Faculty of Life Sciences

University of Reading

Diet and blood pressure – a role for dairy?

Katherine M. Livingstone

Food Production and Quality Research Division, University of Reading, UK

Dairy Council (NI), Belfast, 2013

University of Reading

Contents

Hypertension

- Definition and prevalence

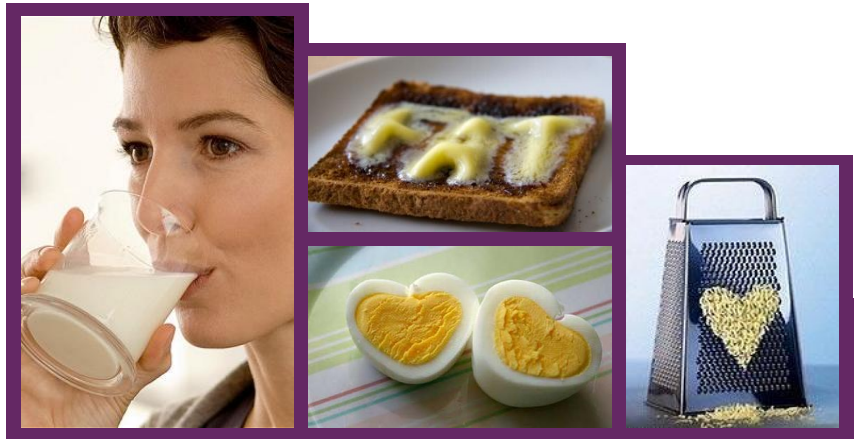
Role of Diet

- Role of diet in Hypertension
- Is there a role for dairy products?

Potential mechanisms

- Regulation of healthy blood pressure
- How diet and dairy may help regulate

University of Reading



Hypertension

- Definition and prevalence

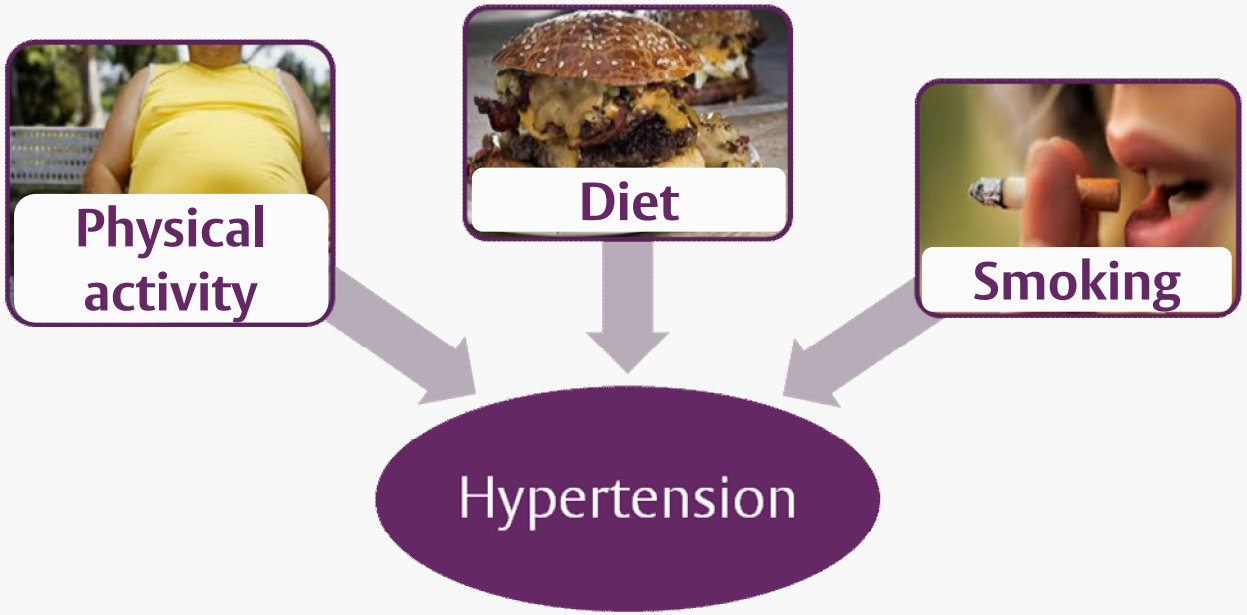
University of Reading

Definition of hypertension

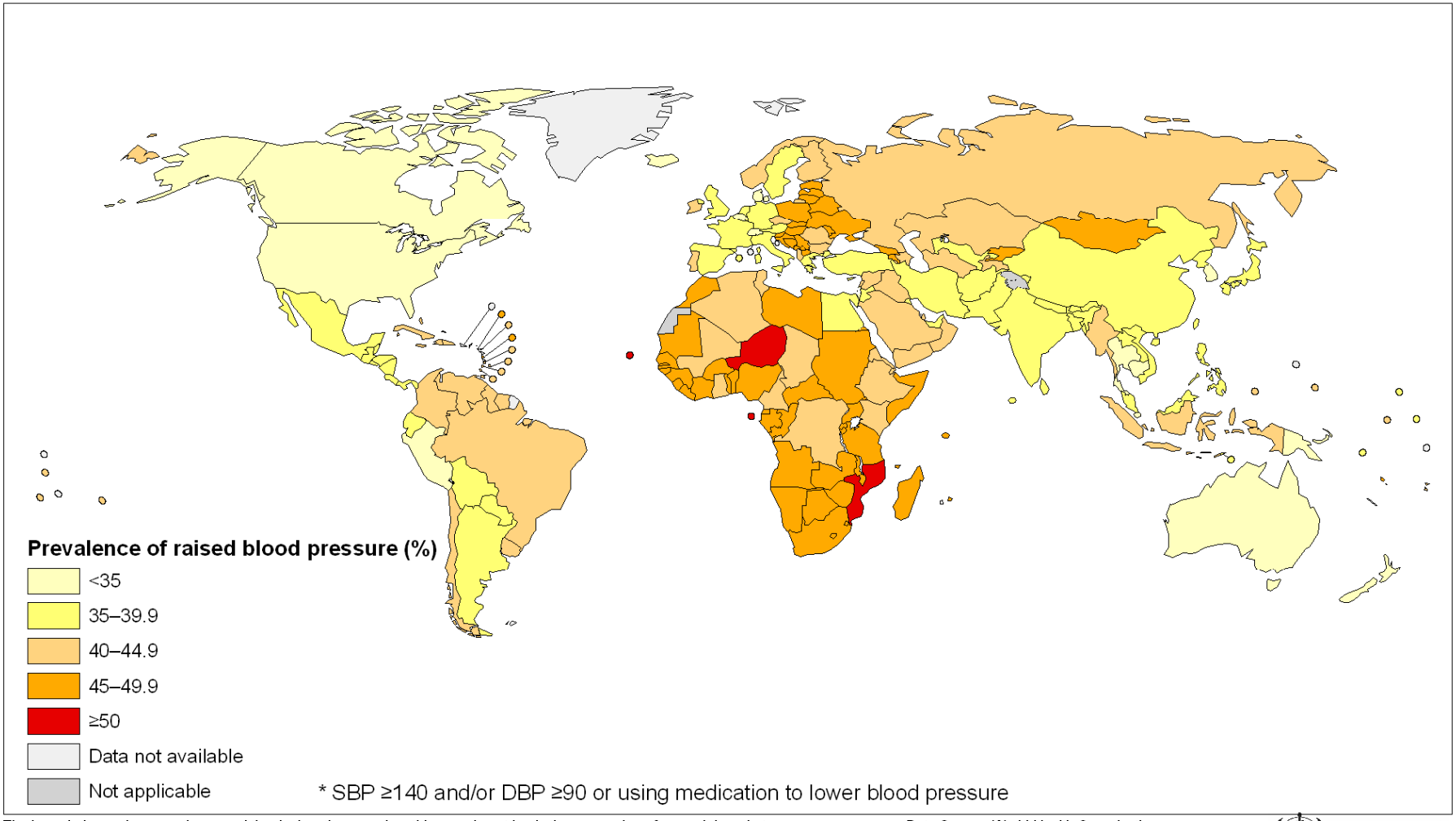
Systolic blood pressure (SBP) ≥**140 mm Hg** or

Diastolic blood pressure (DBP) ≥ **90 mm Hg** or

Use of anti-hypertensive medication



Prevalence of raised blood pressure*, ages 25+, age standardized
Both sexes, 2008



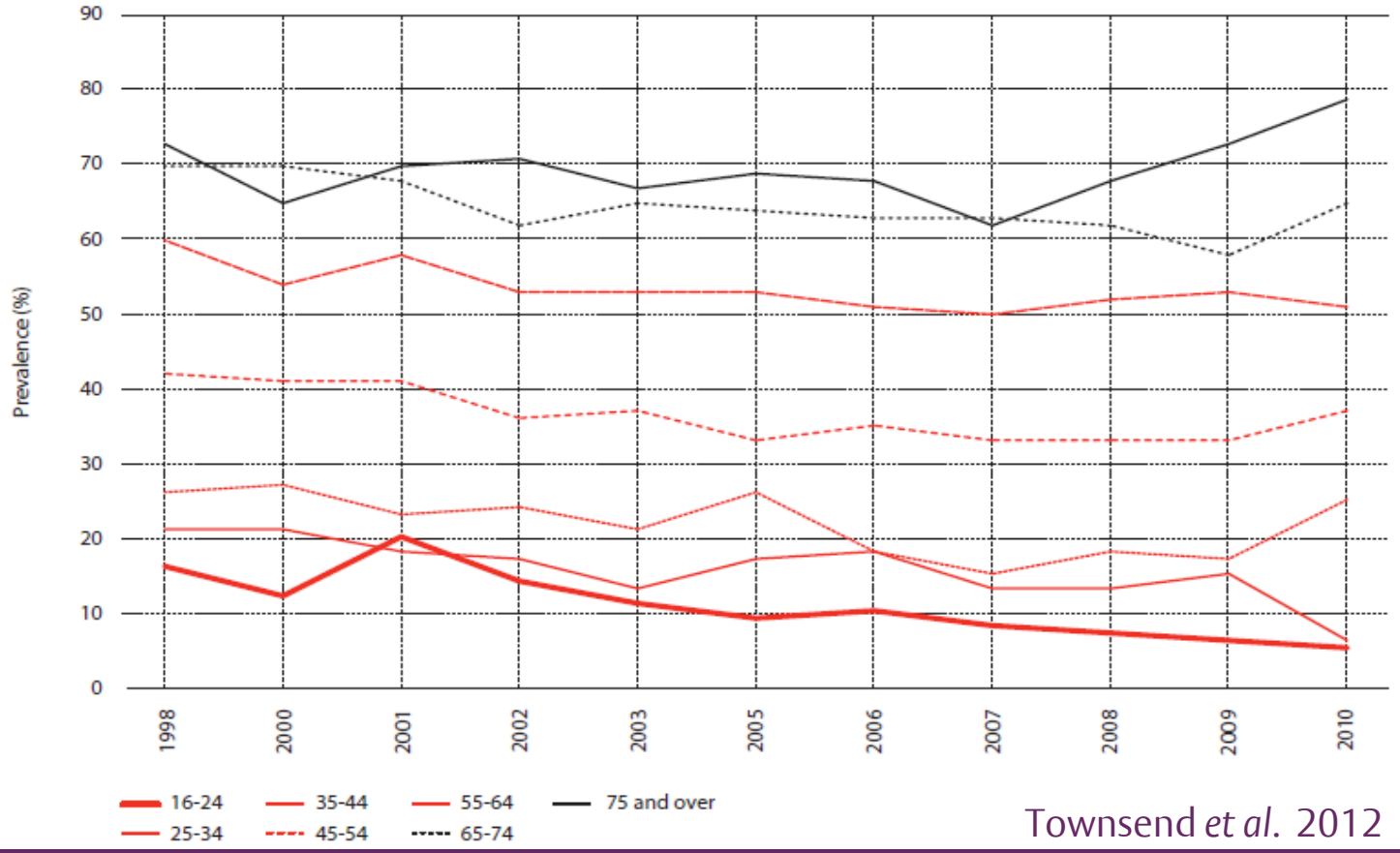
Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

University of Reading

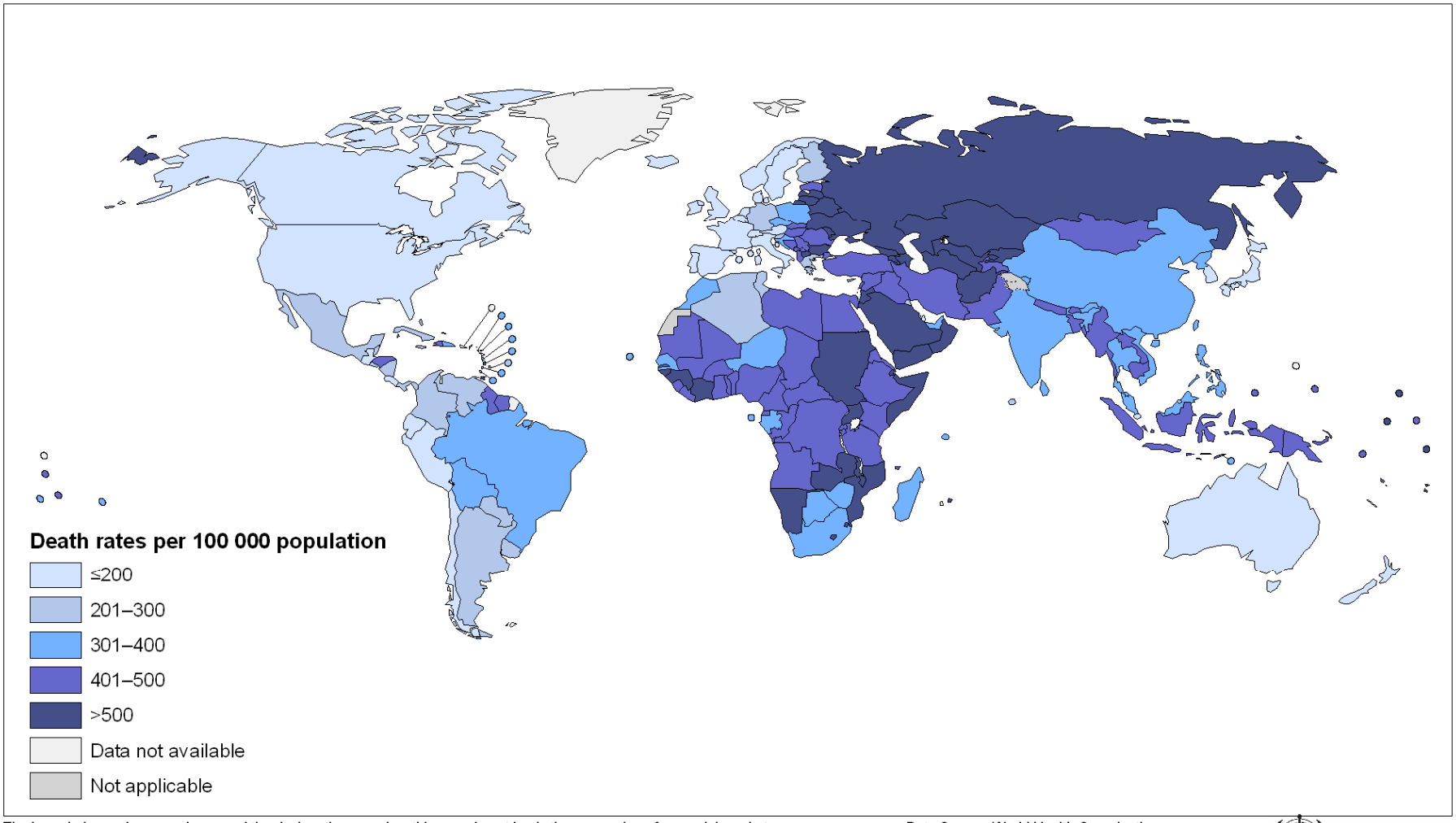
Hypertension in the UK

Figure 5.2a
Prevalence of high blood pressure in men, by age, England 1998 to 2010



Townsend *et al.* 2012

Cardiovascular diseases and diabetes, death rates per 100 000 population, age standardized Males, 2008



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

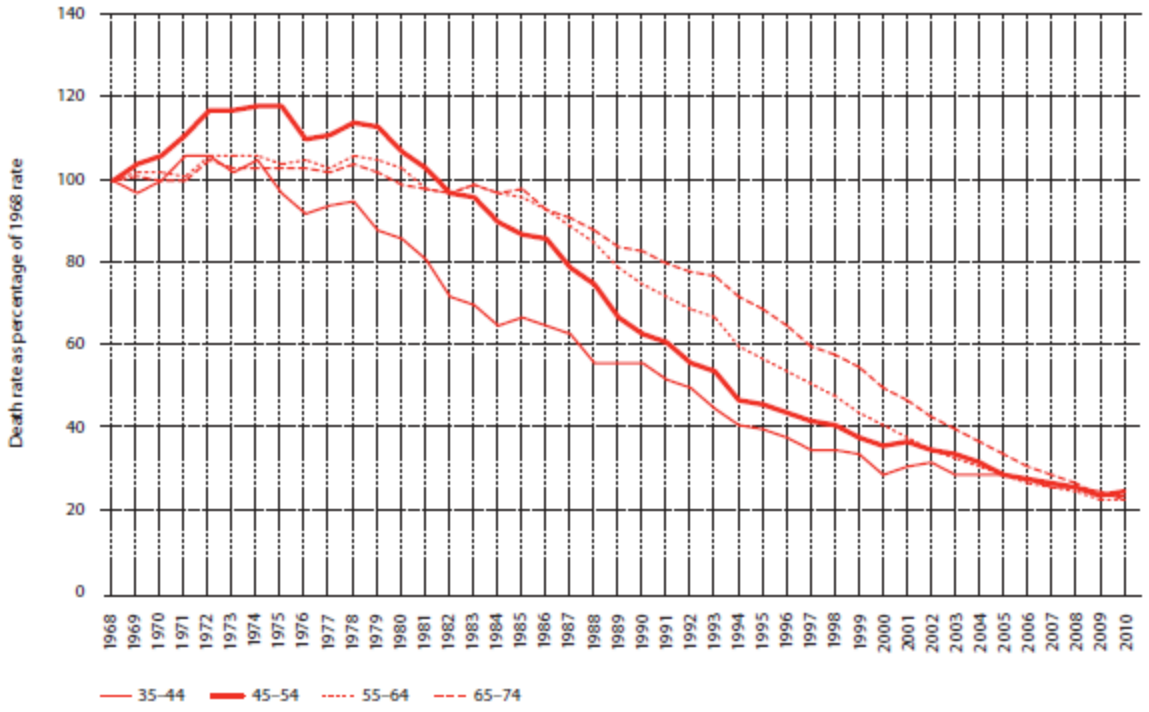
Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

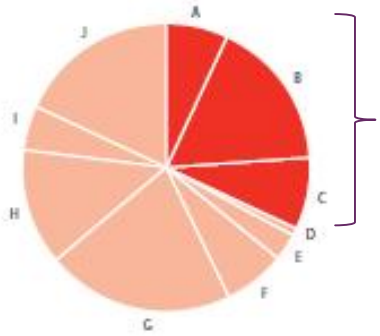
University of Reading

Cardiovascular disease in the UK

Age-specific death rates from coronary heart disease (CHD) as a percentage of the rate in 1968, in men, United Kingdom 1968 to 2010



Deaths by cause in men, United Kingdom 2010



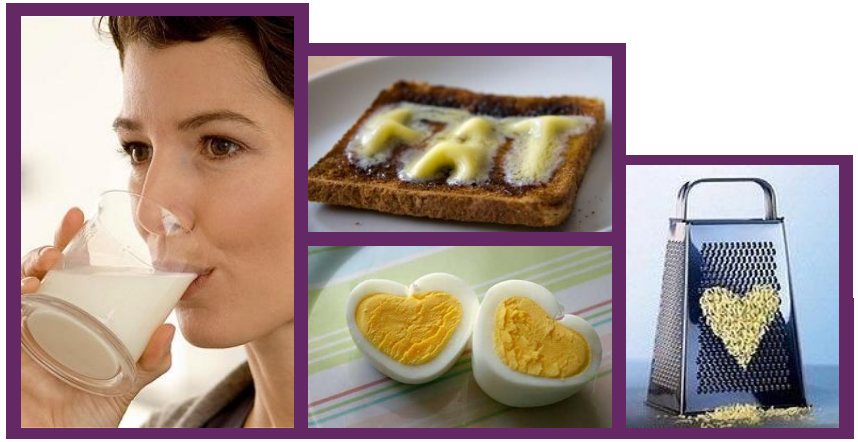
32 % of all deaths

A. Stroke (7%)
B. Coronary heart disease (17%)
C. Other cardiovascular disease (8%)
D. Diabetes (1%)
E. Colo-rectal cancer (3%)
F. Lung cancer (7%)
G. Other cancers (21%)
H. Respiratory disease (13%)
I. Injuries and poisoning (5%)
J. All other causes (18%)

Townsend *et al.* 2012

Faculty of Life Sciences

University of Reading



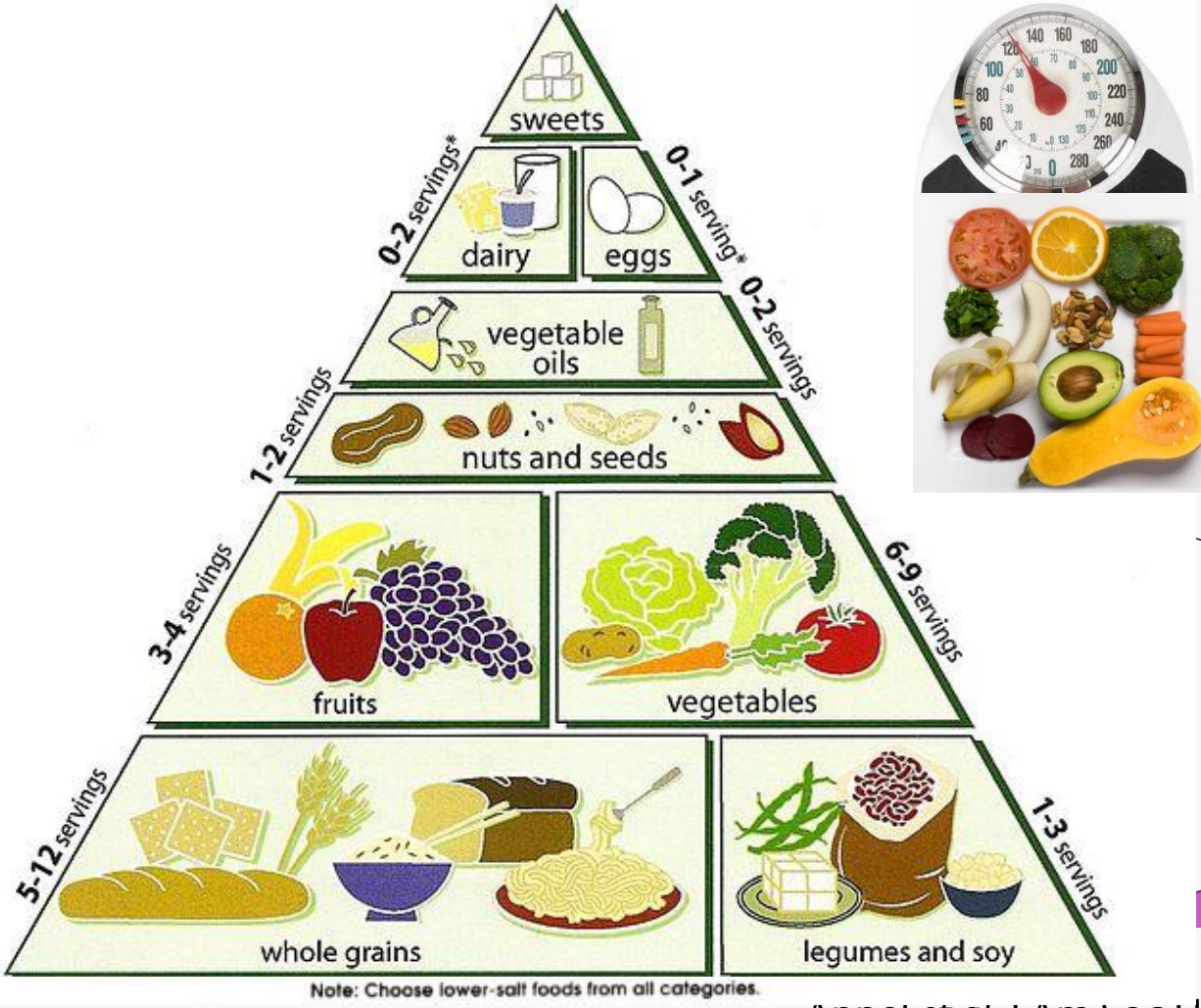
Hypertension

Role of diet

Dairy Council (NI), Belfast, 2013

University of Reading

Hypertension - role of diet



Å
Å
Å
Å

Appel *et al.* J Am Soc Hypertens. 2010

Hypertension – role of diet

BBC Sign in News Sport Weather iPlayer TV Rad

NEWS HEALTH

Home World UK England N. Ireland Scotland Wales Business Politics Health Education Sci/Envir

16 April 2013 Last updated at 01:49

6.1K Share

Beetroot 'can lower blood pressure'

Drinking a cup of beetroot juice can lower blood pressure, researchers say.

Drinking 250ml (8oz) cut high blood pressure readings by 10mm of mercury (mmHg) in a study of 15 patients, bringing some into the normal range, the journal **Hypertension** reports.

Most marked after three to six hours, the effect was detectable a day later.

The juice contained as much nitrate as two beetroots

Scientists say the nitrate in beetroot widens blood vessels to aid flow. And many people with angina use a nitrate drug to ease their symptoms.

The researchers, from Barts and The London School of Medicine and Dentistry, who have been studying beetroot's blood pressure lowering effects for years, say more work is still needed.

And they warn there could be one unexpected consequence of drinking beetroot juice - it can turn your urine pink.

Nitrate is found naturally in soil, where it is taken in by vegetables through the roots to help them grow.

Related Stories

Beetroot juice 'boosts stamina'

Burgers 'healthier with beetroot'

University of Reading

Diet and blood pressure: clinical trial

The New England Journal of Medicine

VOLUME 336 APRIL 17, 1997 NUMBER 16

A CLINICAL TRIAL OF THE EFFECTS OF DIETARY PATTERNS ON BLOOD PRESSURE

LAWRENCE J. APPEL, M.D., M.P.H., THOMAS J. MOORE, M.D., EVA OBARZANEK, PH.D., WILLIAM M. VOLLMER, PH.D., LAURA P. SVETKEY, M.D., M.H.S., FRANK M. SACKS, M.D., GEORGE A. BRAY, M.D., THOMAS M. VOGT, M.D., M.P.H., JEFFREY A. CUTLER, M.D., MARLENE M. WINDHAUSER, PH.D., R.D., PAO-HWA LIN, PH.D., AND NJERI KARANJA, PH.D., FOR THE DASH COLLABORATIVE RESEARCH GROUP*

Appel *et al.* N Engl J Med. 1997

University of Reading

Dietary patterns and blood pressure: diets

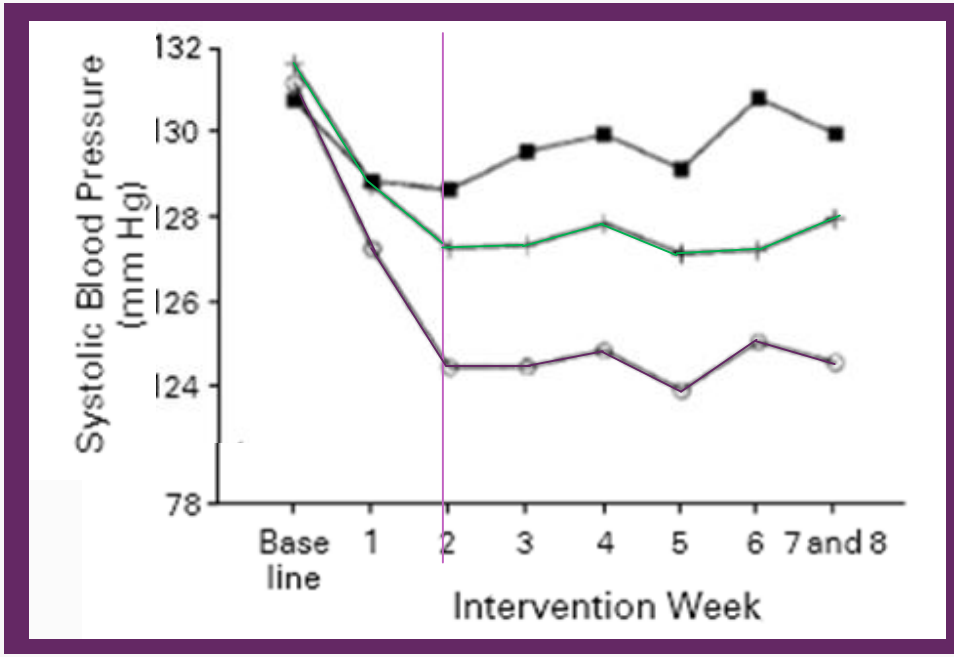
Control	Fruit/vegetable	Combination
ÅLow (2 s/d) 	ÅHigh (8 s/d) 	ÅHigh (9 s/d) 
ÅLow (0.5 s/d) 	ÅLow (0.3 s/d) 	ÅHigh (3 s/d) 
Å**Typical** total and saturated fat intake	Å**Typical** total and saturated fat intake	Å**Low** total and saturated fat intake

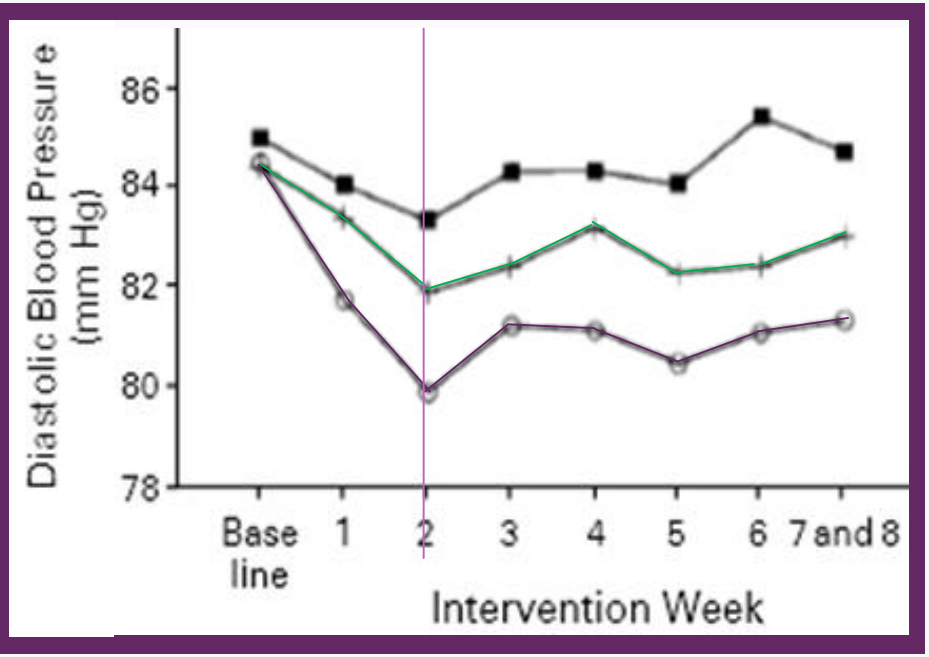
Appel *et al.* N Engl J Med. 1997

University of Reading

Clinical trial results

Control diet
Fruits-and-vegetables diet
Combination diet



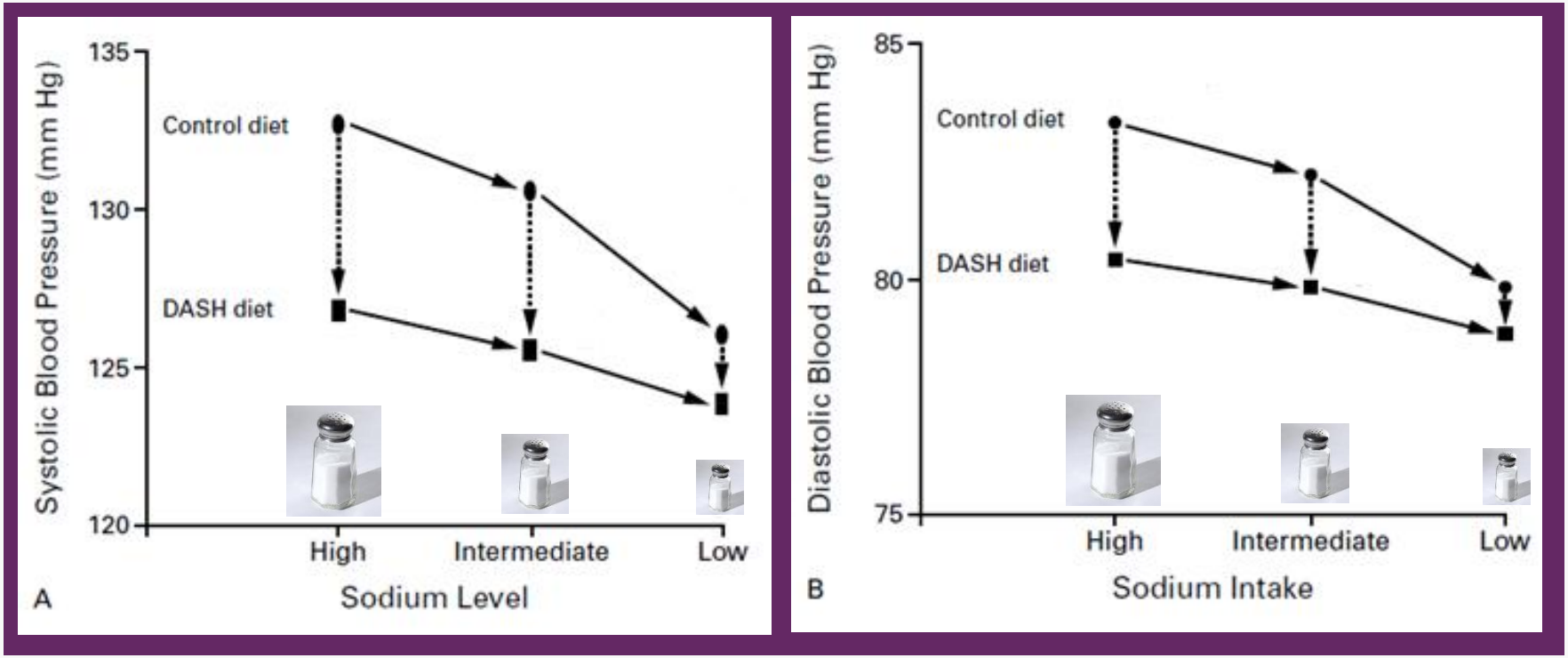


Appel *et al.* N Engl J Med. 1997

University of Reading

Follow up study: DASH II

- *High* sodium (150 mmol/d), *intermediate* (100 mmol/d) or *low* (50 mmol/d)



Sacks *et al.* N Engl J Med. 2001

THE TIMES

Diet and Fitness

News | Opinion | Business | Money | Sport | Life | Arts | Puzzles | Papers

Welcome to your preview of The Times

The DASH diet: the weight-loss plan approved by doctors

Ruby Warrington
Last updated at 12:01AM, November 24 2012

When doctors devised an eating plan to fight high blood pressure, cholesterol and diabetes, weight loss was an added bonus

Young woman crouching on weight scales.
Innocenti and Lee

Post a comment
Print

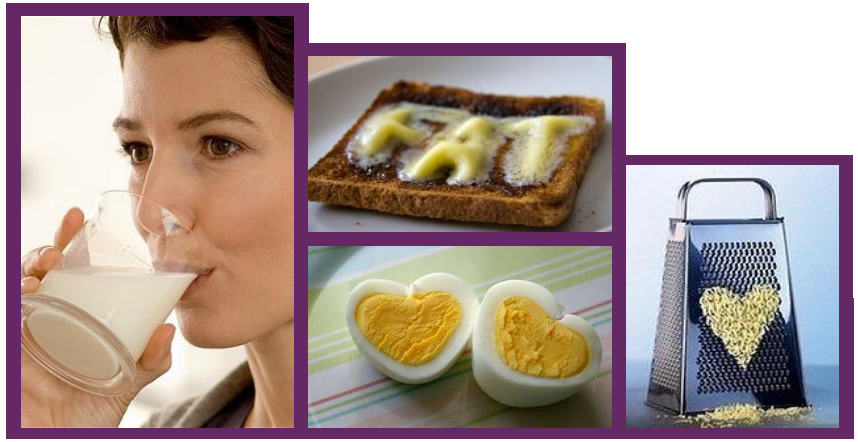
Share via
Facebook
Twitter
Google+

An eating programme devised by doctors to fight high blood pressure has become the latest weight-loss phenomenon andnamed America's healthiest diet two years in a row.

Beating big-name diet plans such as WeightWatchers and Atkins, the unsexily named DASH Diet, which stands for "Dietary Approaches to Stop Hypertension", was given the accolade by the respected ranking magazine *US News & World Report* and is the subject of two top-selling diet books this year.

Faculty of Life Sciences

University of Reading



Hypertension

Is there a role for dairy products?

University of Reading

Dairy Consumption and Incidence of Hypertension

A Dose-Response Meta-Analysis of Prospective Cohort Studies

Sabita S. Soedamah-Muthu,* Lisa D.M. Verberne,* Eric L. Ding,
Mariëlle F. Engberink, Johanna M. Geleijnse

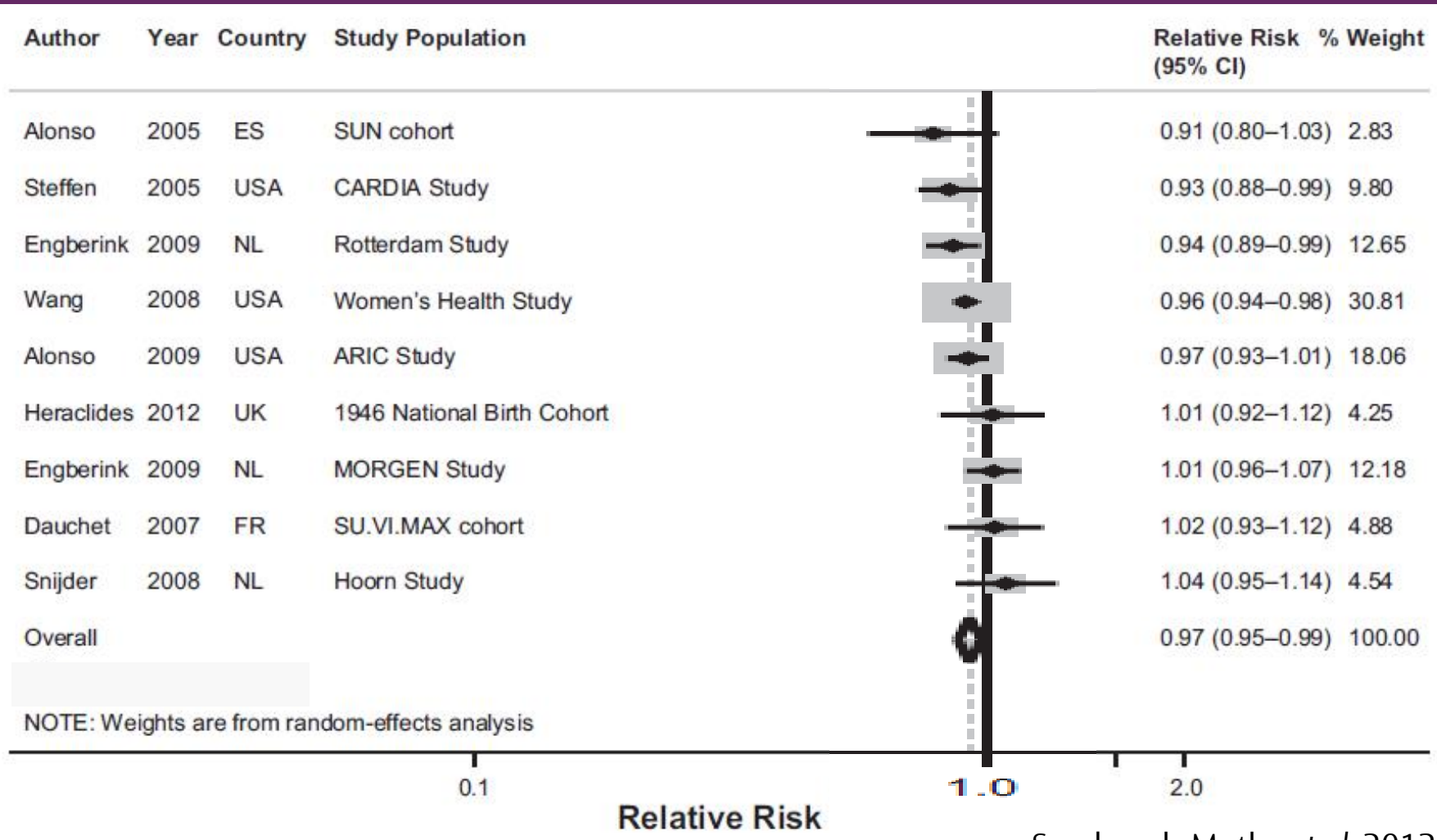
Abstract—Observational and clinical studies suggest that dairy intake, particularly low-fat dairy, could have a beneficial effect on blood pressure. We performed a dose-response meta-analysis of prospective cohort studies on dairy intake and risk of hypertension in the general population. A systematic literature search for eligible studies was conducted until July 2011, using literature databases and hand search. Study-specific dose-response associations were computed according to the generalized least squares for trend estimation method, and linear and piecewise regression models were created. Random-effects models were performed with summarized dose-response data. We included 9 studies with a sample size of 57 256, a total of 15 367 incident hypertension cases, and a follow-up time between 2 and 15 years. Total dairy (9 studies; range of intake, ≈100–700 g/d), low-fat dairy (6 studies; ≈100–500 g/d), and milk (7 studies; ≈100–500 g/d) were inversely and linearly associated with a lower risk of hypertension. The pooled relative risks per 200 g/d were 0.97 (95% CI, 0.95–0.99) for total dairy, 0.96 (95% CI, 0.93–0.99) for low-fat dairy, and 0.96 (95% CI, 0.94–0.98) for milk. High-fat dairy (6 studies), total fermented dairy (4 studies), yogurt (5 studies), and cheese (8 studies) were not significantly associated with hypertension incidence (pooled relative risks of ≈1). This meta-analysis of prospective cohort studies suggests that low-fat dairy and milk could contribute to the prevention of hypertension, which needs confirmation in randomized controlled trials. (*Hypertension*. 2012;60:1131-1137.) • Online Data Supplement

Key Words: dairy products ■ milk ■ hypertension ■ blood pressure ■ meta-analysis ■ prospective studies

Soedamah-Muthu *et al. Hypertension*. 2012

University of Reading

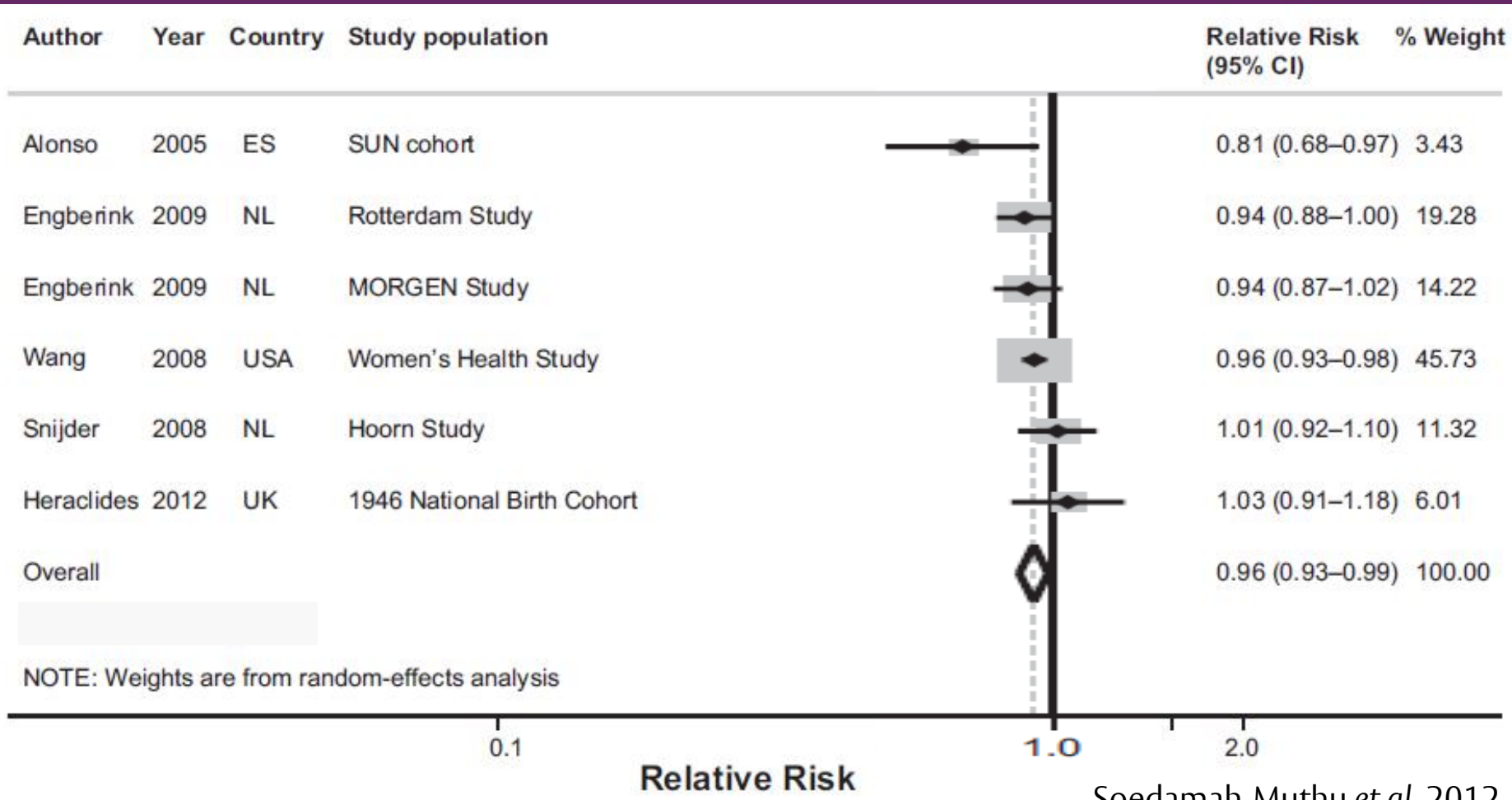
Total dairy intake and hypertension



Soedamah-Muthu *et al.* 2012

University of Reading

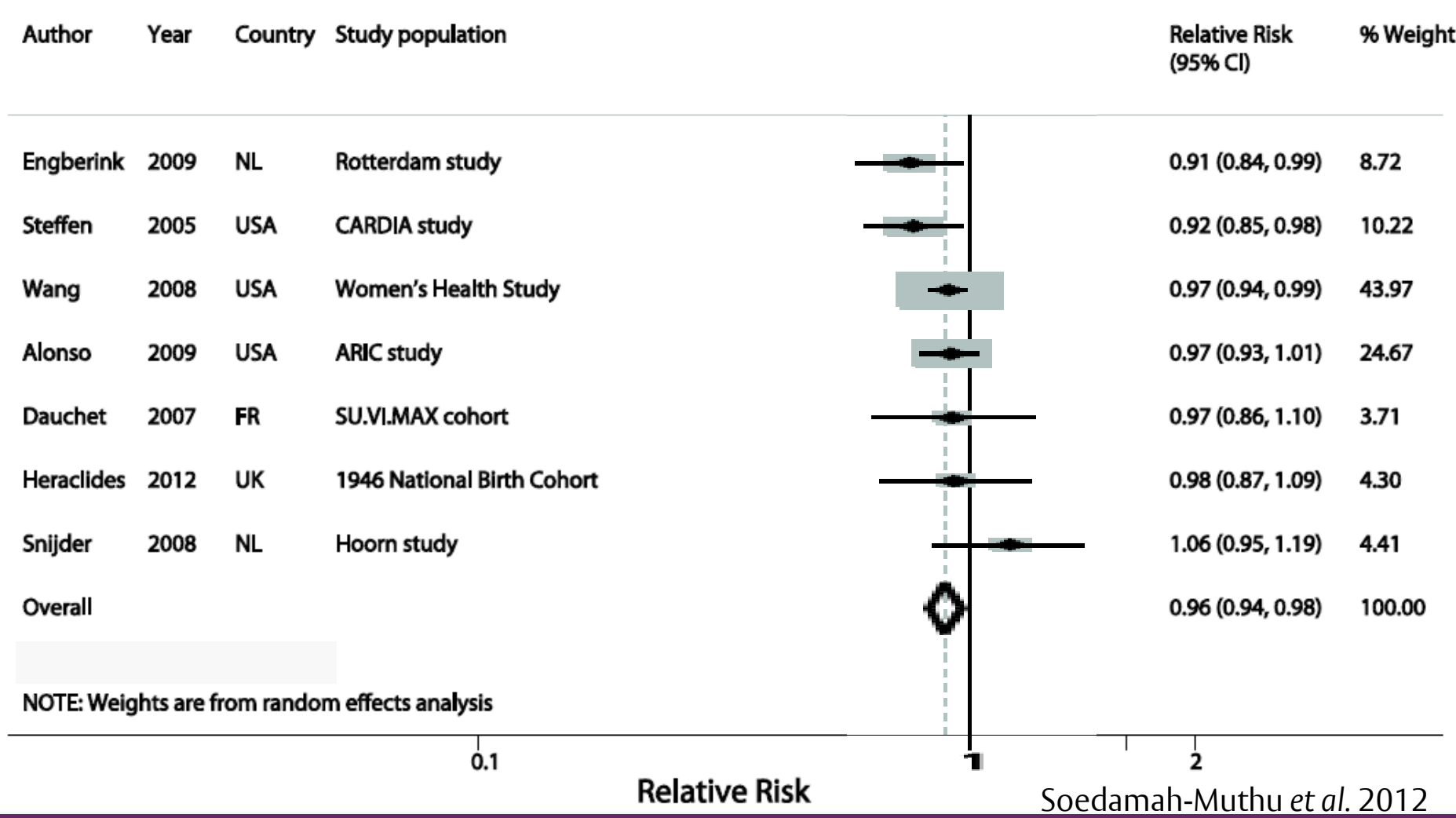
Low-fat dairy intake and hypertension



Soedamah-Muthu *et al.* 2012

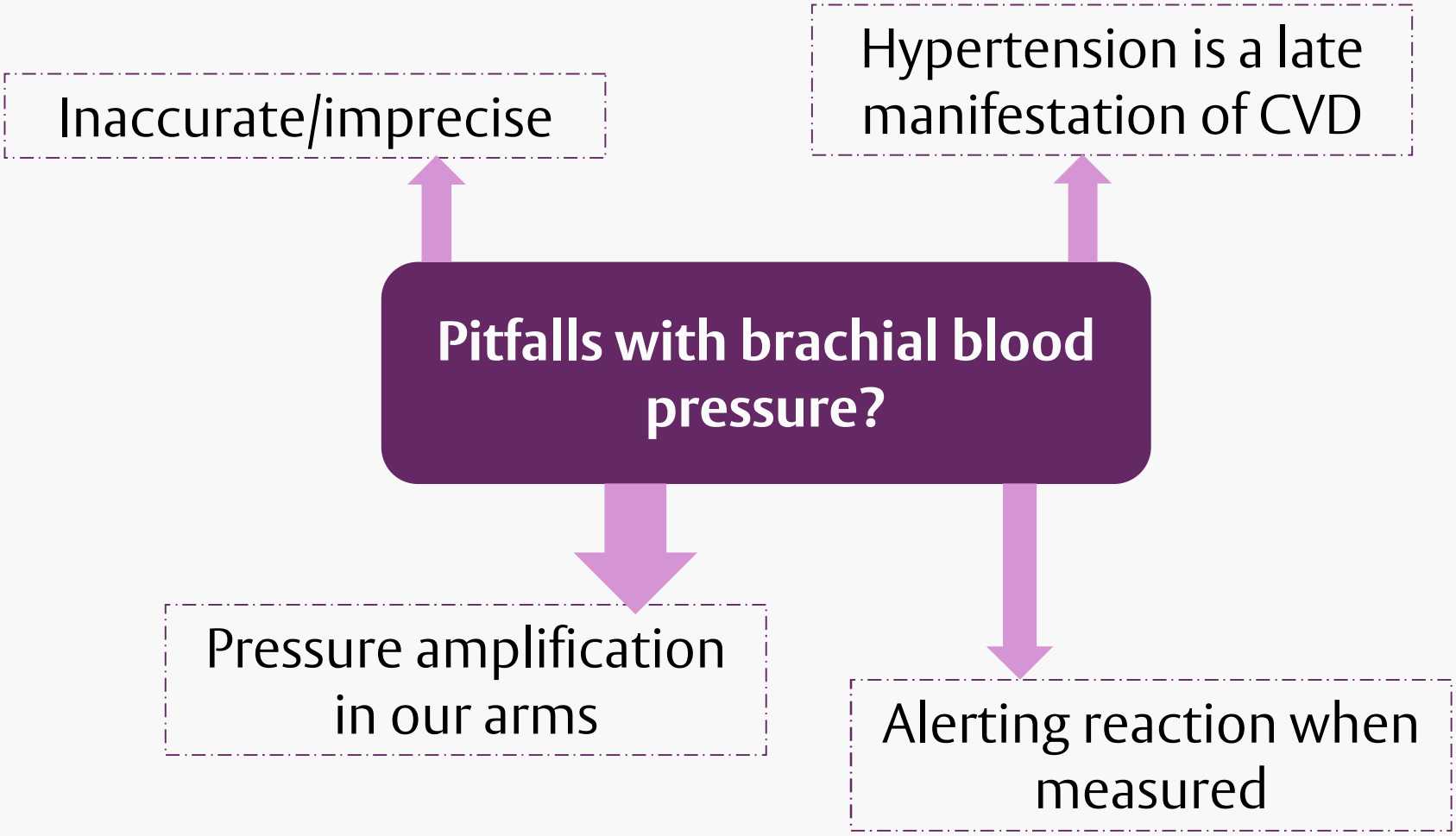
University of Reading

Milk intake and hypertension



Soedamah-Muthu *et al.* 2012

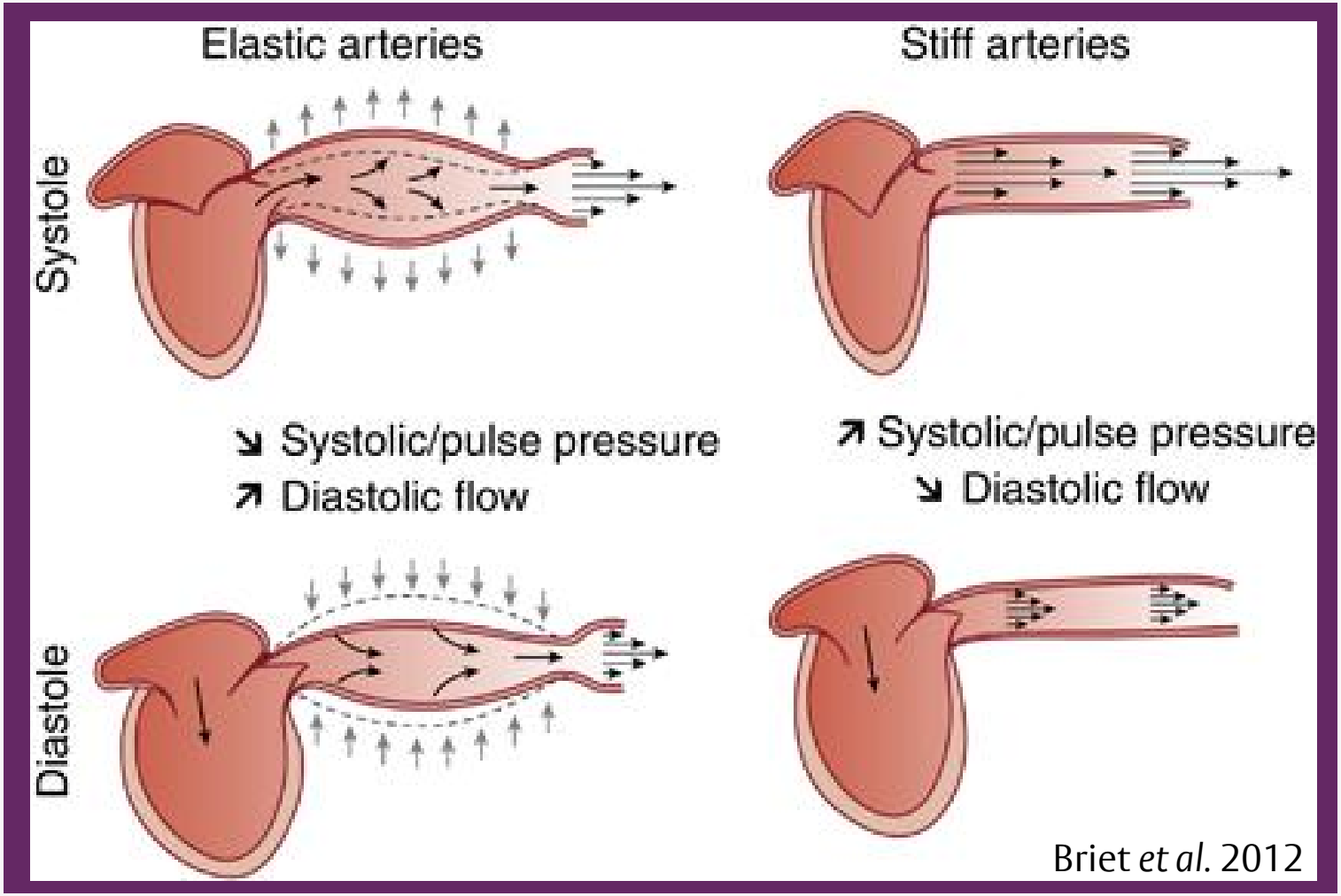
University of Reading



Franklin *et al.* 2008

University of Reading

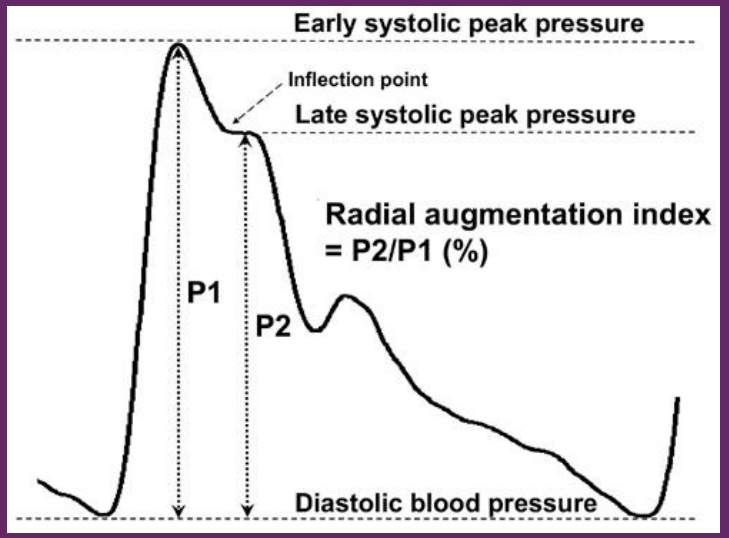
Beyond brachial blood pressure?



University of Reading

Arterial stiffness

Pulse wave velocity and augmentation index are strong, independent predictor of CVD events and all cause mortality
(Vlachopoulos *et al.* 2010; Janner *et al.*, 2012)



University of Reading

Relations Between Dairy Food Intake and Arterial Stiffness

Pulse Wave Velocity and Pulse Pressure

Georgina E. Crichton, Merrrill F. Elias, Gregory A. Dore, Walter P. Abhayaratna, Michael A. Robbins

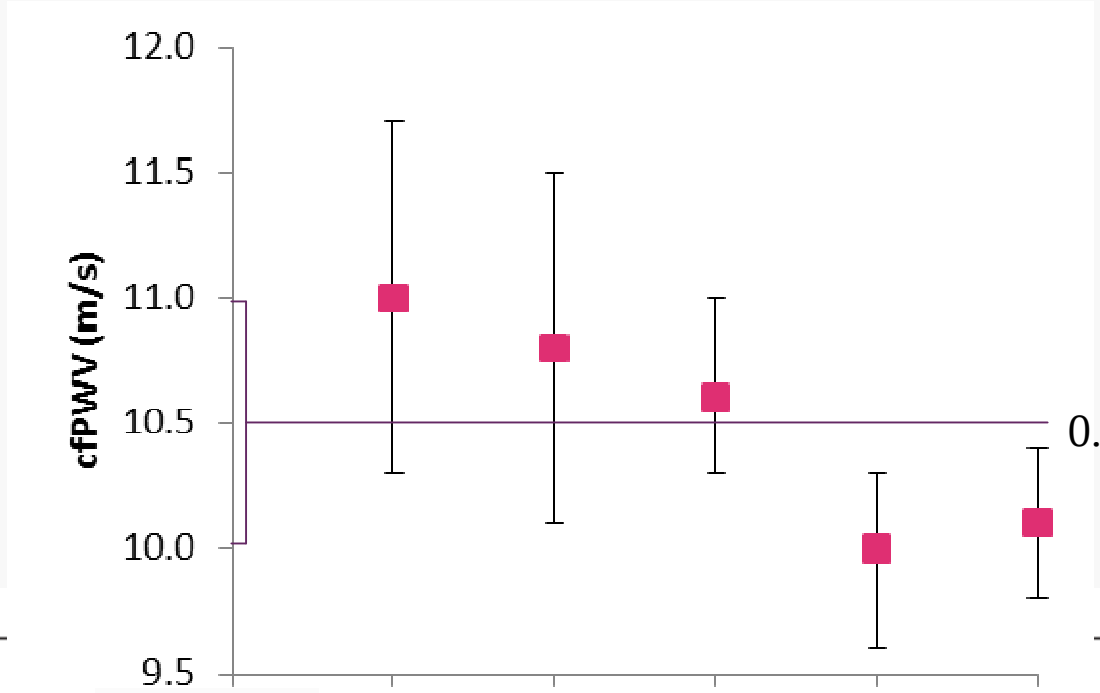
Abstract—Modifiable risk factors, such as diet, are becomingly increasingly important in the management of cardiovascular disease, one of the greatest major causes of death and disease burden. Few studies have examined the role of diet as a possible means of reducing arterial stiffness, as measured by pulse wave velocity, an independent predictor of cardiovascular events and all-cause mortality. The aim of this study was to investigate whether dairy food intake is associated with measures of arterial stiffness, including carotid-femoral pulse wave velocity and pulse pressure. A cross-sectional analysis of a subset of the Maine-Syracuse Longitudinal Study sample was performed. A linear decrease in pulse wave velocity was observed across increasing intakes of dairy food consumption (ranging from never/rarely to daily dairy food intake). The negative linear relationship between pulse wave velocity and intake of dairy food was independent of demographic variables, other cardiovascular disease risk factors, and nutrition variables. The pattern of results was very similar for pulse pressure, whereas no association between dairy food intake and lipid levels was found. Further intervention studies are needed to ascertain whether dairy food intake may be an appropriate dietary intervention for the attenuation of age-related arterial stiffening and reduction of cardiovascular disease risk. (***Hypertension***. **2012; 59:00.)** • **Online Data Supplement**

Key Words: pulse wave velocity ■ arterial stiffness ■ blood pressure ■ dairy food

Crichton *et al.* 2012

University of Reading

Dairy intake and Pulse Wave Velocity



Outcome Measure	Covariate Set	Me								≥1 Time per d (n=216) Mean	95% CI	*P**
cfPWV	Age-adjusted	1(								10.0¶	9.7–10.3	.000‡
	Basic	10.6	9.8–11.4	10.9	10.2–11.6	10.7	10.3–11.1	10.0	9.6–10.3	10.1	9.7–10.4	.016†
	Extended 3	11.0	10.3–11.7	10.8	10.1–11.5	10.6	10.3–11.0	10.0	9.6–10.3	10.1	9.8–10.4	.018‡

Crichton *et al.* 2012

University of Reading

Does Dairy Food Intake Predict Arterial Stiffness and Blood Pressure in Men?

Evidence from the Caerphilly Prospective Study

Katherine M. Livingstone, Julie A. Lovegrove, John R. Cockcroft, Peter C. Elwood, Janet E. Pickering, D. Ian Givens

Abstract—Arterial stiffness is an independent predictor of cardiovascular disease events and mortality, and like blood pressure, may be influenced by dairy food intake. Few studies have investigated the effects of consumption of these foods on prospective measures of arterial stiffness. The present analysis aimed to investigate the prospective relationship between milk, cheese, cream, and butter consumption and aortic pulse wave velocity, augmentation index, systolic and diastolic blood pressure, as well as cross-sectional relationships between these foods and systolic and diastolic blood pressure and metabolic markers using data from the Caerphilly Prospective Study. Included in this cohort were 2512 men, aged 45 to 59 years, who were followed up at 5-year intervals for a mean of 22.8 years (number follow-up 787). Augmentation index was 1.8% lower in subjects in the highest quartiles of dairy product intake compared with the lowest (P trend=0.021), whereas in the highest group of milk consumption systolic blood pressure was 10.4 mm Hg lower (P trend=0.033) than in nonmilk consumers after a 22.8-year follow-up. Cross-sectional analyses indicated that across increasing quartiles of butter intake, insulin (P trend=0.011), triacylglycerol (P trend=0.023), total cholesterol (P trend=0.002), and diastolic blood pressure (P trend=0.027) were higher. Across increasing groups of milk intake and quartiles of dairy product intake, glucose (P trend=0.032) and triglyceride concentrations (P trend=0.031) were lower, respectively. The present results confirm that consumption of milk predicts prospective blood pressure, whereas dairy product consumption, excluding butter, is not detrimental to arterial stiffness and metabolic markers. Further research is needed to better understand the mechanisms that underpin these relationships. (*Hypertension*. 2013;61:00-00.) ● **Online Data Supplement**

Key Words: dairy products ■ blood pressure ■ aortic pulse wave velocity ■ augmentation index ■ cardiovascular disease

Livingstone *et al*. *Hypertension*. 2013 , 61, 42-47.

University of Reading

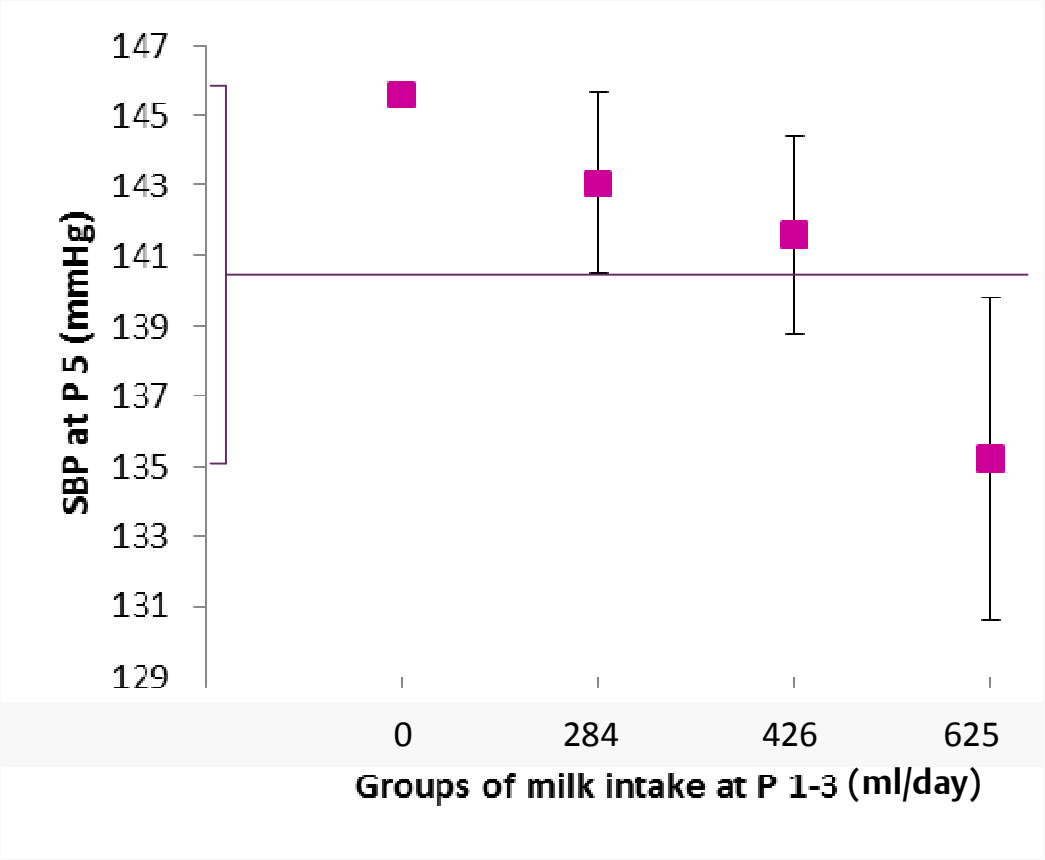
Caerphilly Prospective Study

Subjects	Follow-up	Assessments
ÅPhase 1 (P1; 1979)	Å5-year intervals for 22.8 ± 1.2 years	ÅFood frequency questionnaire (FFQ)
Å2,512 men from Wales	ÅP2 (1984)	ÅBlood sample
ÅAged 45-59 years	ÅP3 (1994)	ÅBlood pressure
	ÅP4 (1999)	ÅArterial Stiffness: Pulse Wave Velocity/ Augmentation Index
	ÅP5 (2004)	

Livingstone *et al*. *Hypertension*. 2013 , 61, 42-47.

University of Reading

Milk intake predicts Systolic Blood Pressure

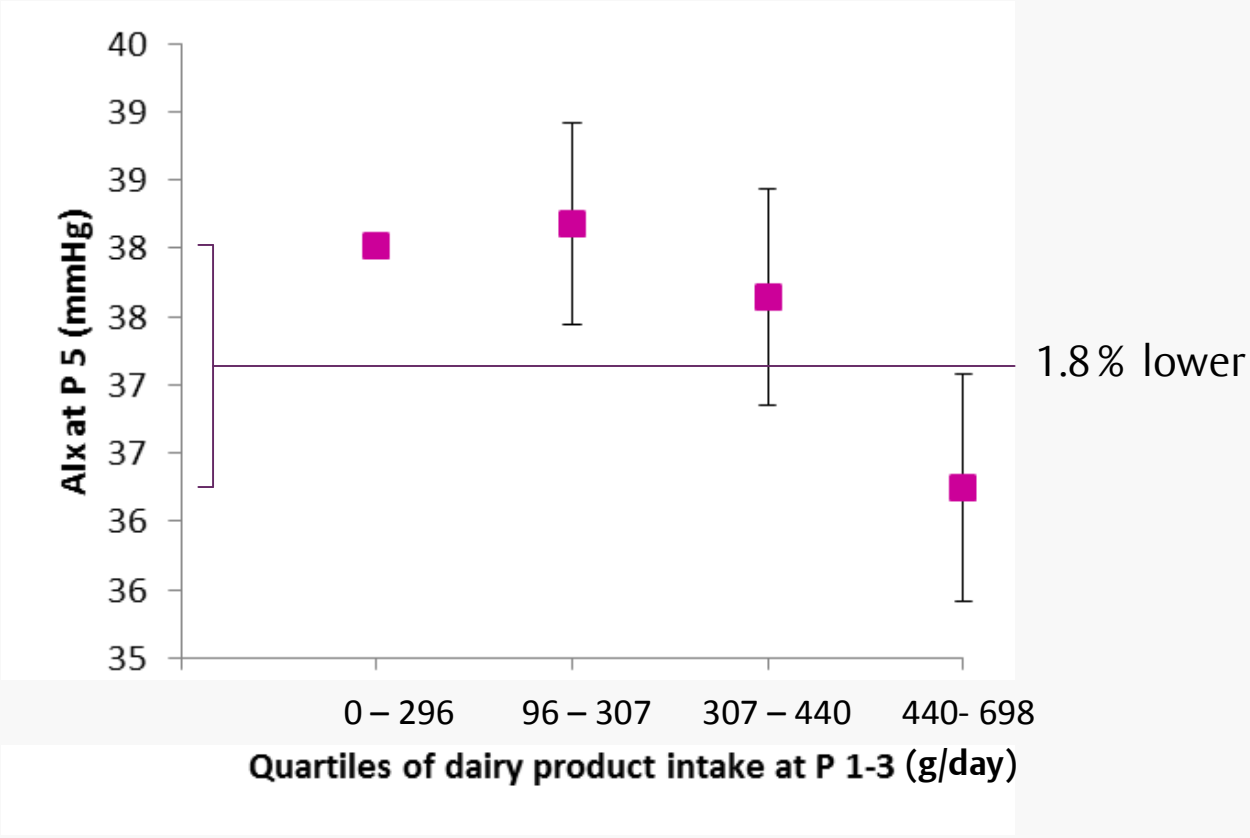


At mean phase (P) 1-3, increasing milk consumption was associated with a lower phase 5 SBP (Coefficient: -0.013 ± 0.006, *P trend*=0.033)

Livingstone *et al*. *Hypertension*. 2013 , 61, 42-47.

University of Reading

Dairy intake predicts Augmentation Index

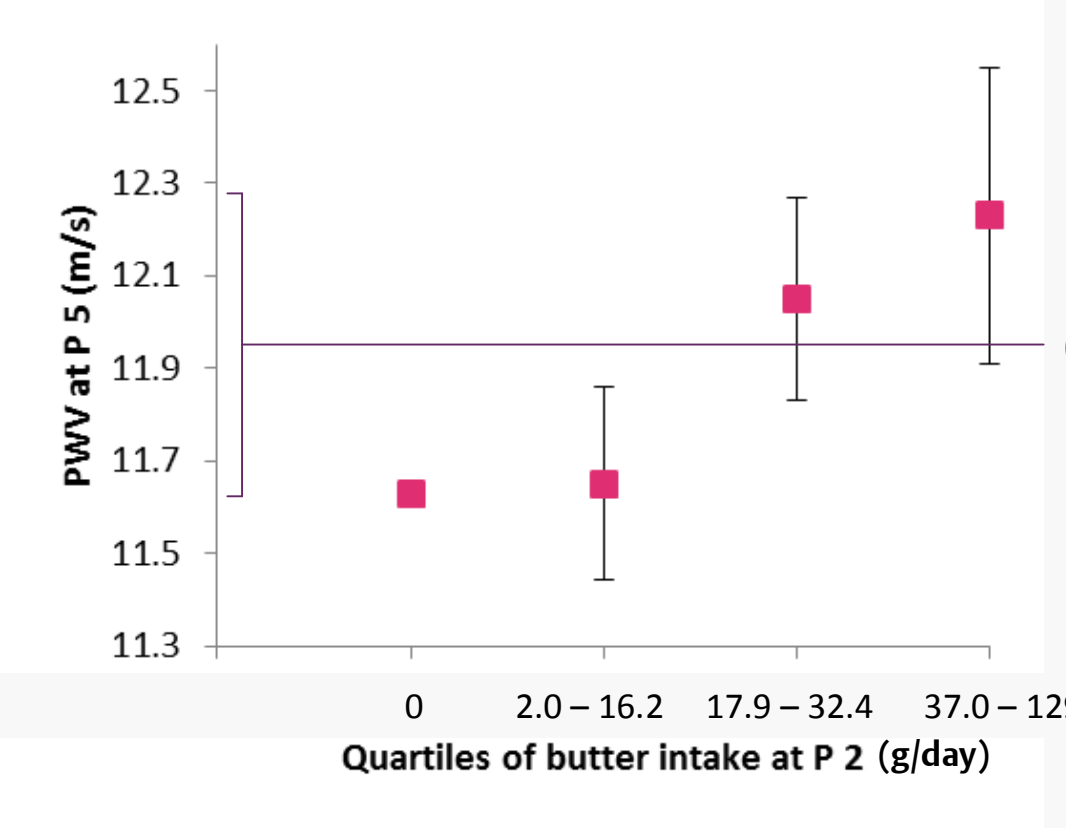


At mean phase (P) 1-3, increasing dairy consumption was associated with a lower phase 5 augmentation index (Coefficient: -0.613 ± 0.266, *P trend*=0.021)

Livingstone *et al*. *Hypertension*. 2013 , 61, 42-47.

University of Reading

Butter intake predict Pulse Wave Velocity

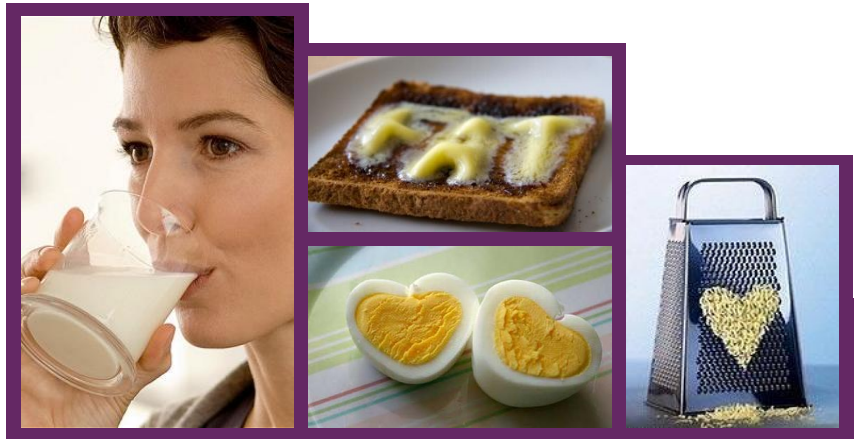


At phase (P) 2, increasing butter consumption was associated with a higher phase 5 pulse wave velocity (Coefficient: 0.211 ± 0.089, *P trend*=0.018)

Livingstone *et al*. *Hypertension*. 2013 , 61, 42-47.

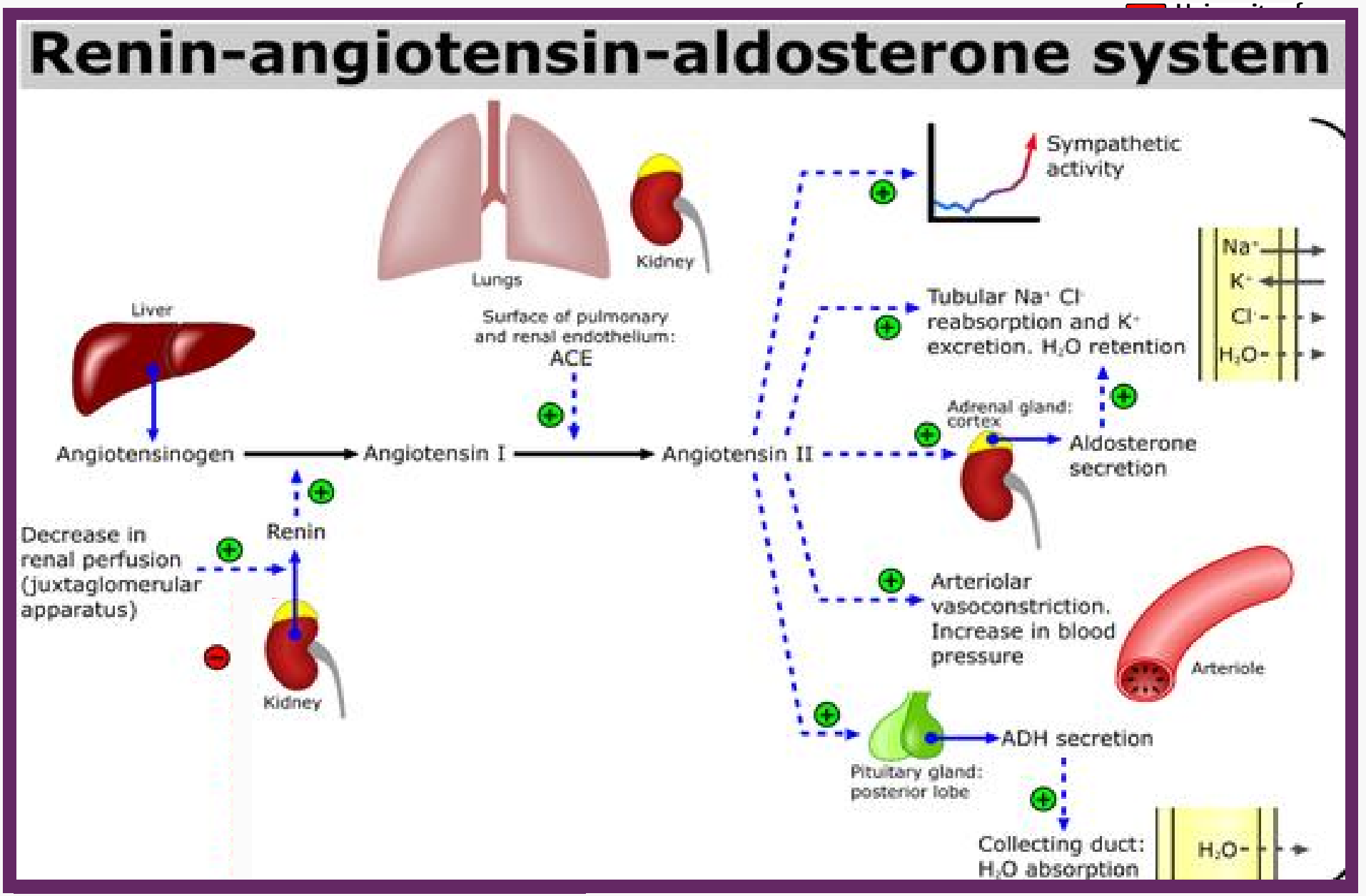
Faculty of Life Sciences

University of Reading

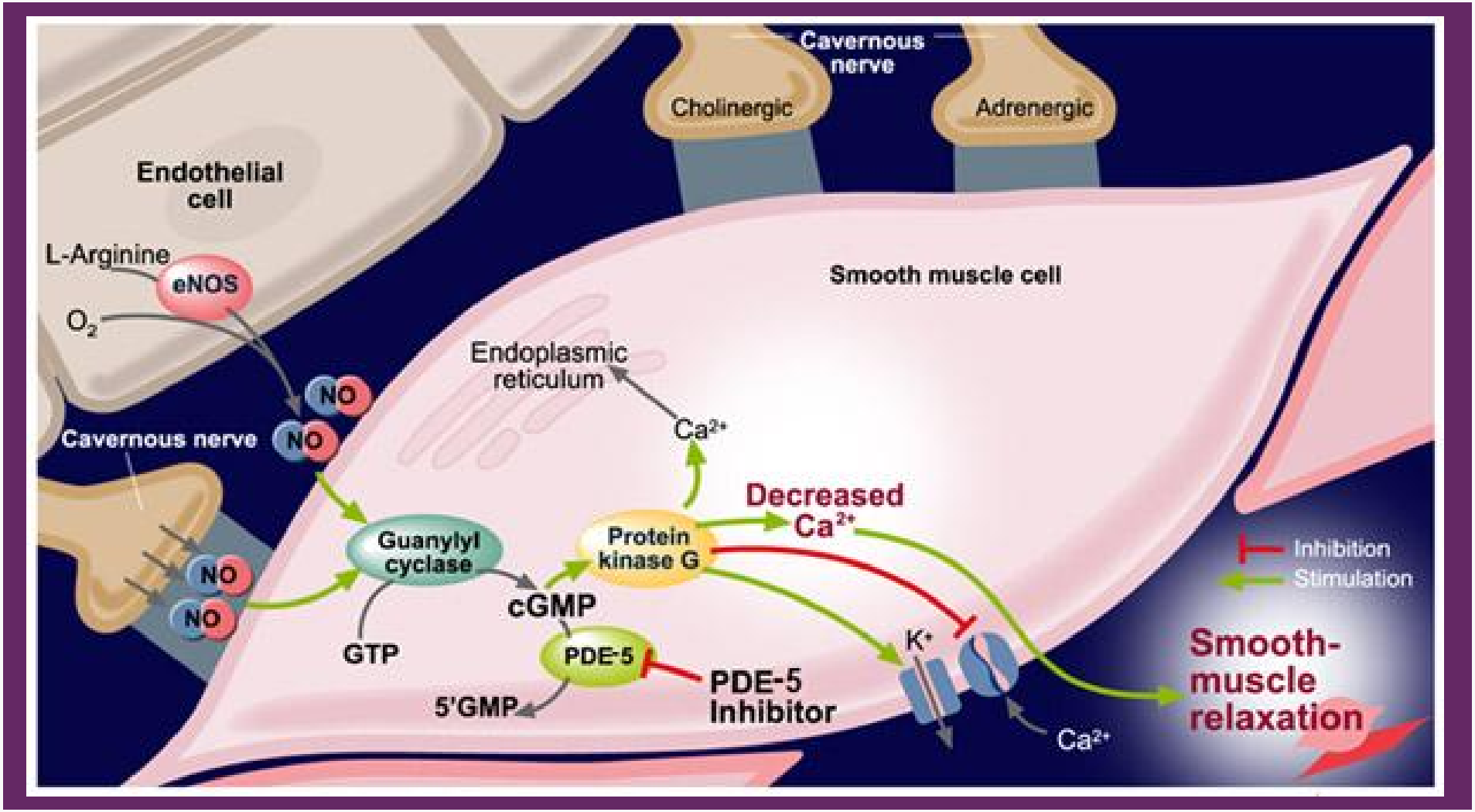


Hypertension

Potential mechanisms

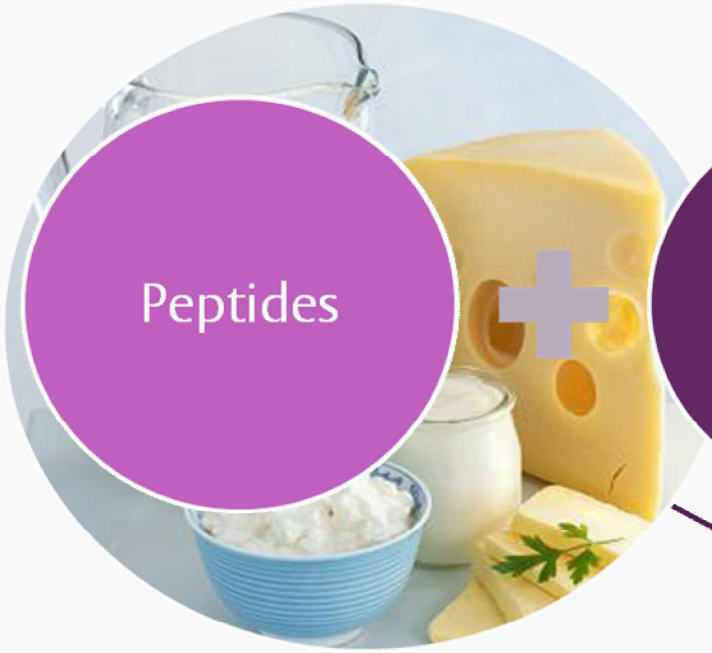

Renin-angiotensin-aldosterone system
Lungs
Kidney
Liver
Surface of pulmonary and renal endothelium:
ACE
Angiotensinogen
Angiotensin I
Angiotensin II
Renin
Decrease in renal perfusion (juxtaglomerular apparatus)
Kidney
Sympathetic activity
Tubular Na⁺ Cl⁻ reabsorption and K⁺ excretion. H₂O retention
Na⁺
K⁺
Cl⁻
H₂O
Adrenal gland: cortex
Aldosterone secretion
Arteriolar vasoconstriction. Increase in blood pressure
Arteriole
ADH secretion
Pituitary gland: posterior lobe
Collecting duct: H₂O absorption
H₂O

Hypertension – potential mechanisms



University of Reading

Potential mechanisms for dairy



Peptides

Minerals

Blood pressure

Arterial stiffness

- Magnesium, Potassium and Calci
- Bic

=

Regulation

- Similar to blood pressure
- L-arganine precursor of nitric oxide?

van Meijl *et al.* (2008) *Nutr Res Rev;*
Turpeinen et al. (2004) Annals of Medicine
FitzGerald *et al.* (2004) *J Nutr*;134:980S-988S.

University of Reading

Conclusions

Diet appears to have a role in maintaining a healthy blood pressure

Dairy products lower blood pressure but also arterial stiffness

Dairy products should be incorporated into a health balanced diet

Acknowledgements

University of Reading:

- Professor Julie Lovegrove
- Professor Ian Givens
- Professor Chris Reynolds
- Dr. Kirsty Kliem

Collaborators:

- Professor Yoav Ben-Shlomo
- Professor John Cockcroft
- Professor Peter Elwood
- Janet Pickering

Contact: k.m.livingstone@pgr.reading.ac.uk

University of Reading

Thank you.

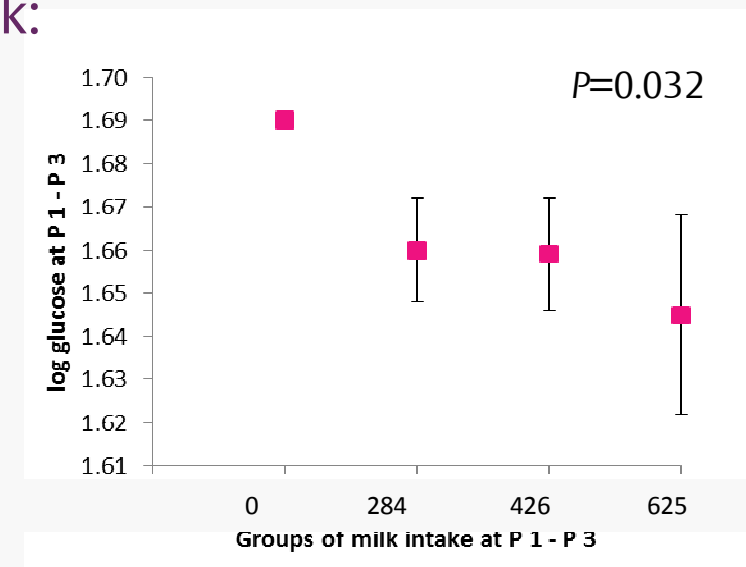
Contact: k.m.livingstone@pgr.reading.ac.uk

Results : cross-sectional metabolic markers

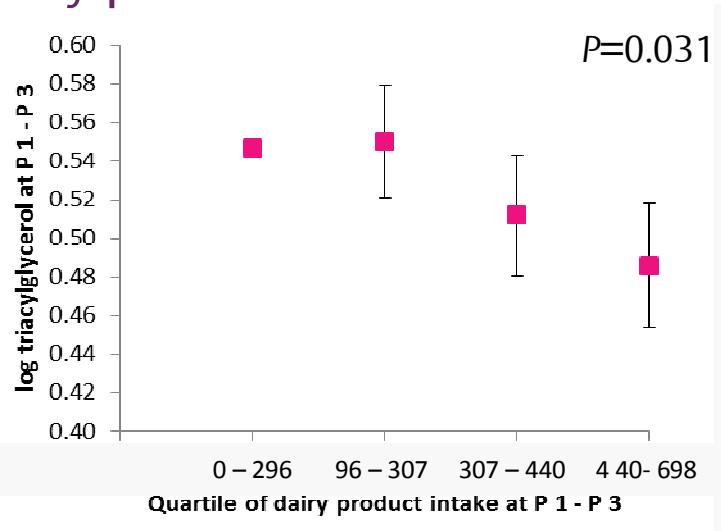
Livingstone *et al. Hypertension.* 2013 , 61, 42-47.

University of Reading

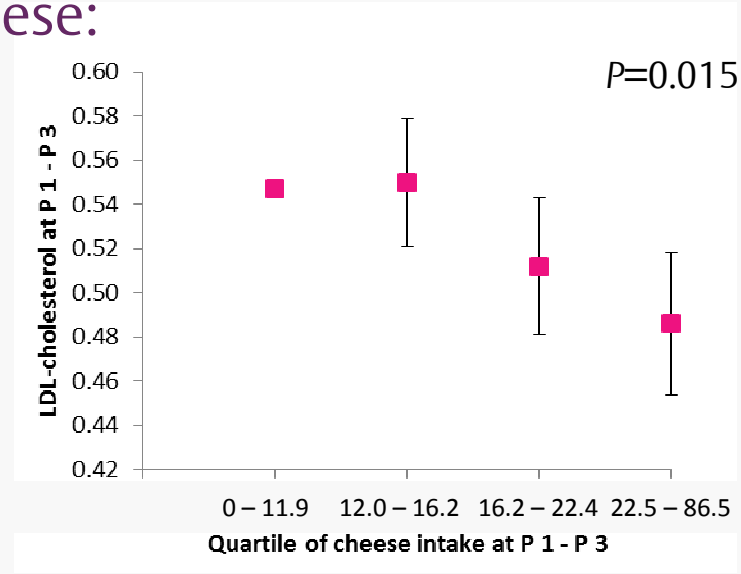
Milk:

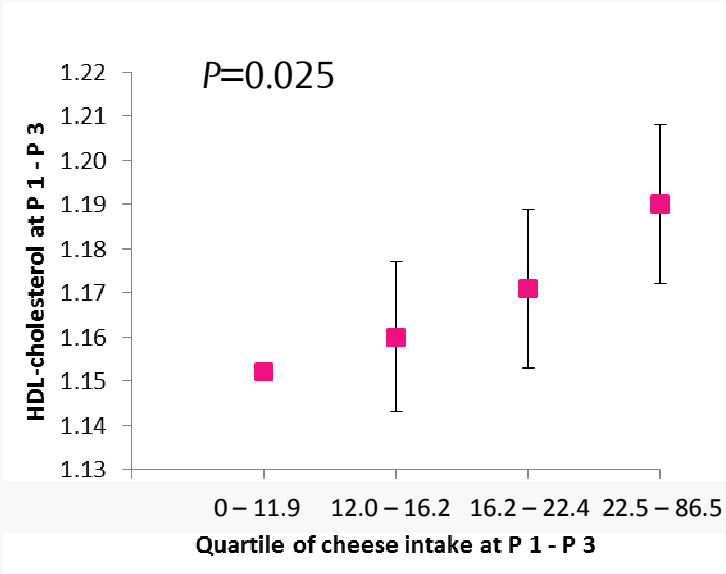


Dairy products:



Cheese:



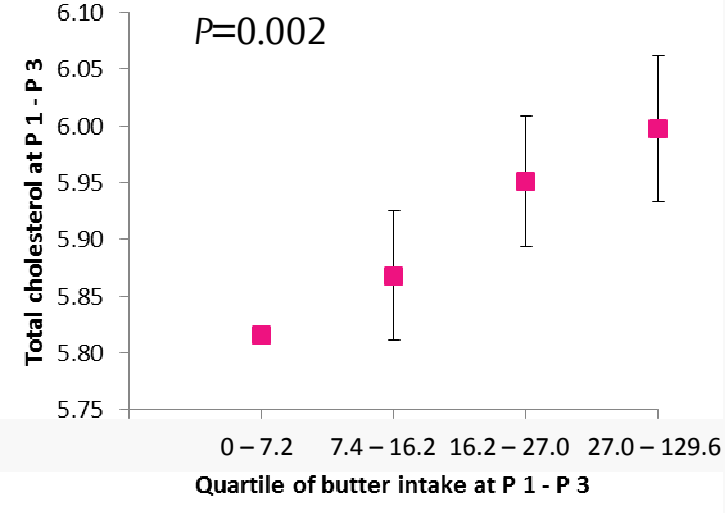


Results : cross-sectional, butter intake

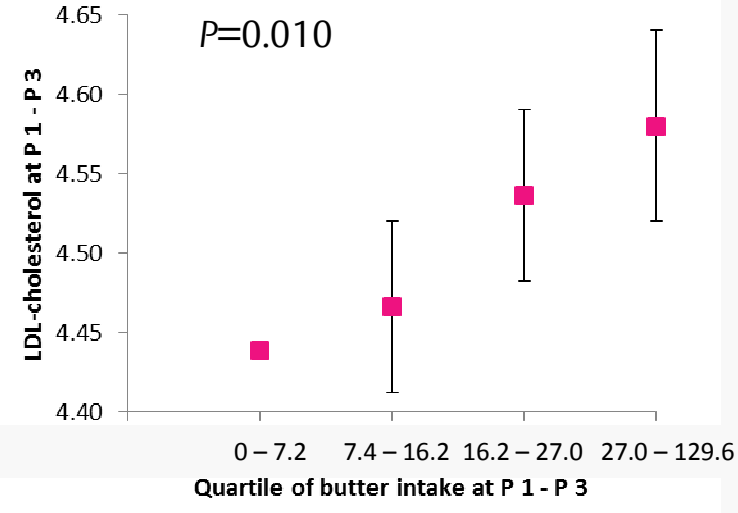
Livingstone *et al. Hypertension.* 2013 , 61, 42-47.

University of Reading

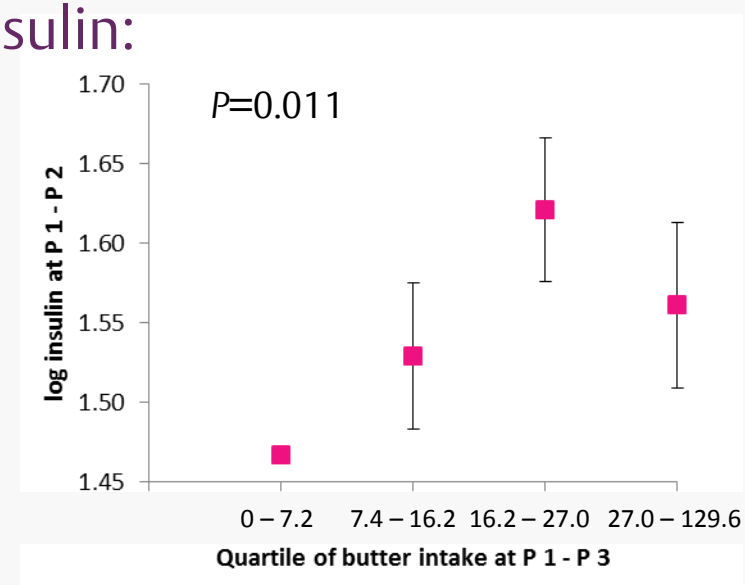
Total cholesterol:



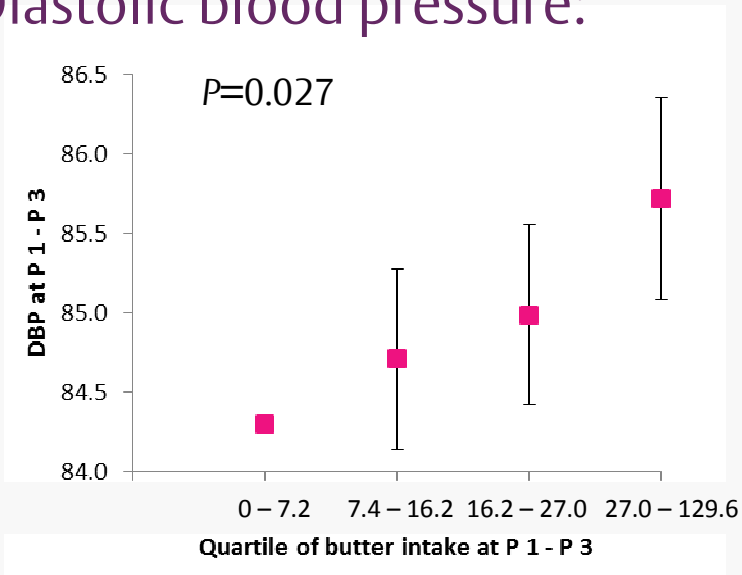
LDL-cholesterol:



Insulin:



Diastolic blood pressure:



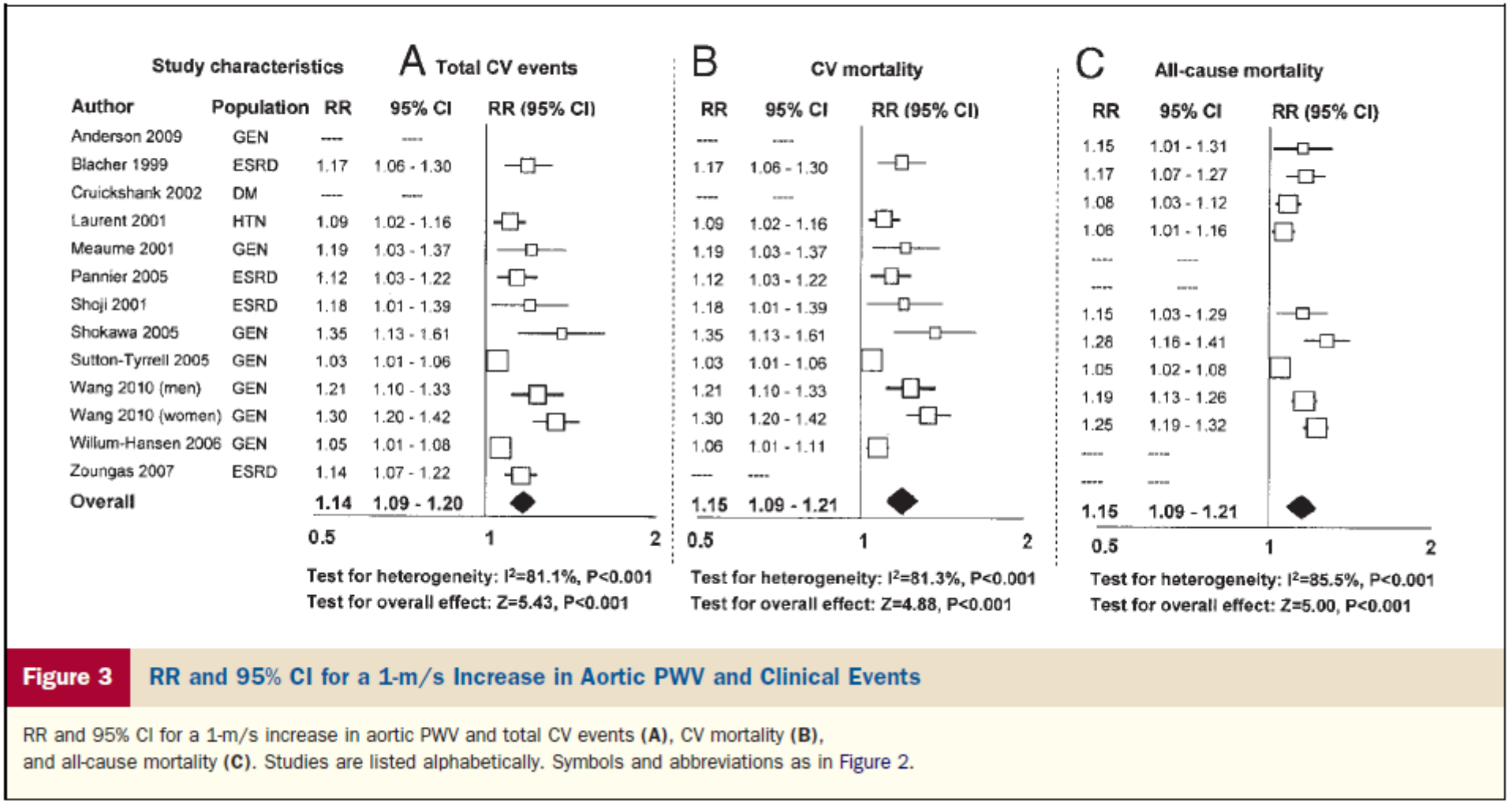


Figure 3 **RR and 95% CI for a 1-m/s Increase in Aortic PWV and Clinical Events**

RR and 95% CI for a 1-m/s increase in aortic PWV and total CV events **(A)**, CV mortality **(B)**, and all-cause mortality **(C)**. Studies are listed alphabetically. Symbols and abbreviations as in Figure 2.