



# Nutrition and Bone: Beyond Calcium and Vitamin D

Speaker: Dr. Sandra Iuliano

University of Melbourne (Australia)

Moderator: Prof. Belinda Beck

Griffith University (Australia)

# Moderator Introduction

## Prof. Belinda Beck

- ❖ Belinda Beck is a Professor in the School of Health Sciences & Social Work at Griffith University's Gold Coast campus and a member of the Menzies Health Institute Queensland. She specializes in musculoskeletal anatomy and bone research, focusing on the effects of mechanical loading on bone.
- ❖ Dr. Beck has secured over \$3 million in research funding, authored 100+ scientific papers, and led the LIFTMOR clinical trials, establishing exercise as a therapy for osteoporosis. In 2015, she founded The Bone Clinic to implement her research findings through the ONERO program.
- ❖ She serves on multiple advisory committees, including the Medical and Scientific Advisory Committee of Healthy Bones Australia, and is a member of the Capture the Fracture® Governance.



# Speaker Introduction

## Dr. Sandra Iuliano

- ❖ Dr. Sandra Iuliano is a senior research fellow in the department of medicine, University of Melbourne, researching nutrition and exercise across the lifespan; specifically, to improve musculoskeletal health.
- ❖ Relative to aging, her work focused on food-based approaches to prevent falls, fractures, and malnutrition in older adults in aged-care.
- ❖ She provided input into the quality and safety standards for aged care, was summoned to present evidence at the Royal Commission in aged-care and is a member of the National Aged-Care Advisory Council.



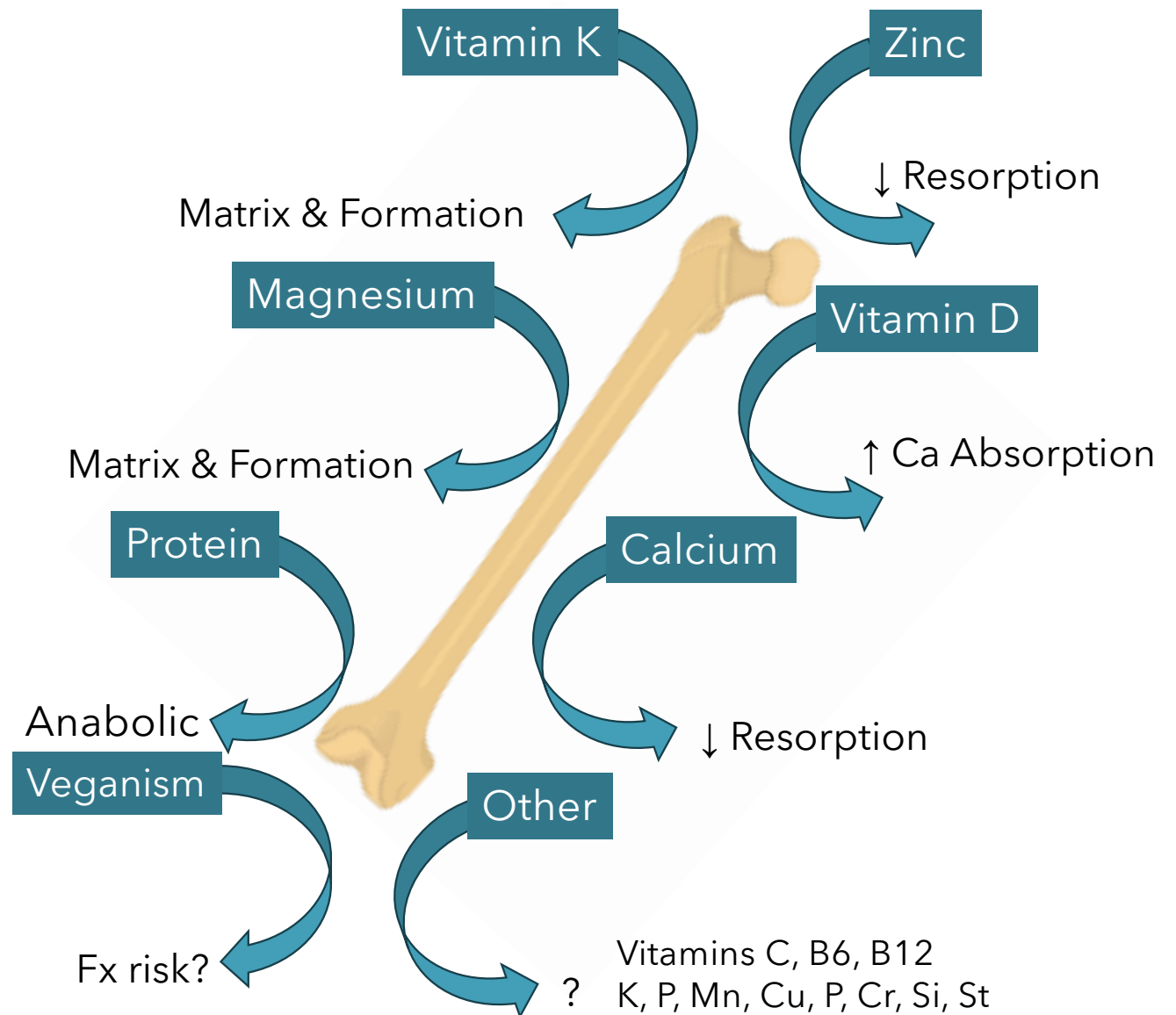
# Bone & Nutrition

## Beyond Calcium & Vitamin D

**Dr Sandra Iuliano (PhD)**

Department of Medicine  
University of Melbourne / Austin Health

# Bone and Nutrition Beyond Calcium & Vitamin D



# Nutrition Topics Covered

---

Vitamin K



---

Magnesium



---

Zinc



---

Veganism



---

Dietary patterns



---

Dietary sustainability & Bone



---

Other



# Learning Outcomes

- Understand the primary food sources for bone related nutrients.
- Learn how to interpret food / nutrition research outcomes relative to bone.
- Recognise the types of dietary patterns that support bone health.
- Know the nutritional needs of older adults relative to bone and recognize their nutritional challenges and barriers to optimize bone health.
- Conclude if bone health can be achieved through food in an environmentally sustainable way.





# Vitamin K and Bone

---





# Vitamin K & Bone

## Two forms

Vit K1    phylloquinone    Green leafy vegetables  
Vit K2    menaquinone    Bacteria



## Vitamin K

- co-enzyme
- carboxylation of osteocalcin
- ↑ osteoblast activity
- ↓ osteoclast genesis

**Malabsorption** e.g., cystic fibrosis, celiac disease, ulcerative colitis, short bowel syndrome, etc

## Deficiency

Rare

## Interactions with medications

- Anti-coagulants (e.g., warfarin) consistent intake
- Anti-biotics: may destroy K-producing bacteria
- Bile acid sequestrants: ↓ absorption of fat-soluble vitamins
- Weight loss medications e.g., Orlistat: ↓ absorption

## Measurement

Time to blood clot

## Trials

Often administered with other nutrients (Ca, VitD)  
Various forms & doses of Vitamin K (1, 4, 7)

## Cross section

Serum (difficult to measure) v intake (FFQ, record, recall) + microbial production

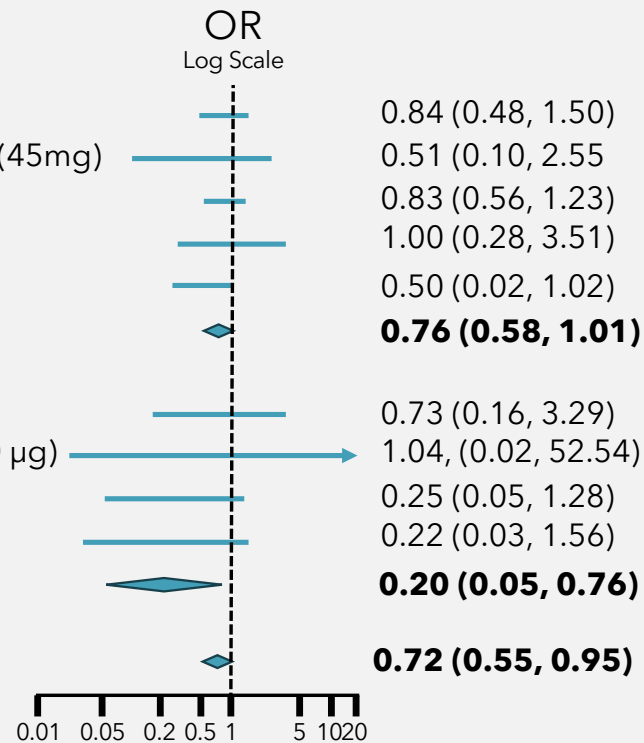
# Vitamin K Supplementation & Fractures

## Low risk of Bias

Author (Year)	Country	Study Design	Intervention	OR (95% CI)	Duration
Tanaka 2017	Jap	W-OP >65yr.	RIS, K4 (45mg)	0.84 (0.48, 1.50)	2 y
Jiang 2014	Chn	W-PM	$\alpha$ calcitriol, Ca, K4 (45mg)	0.51 (0.10, 2.55)	1 y
Inoue 2009	Jap	W-PM-OP	Ca, K4 (45mg)	0.83 (0.56, 1.23)	4 y
Emaus 2010	Nor	W-PM-H	K7 (360 $\mu$ g)	1.00 (0.28, 3.51)	1 y
Cheung 2008	Can	W-PM-Open	D, Ca, K1 (5 $\mu$ g)	0.50 (0.02, 1.02)	2+2y

## High risk of Bias

B-Smith 2007	UK	W-H > 60yr	D, Ca, K1 (200 $\mu$ g)	0.73 (0.16, 3.29)	2 y
Jokar 2016	Iran	W-PM-OP	ALD, Ca, D, K1 (10 $\mu$ g)	1.04 (0.02, 52.54)	1 y
Shiraki 2000	Jap	W-OP	Ca, K4 (45mg)	0.25 (0.05, 1.28)	2 y
Ishida 2004	Jap	W-OP	K4 (45mg)	0.22 (0.03, 1.56)	2 y



# Dietary Sources of Vitamin K



Kale

1000 mcg\*



Collard Greens

770 mcg\*



Broccoli

220 mcg\*



Spinach

153 mcg\*



Cabbage

85 mcg\*



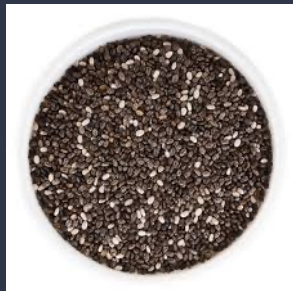
Lettuce

13 mcg\*

**Recommended intake: Older adults 60–70 mcg / day (Aust)**

**One cup of most green leafy vegetables per day would meet vitamin K needs**

\*Content per cup



# Magnesium and Bone

---

# Magnesium & Bone

**Location** 50-60% present in bone  
< 1% in serum (tightly regulated)

**Magnesium**

- co-factor in 300+ enzyme
- synthesis of bone matrix
- ↑ osteoblast proliferation

**Deficiency** Difficult to determine  
Often occurs with other nutrients

**Measurement** Serum

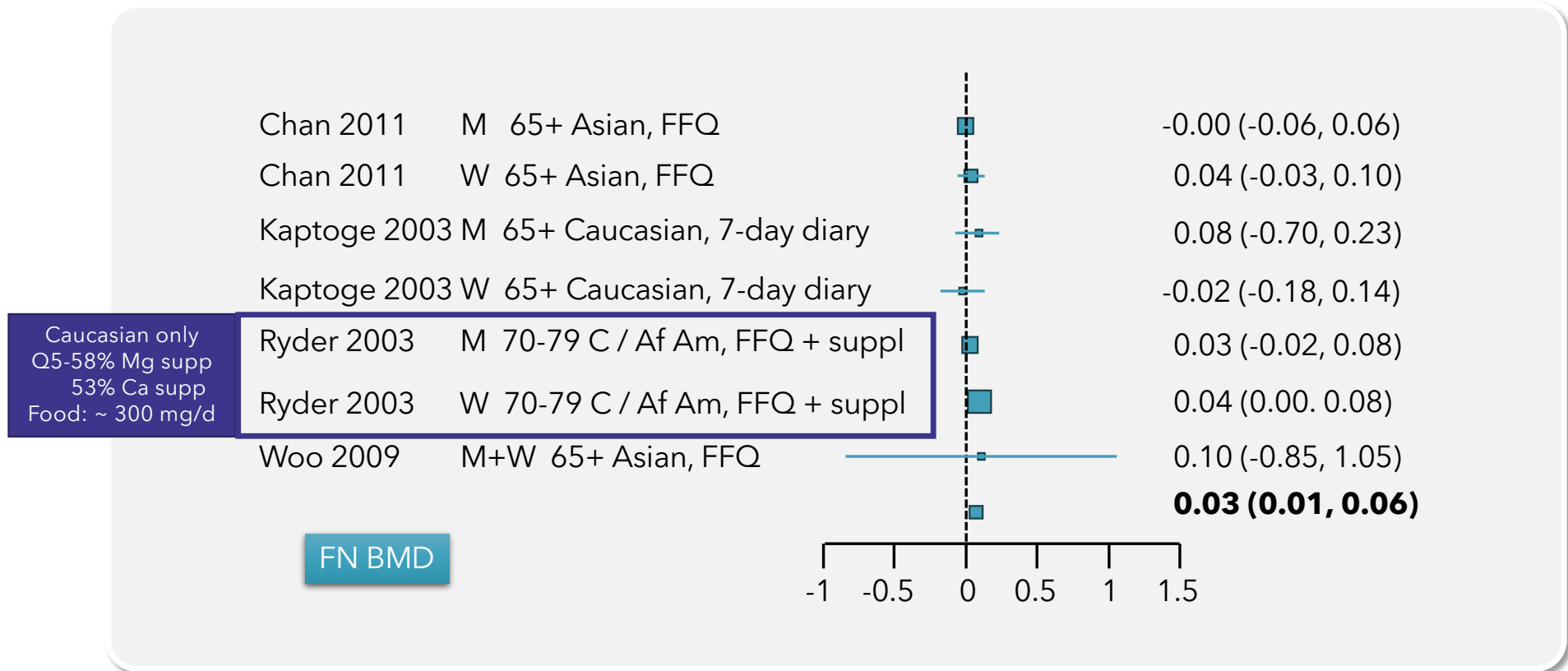
**Trials** Limited Supplementation studies in post-menopausal women: decrease PTH

**Cross section** Correlations between low serum Mg & BMD / Fx risk (mostly post-menopausal women)  
Other nutrients are also lower



**CKD Patients  
Specific considerations  
may assist with mineral  
metabolism**

# Magnesium & BMD in Older Adults



# Magnesium & BMD in Older Adults

Ryder et al. JAGS, 2005

Food per 1000 kcal	Quintile 1	Quintile 5*
Fat (g)	41 ± 7	32 ± 9
Protein (g)	32 ± 7	40 ± 8
Carbohydrates (g)	125 ± 21	142 ± 22
Magnesium (mg)	116 ± 12	208 ± 32
Calcium (mg)	322 ± 96	541 ± 201
Vitamin D (IU)	85 ± 44	146 ± 86
Potassium (mg)	1211 ± 188	1992 ± 383
Vitamin C (mg)	63 ± 31	99 ± 44
F&V Fibre (g)	3 ± 1	6 ± 3
Mg supplement (%)	1.5	57.7
Ca supplement (%)	11.3	53.3

Higher intake  
of numerous  
macro- &  
micro-nutrients

# Dietary Sources of Magnesium



30 g nuts

60-80 mg



½ cup beans  
cooked

35-60 mg



30 g  
pepita

156 mg



½ cup brown  
rice - cooked

42 mg



½ cup porridge  
cooked

36 mg



90 g salmon

26 mg



30 g chia

111 mg



250 ml milk

26 mg



240 g Yoghurt

42 mg



½ cup spinach  
cooked

78 mg

**Recommended intake: Older women 320 mg; men 420 mg / day (Aust)**





# Zinc and Bone

---

# Zinc & Bone

<b>Location</b>	~30% present in bone
<b>Zinc</b>	<ul style="list-style-type: none"><li>- Osteoblast differentiation</li><li>- ↓ Resorption</li><li>- ↑ Osteoclast apoptosis</li></ul>
<b>Deficiency</b>	Older adults: Delayed wound healing Cognitive & Psychological function
<b>Measurement</b>	Serum (affected by age, sex, time of blood draw)
<b>Trials</b>	Most case-controls
<b>Cross section</b>	Dietary & serum levels

**Consider weight loss,  
chronic alcohol use,  
malabsorptive  
digestive diseases**

# Zinc & Bone in Older Adults

Group	Serum levels	P	Dietary intake	P
All - osteoporotic, osteopenic, post-menopausal, fractures	-3.2 (-7.1, 0.6) N=24	.10	-0.3 (-0.8, 0.1) N=15	.15
Osteoporosis	<b>-12.7 (-19.3, - 6.1)</b> <b>N=12, Low evidence</b>	<b>.00</b>	-0.01 (-1.6, 1.6) N=4, Mod	.99
Osteopenia	-8.3 (-19.3, 2.7) N=4 High	.14	-0.3 (-2.9, 3.4) N=2 High	.88
Post-menopausal women	-6.8 (-17.6, 4.0) N=17, High	.22	-0.4 (-1.6, 0.7) N=6, High	.49
Fractures	No data		<b>-0.5 (-0.9, -0.1)</b> <b>PRO -0.4 (-7.5, -0.6)</b> <b>N=4, Low evidence</b>	<b>.02</b> <b>.02</b>

# Dietary Sources of Zinc



2 oysters

60-80 mg



Beef  
90g

3.8 mg



30 g  
pepita

2.2 mg



Pork / Turkey  
90g

2.0 mg



Lentils  
½ cup

1.3 mg



Cheese  
40g

1.5 mg



Greek yogurt  
120 g

1.0 mg



Milk  
1 cup (250 ml)

1.0 mg

**Recommended intake: Older women 8 mg; men 14 mg / day (Aust)**



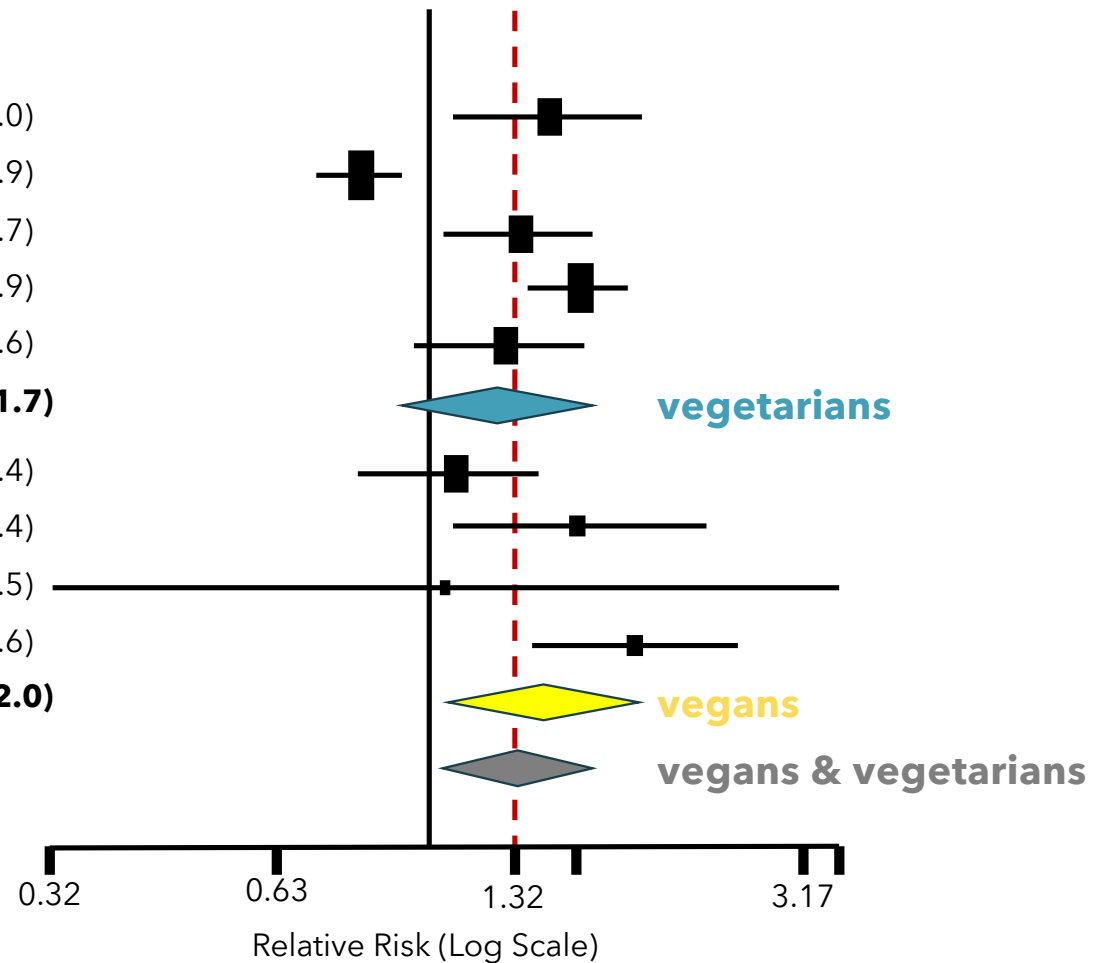
# Veganism and Bone

---

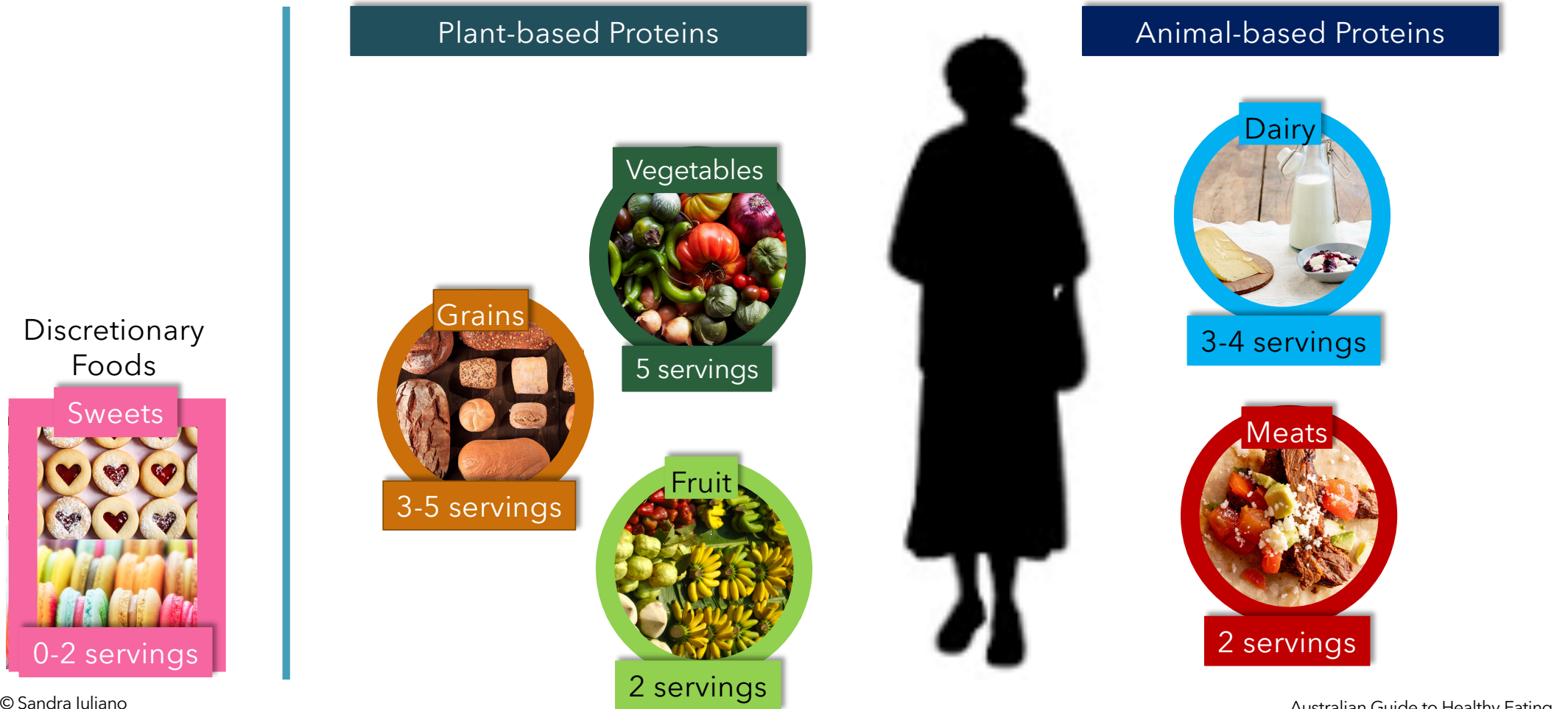
# Is Veganism Aligned with Bone Health?

## Fracture Rates

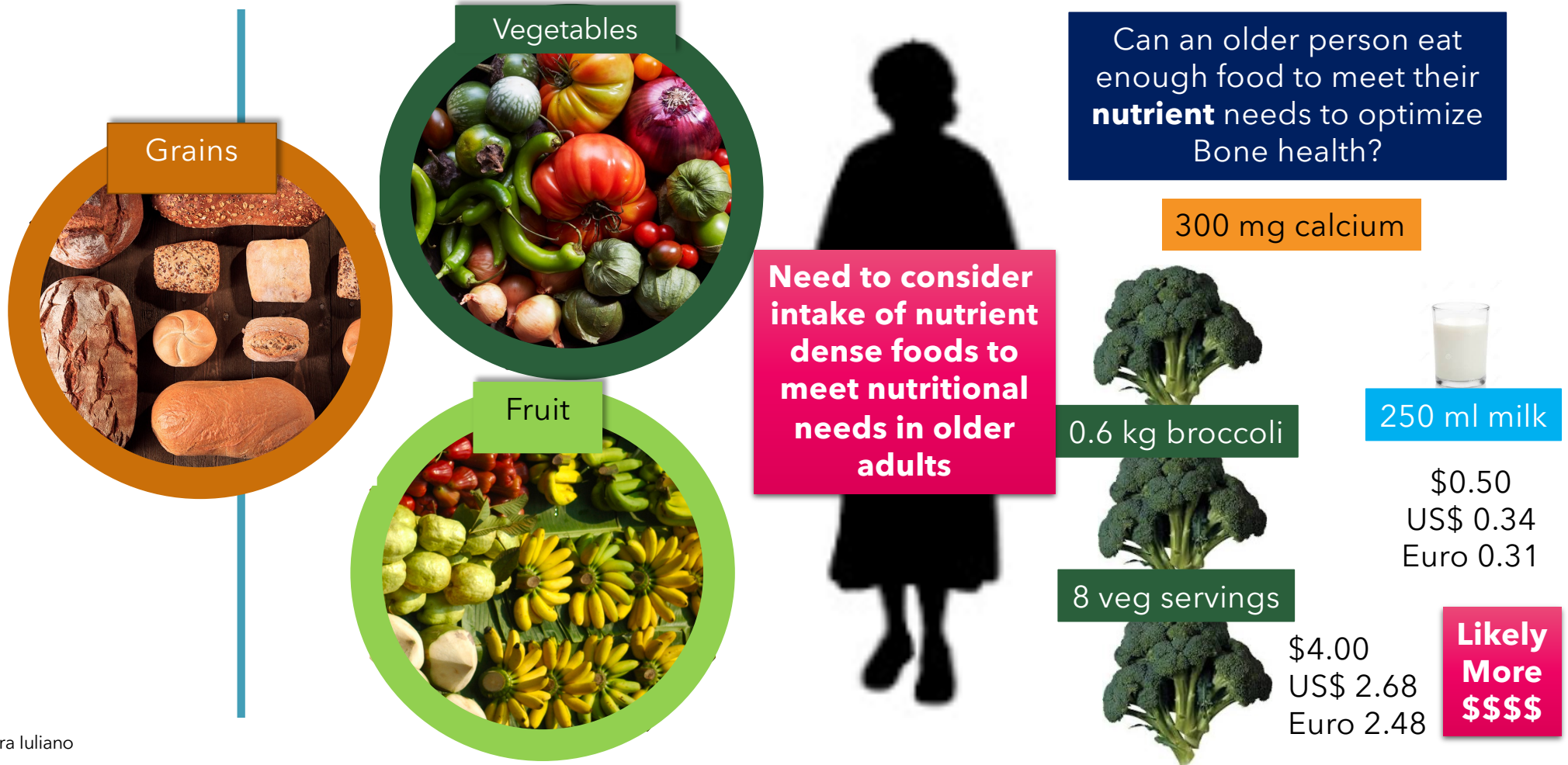
Thorpe 2007	Women	1.5 (1.1, 2.0)
Appleby 2007	Women	0.8 (0.7, 0.9)
Appleby 2007	Men	1.3 (1.0, 1.7)
Dash 2012	Women	1.6 (1.4, 1.9)
L-Matthews 2014	W&M	1.3 (1.0, 1.6)
<b>TOTAL VEGETARIAN</b>		<b>1.3 (0.9, 1.7)</b>
Appleby 2007	Women	1.1 (0.8, 1.4)
Appleby 2007	Men	1.6 (1.1, 2.4)
Ho-Pham 2021	Women	1.1 (0.3, 3.5)
L-Matthews 2014	W&M	1.9 (1.4, 2.6)
<b>TOTAL VEGAN</b>		<b>1.4 (1.1, 2.0)</b>



# What Happens When Animal-Based Proteins are Excluded

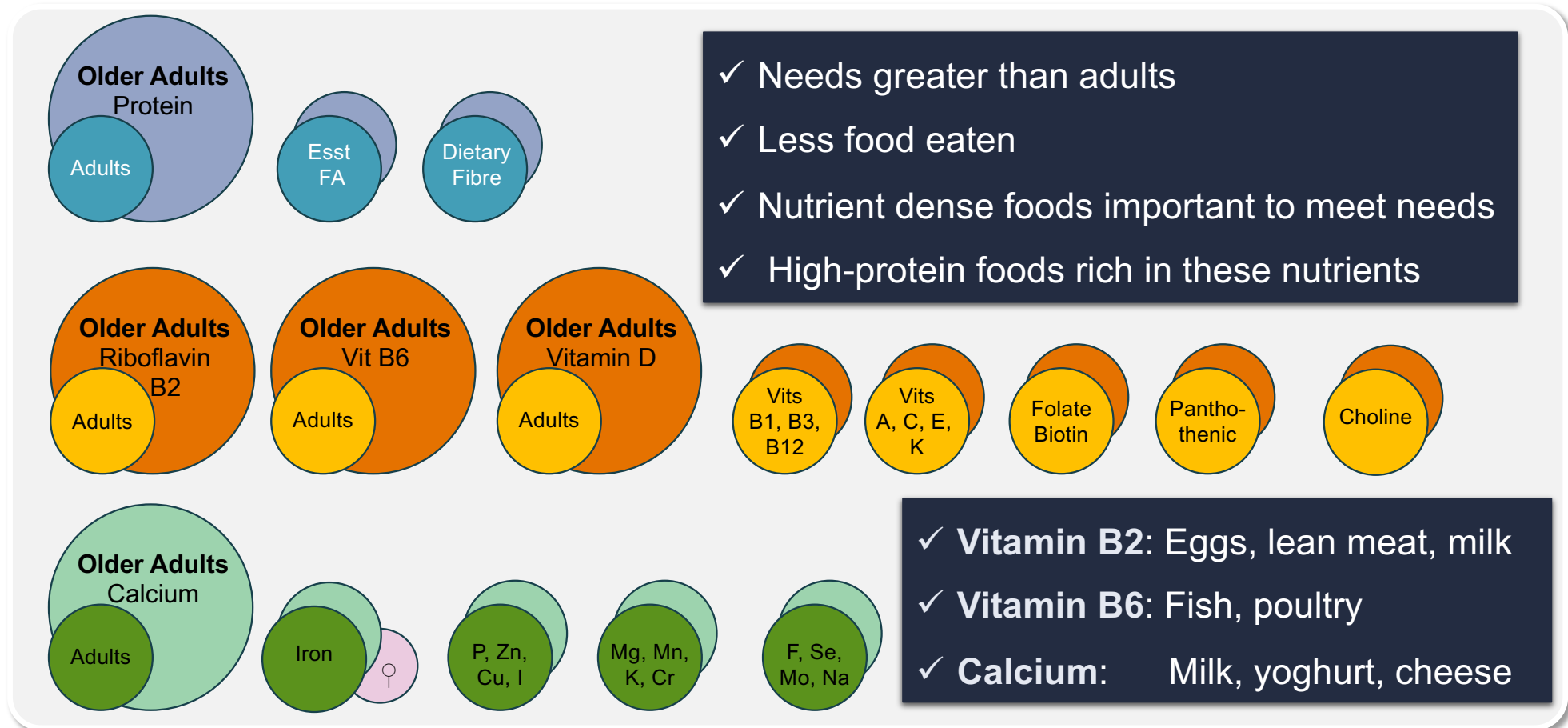


# What Happens When Animal-Based Proteins are Excluded





# Nutrient Requirements of Older Adults (>70 years of age)



- ✓ Needs greater than adults
- ✓ Less food eaten
- ✓ Nutrient dense foods important to meet needs
- ✓ High-protein foods rich in these nutrients

- ✓ **Vitamin B2:** Eggs, lean meat, milk
- ✓ **Vitamin B6:** Fish, poultry
- ✓ **Calcium:** Milk, yoghurt, cheese

# Dietary Patterns and Bone

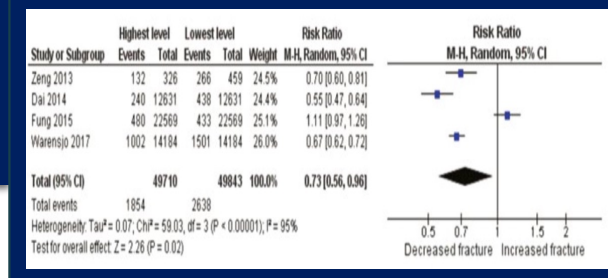
---



# Dietary Patterns and Hip Fracture Risk

Study	Sample	Healthy Diet	Other diet	RR / OR
Warensjo 2017 Sweden	Women 56,000+ > 50yo	Fish, wholegrains, eggs, poultry, pasta, rice Fruit & Veg, <b>fermented milk</b> Q1- 4	<b>Western / convenience:</b> sweet & savory snacks, meat, jam, white bread, sodas, bakery products	<b>Healthy</b> 0.84 (0.81, 0.86) <b>Western</b> 1.06 (1.03, 1.09)
Zeng, 2013 China	Case - Control	Freshwater fish, fruit & veg T1 - 3	<b>High fat:</b> red meat, poultry with skin, organ meat,	<b>Healthy</b> 0.42 (0.24, 0.73) <b>High fat</b> 2.25 (1.38, 3.69)
Dai 2014 Singapore Chinese	W&M 63,000+	Fruit, veg, soy, legumes	<b>Meat-dim sim:</b> meat, refined starches	<b>Healthy:</b> 0.7 (0.6, 0.8) <b>Other:</b> 1.2 (1.0, 1.4)
Fung 2015 USA	W&M 100,000+	<b>Prudent:</b> Fruit & Veg, wholegrains, poultry, <b>low fat dairy</b> Q1 - 5	<b>Western:</b> red & processed meat, refined grains, sweets, high fat dairy*	<b>Prudent:</b> 1.1 (1.0, 1.4) <b>Western:</b> 1.1 (0.9, 1.3)

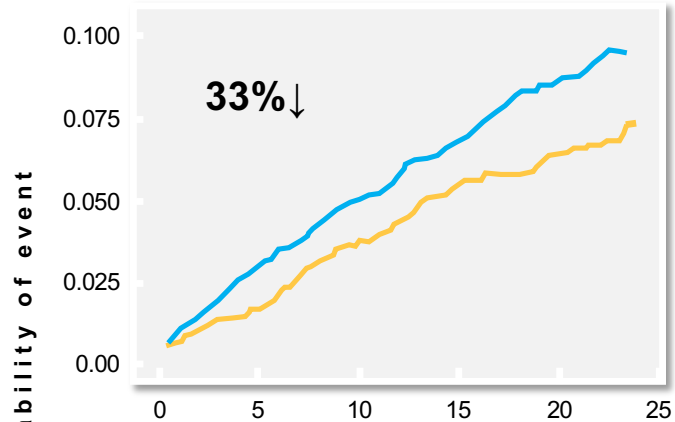
**Not comparing  
similar diets**



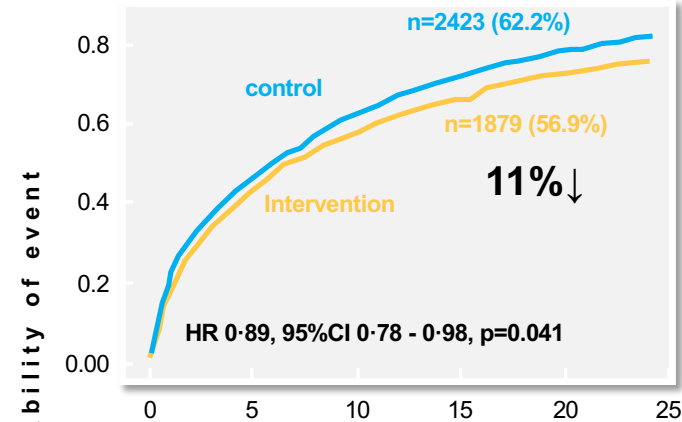
High fat dairy\*  
Includes  
butter, cream, ice-cream

# Fracture Prevention & Dairy Consumption

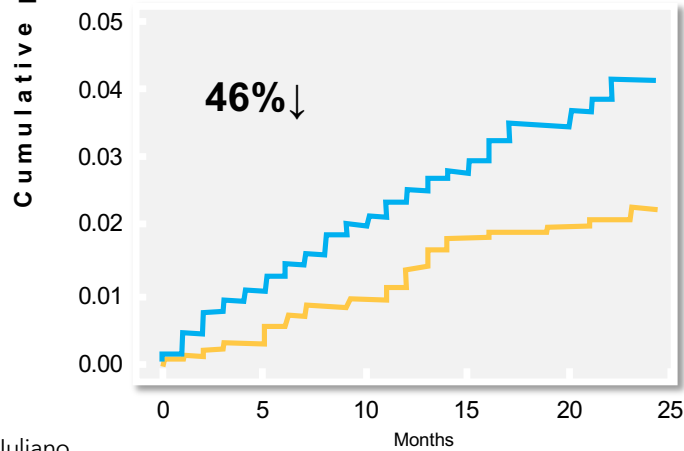
**ALL FRACTURES**



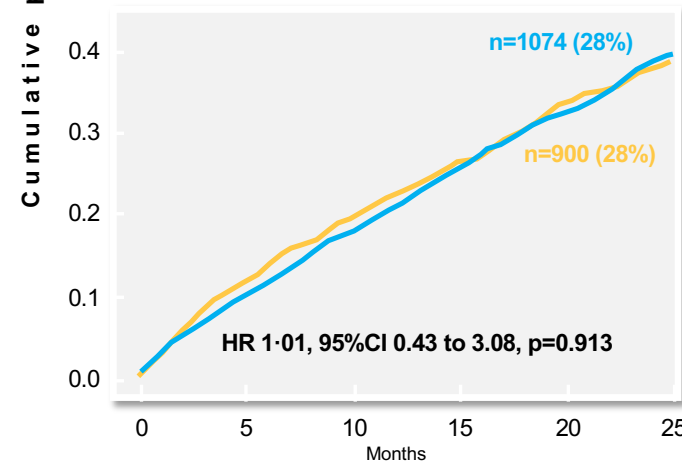
**FALLS**



**HIP FRACTURES**



**MORTALITY**



**Milk, Yoghurt & Cheese**

**3.5 servings daily**

**Milk: 250 ml**

**Cheese: 40 g**

**Yoghurt: 200 g**

**Skim milk powder**

**7000+ older adults**

**60 aged care homes**

# Which Dietary Patterns are Associated with Good Bone Health?

Healthy

Vegetables



Fruit



Whole Grains



Dairy

Dairy



Western

Processed Meats



High in  
Fat  
Sugar  
Salt

Meats



Sweets  
Soft drinks

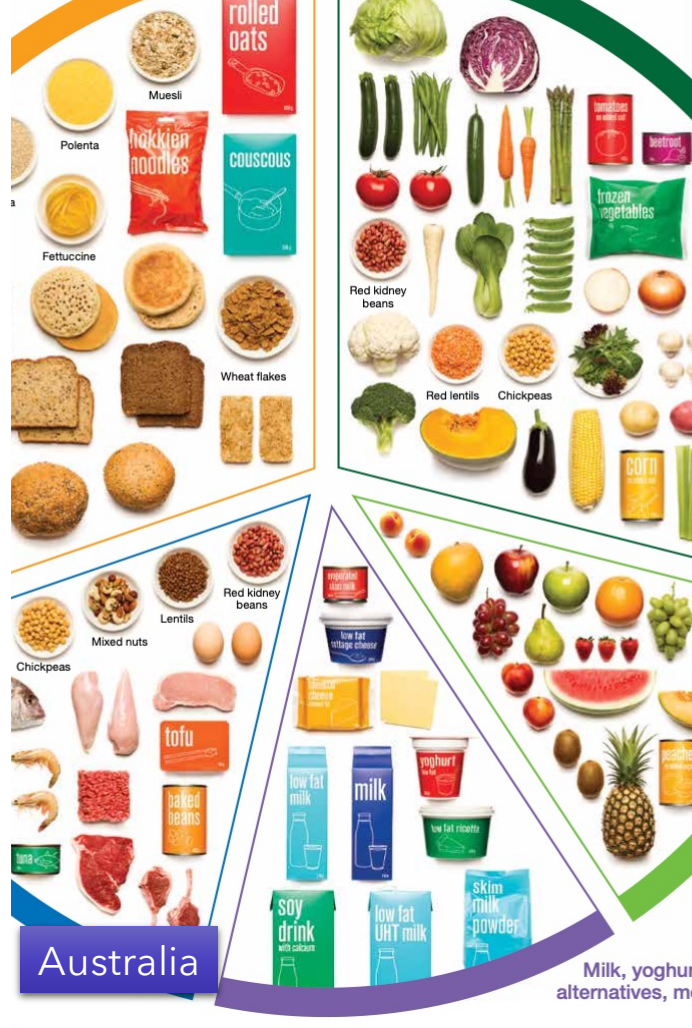


# Dietary Recommendations & Bone Health



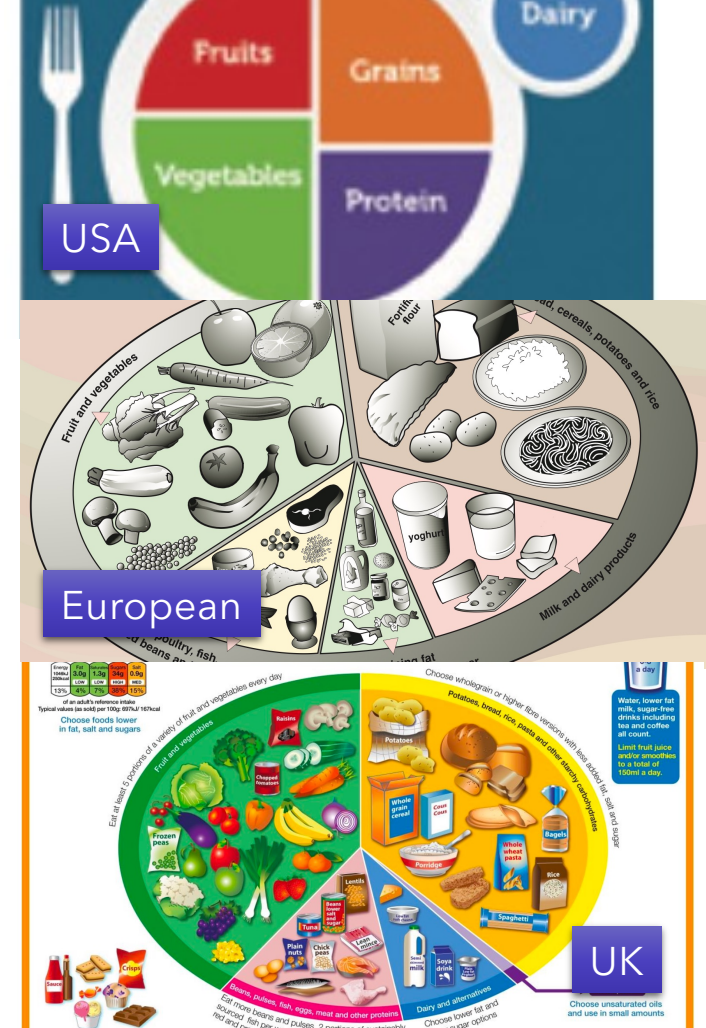
Canada

© Sandra Iuliano



Australia

Milk, yoghurt alternatives, mc



USA

European

UK

# Principles of Sustainable Eating

---



# Principles of Sustainable Eating

## GUIDING PRINCIPLES FOR SUSTAINABLE HEALTHY DIETS

SUSTAINABLE HEALTHY DIETS...

### REGARDING THE HEALTH ASPECT

1

Breast feeding

2

Unprocessed foods

3

Wholegrains  
Nuts  
F&V

4

Moderate  
Egg, dairy,  
fish, red meat

Aligns with most Dietary guidelines

8

Minimise Pathogens

7

Reduce NCD's

6

Meet Needs

5

Safe water & fluids

### REGARDING ENVIRONMENTAL IMPACT

9

Greenhouse gas  
Water & Land

10

Biodiversity

11

Minimise  
Hormones &  
Antibiotics

12

Minimise  
Plastics &  
Packaging

Production Costs

Carbon  
Land use  
Water use

### REGARDING SOCIOCULTURAL ASPECTS

16

Reduce Gender effects

15

Accessible  
Desirable

14

Respect  
Local  
Culture

13

Reduce food  
waste and loss

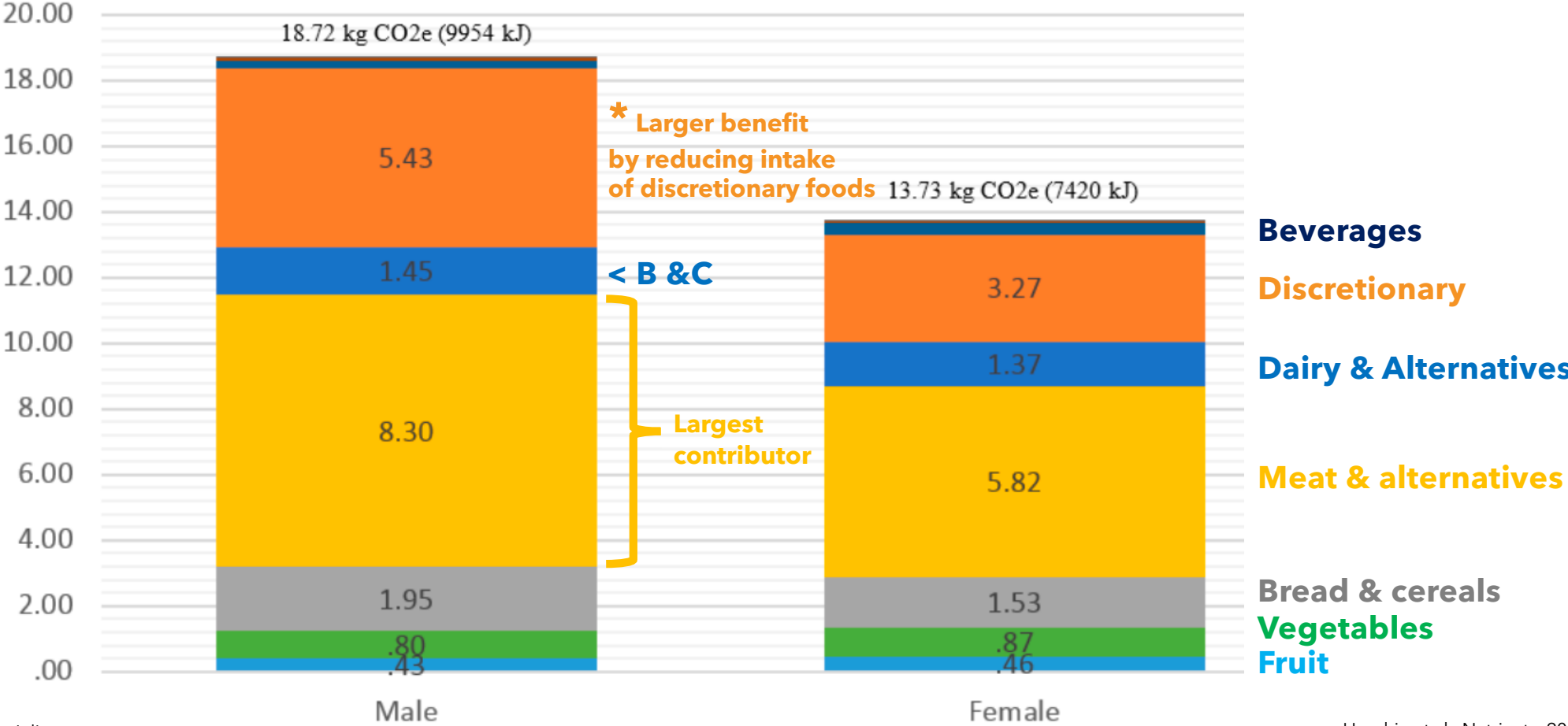
<sup>10</sup> Food processing can be beneficial for the promotion of high quality diets; it can make food more available as well as safer. However, some forms of processing can lead to very high densities of salt, added sugar and saturated fats and these products, when consumed in high amounts, can undermine diet quality. (Global Panel on Agriculture and Food Systems for Nutrition, 2016. Food systems and diets: Facing the challenges of the 21st century. London, UK. <http://library.upi.com/utlz/gaffle/collection/p15738coll5/id/5516/filename/5517.pdf>)

<sup>11</sup> Potatoes, sweet potatoes, cassava and other starchy roots are not classified as fruits or vegetables.

<sup>12</sup> They include up to 30-35 percent of total energy intake from fats, with a shift in fat consumption away from saturated fats to unsaturated fats and towards the elimination of industrial trans fats; less than 10 percent of total energy intake from free sugars (possibly less than 5 percent) and not more than 5 g per day of salt (to be iodized). WHO, 2018. Healthy diet. WHO fact sheet No. 394 (updated August 2018). Geneva, World Health Organization, 2018. <https://www.who.int/nutrition/publications/>



# Greenhouse Gas Emissions & Food Consumption

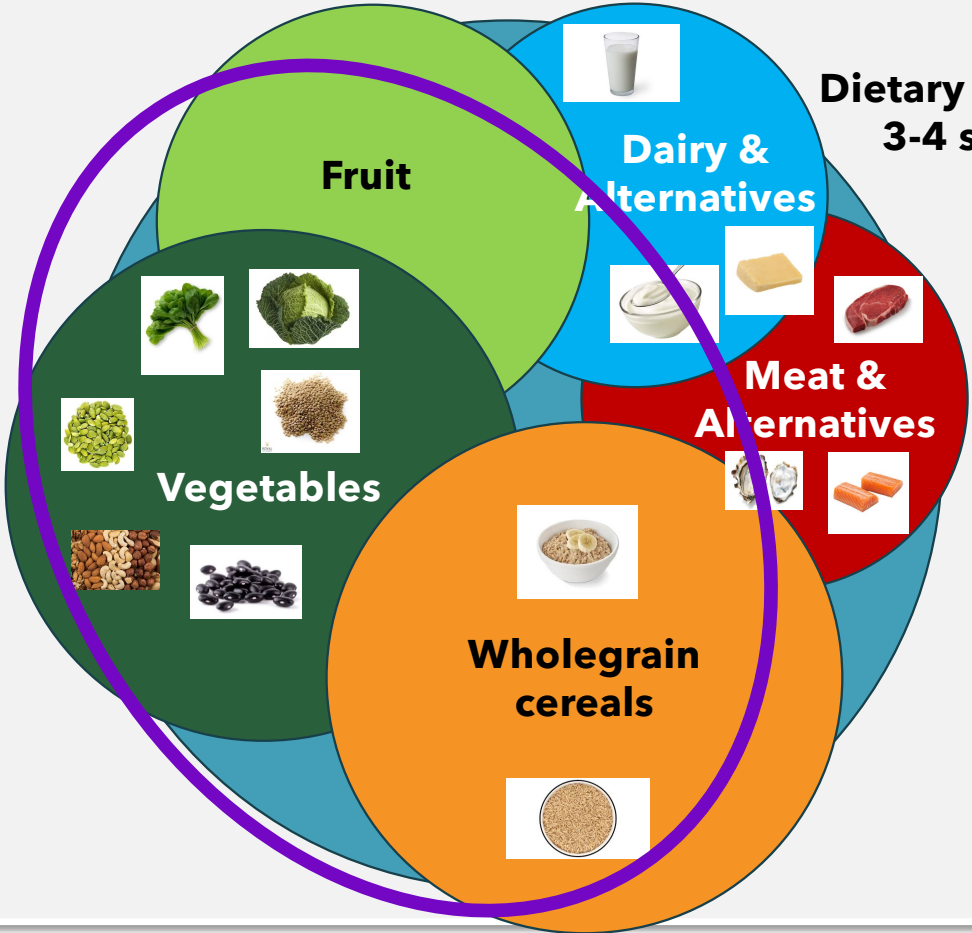


# Nutrition & Bone: What does the Evidence Say?

Nutrition	Evidence	Dietary factors
Vitamin K	Inconclusive	Green leafy vegetables (GL veg)
Magnesium	Inconclusive	Nuts, seeds, lentils, wholegrain, GL veg, milk, yoghurt, salmon
Zinc	Osteoporotic (low level evidence)	Seafood, milk, yoghurt, cheese, lean beef, seeds, lentils
Veganism	Low-moderate	Likely not suitability for older adults
Dietary patterns	Moderate - strong	F&V, wholegrain, dairy, fish, egg, poultry, lean meat, nuts, seeds, legumes
Sustainability	Moderate	Limiting discretionary foods has greater benefit than removing dairy for CO2

# Nutrition & Bone: Beyond Calcium and D

**Vitamin K**  
**Magnesium**  
**Zinc**  
**Vegetarian**  
**'Healthy' diet**  
**Sustainability**



**Dietary guidelines**  
**3-4 servings**

**Dietary guidelines**  
**2 - 2.5 servings**

Lean meat, poultry,  
eggs, fish, seafood  
legumes, nuts & seeds



# Nutrition & Bone: Beyond Calcium and D

A dietary pattern that aligns with most dietary guidelines optimizes bone health and can also be sustainable.



**Thank you**



**Dr. Sandra Iuliano**  
**sandraib@unimelb.edu.au**  
**M: + 61 438 215 615**

# Q&A



# Thank you to our sponsor



Amaz!n™ Prunes





Our vision is a world without fragility fractures  
in which healthy mobility is a reality for all

[www.capturethefracture.org](http://www.capturethefracture.org)