and improved with resistance exercise
  - Intake beyond 1.6g/kg body weight/day had no benefit
- RCT in functionally limited older men showed no benefit beyond recommended dietary allowance (RDA: 0.8 g/kg body weight/day) for lean body mass

Morton et al. Br J Sports med 2019; 52
Bhasin et al. JAMA Intern Med, 2018; 178 (4)

How Much Protein Do We Need?

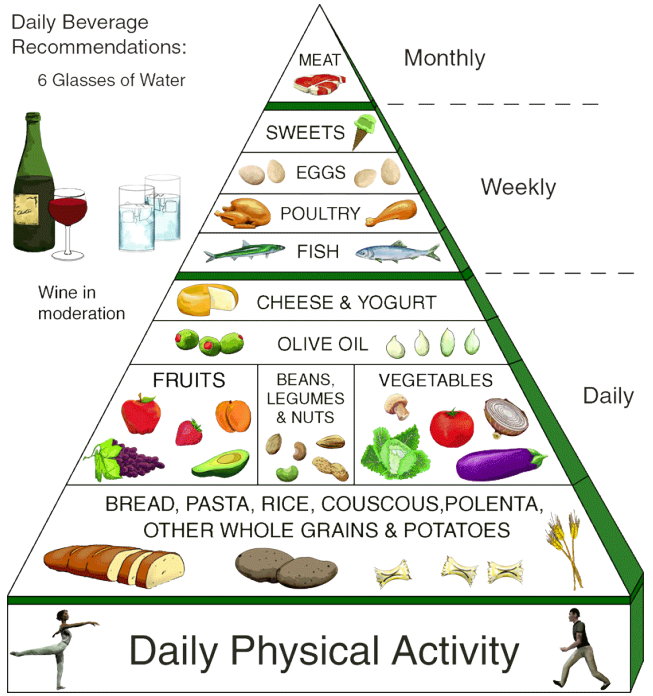
- Recommended Dietary Allowance (RDA): 0.8 grams per kg of body weight/day (IOM, 2005)
- 10-25% of older adults eat less protein than the RDA
- RDA is based on nitrogen balance studies. Prevention of nitrogen loss, an inadequate outcome for older adults at risk of sarcopenia
- Should the RDA be higher for older adults?

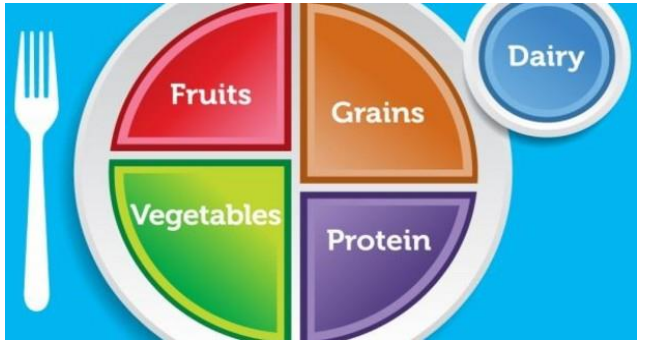
Antioxidants (vitamin C, E and carotenoids)

Study	Study Sample	Exposure	Effect
Melhus, Michaelsson et al. 1999	-n=66,651 women -Age=40-76 y -Nested case-control	Current smokers: - Low Dietary vitamin E - Low Dietary vitamin C - Low Dietary vitamin E & C	Fracture ↑ ↑ ↑ ↑
Sahni et al. 2008	-N=366 men and 592 women -Mean age= 75y -Prospective cohort	High intake of: - Total vitamin C - Supplemental vitamin C	Hip fracture ↓ ↓
Melhus et al. 1999	-n=66,651 women -Age=40-76 y -Nested case-control	Dietary β-carotene among smokers	↑ Hip fracture
Sahni et al. 2008	-N=370 men and 576 women -Mean age= 75y -Prospective cohort	- Total carotenoids - Lycopene - β-carotene	Hip fracture ↓

Dietary Patterns

- Overall diet quality appears to be important for successful aging
- Specific dietary patterns (DASH diet, Mediterranean diet and Healthy Eating Index) as well as food patterns (dairy, fruits and vegetables) have been linked with bone loss, fractures and frailty in epidemiological studies
- Data lacking from prospective studies and clinical trials that use standardized approaches and robust musculoskeletal endpoints





Dietary Alterations of Microbiome: Impact on Bone, Muscle & Fat

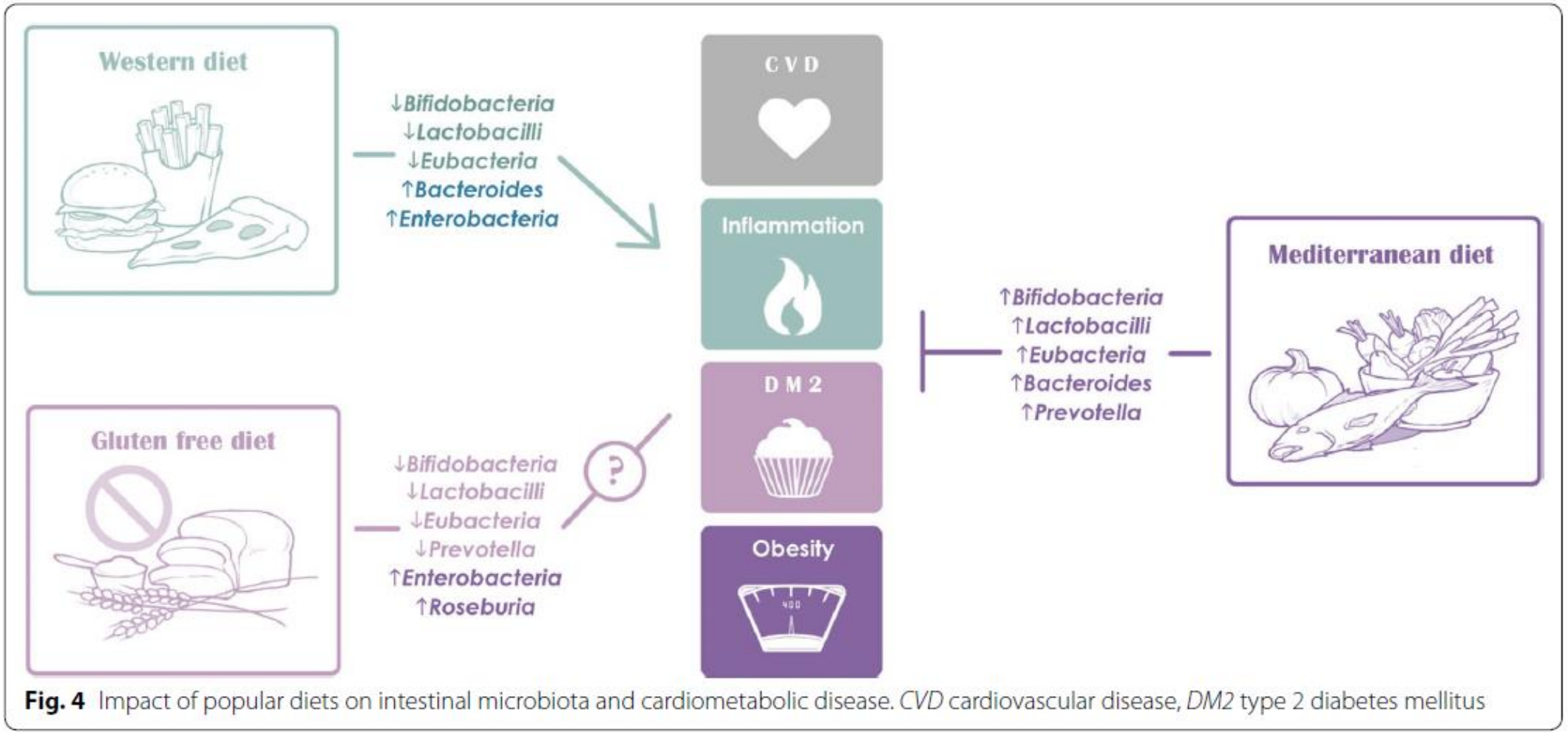


Fig. 4 Impact of popular diets on intestinal microbiota and cardiometabolic disease. *CVD* cardiovascular disease, *DM2* type 2 diabetes mellitus

Singh et al. J Transl Med (2017) 15:73

Diet & Microbiome

- How can microbiome be modified by diet in a sustained manner
- How do individual differences in microbiota alter the therapeutic response to drugs and nutritional interventions
- What is the benefit of prebiotics and probiotics
- How do studies in animals translate into humans
- Incoming data from some cohort studies of gut microbiome and bone and fat

Stevens et al. JBMR 2015; 31 (2)

Knowledge Gaps

- Optimal combination and dose of vitamin D and calcium
- Establish new end points other than nitrogen balance for protein sufficiency in older adults
- Assess dietary protein needs (healthy vs. frail vs. older adults with acute needs and chronic diseases)
- Impact of protein supplementation in conjunction with antioxidants
- Diet and microbiome interactions and their impact on bone, muscle and fat

Research Opportunities

- Nutritional interventions to optimize protein intake and assess distribution of protein across meals
- Prospective studies and clinical trials to evaluate the impact of dietary patterns
- Diet and microbiome → bone, muscle, fat
- Nutrition and frailty
- Nutri omics research
- Cross-cohort collaborations for nutrition and musculoskeletal research