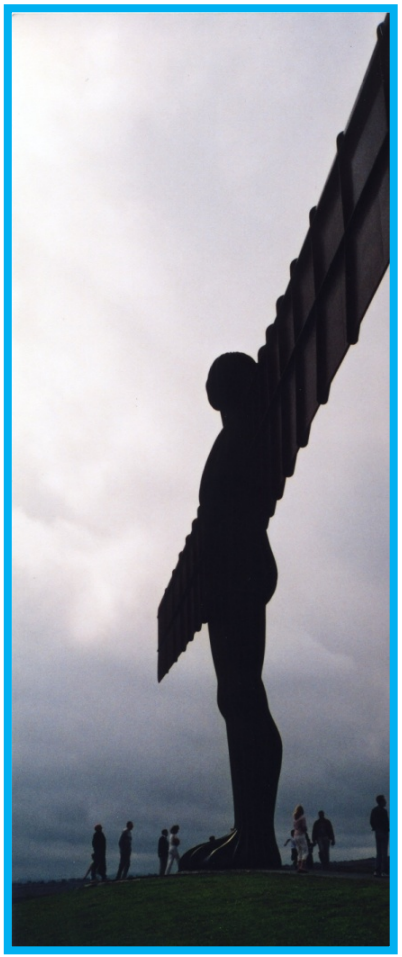
Nutrition and healthy ageing: towards the development of personalised interventions

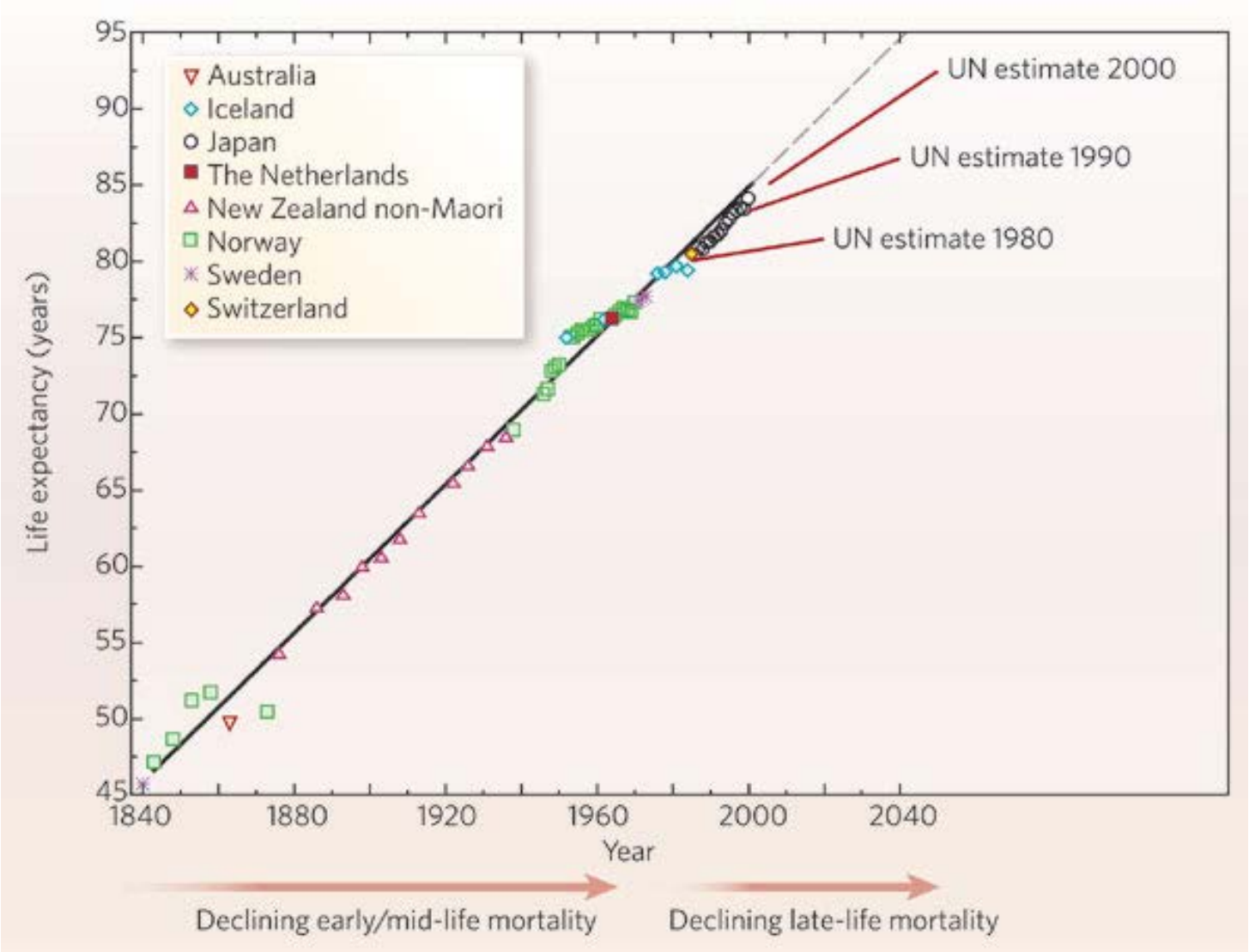


John Mathers

Newcastle University

Human Nutrition Research Centre

The good news



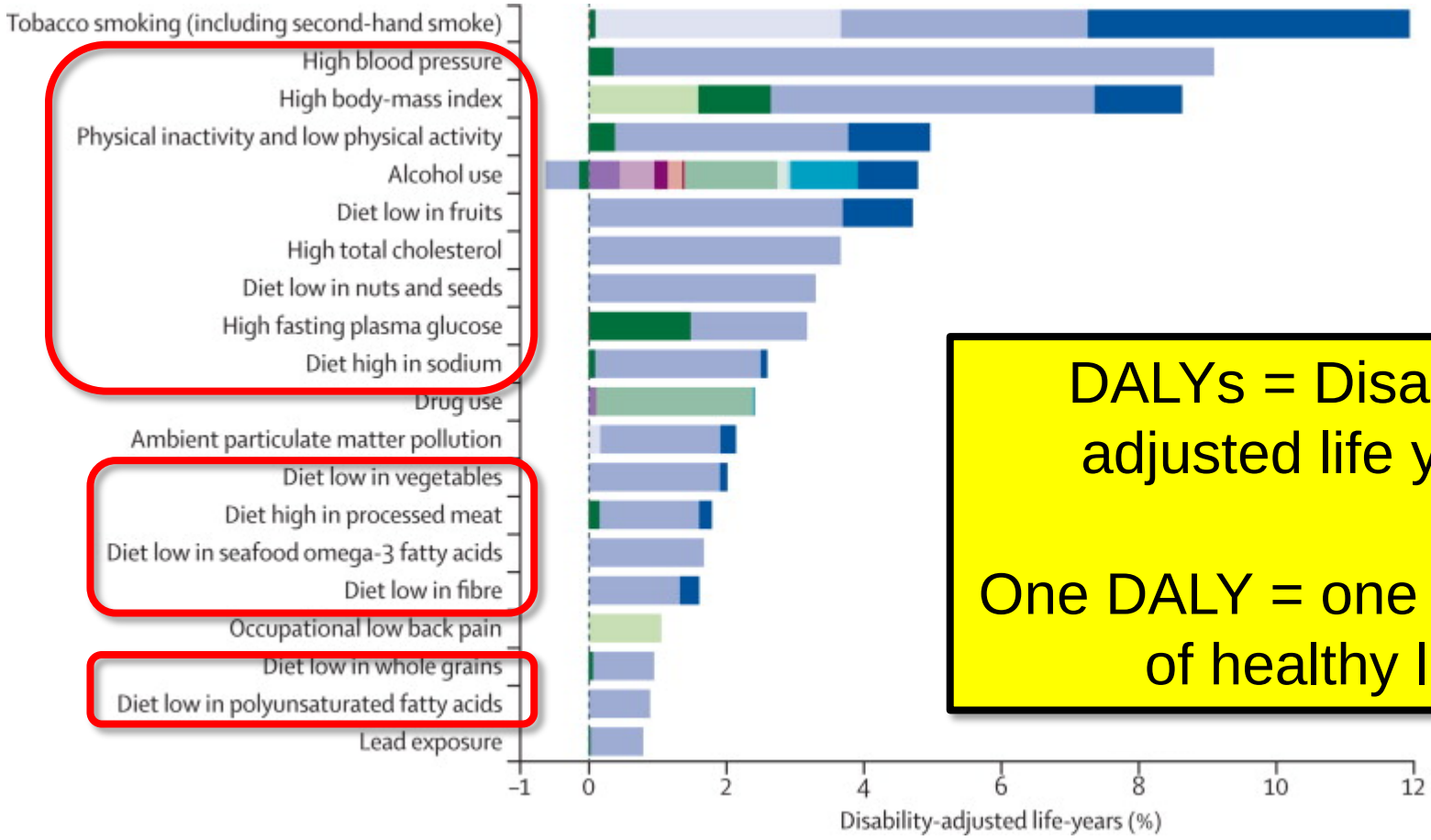
Kirkwood TBL (2008) *Nature* **451**, 644-647

Ageing is major determinant of chronic disease and disability

85%

deaths in the UK caused by age-related diseases

Poor diet and physical inactivity account for much DALYs in UK



DALYs = Disability-adjusted life years

One DALY = one lost year of healthy life

Murray CJ *et al.* (2013) *Lancet* **381,** 997-1020

To wards healthier eating patterns – the challenge of behaviour change

Image from http://www.incite.ws

Changing eating patterns is difficult

- Effects are usually modest
- Changes are difficult to sustain
- Optimistic bias means that people are resistant to change

Potential for personalised nutrition

One size fits all

Personalised nutrition

Newcastle University

Human Nutrition Research Centre

food4me.org

The Food4Me study pan-European personalised nutrition intervention study

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration. (Contract n°265494)

Why and how for personalised nutrition?

- Designed according to key characteristics of individual participants e.g.
  - Socioeconomic characteristics
  - Health status
  - Food preferences…

- Need to collect relevant information about individual participants

- More “personalised” means more complexity

- Digital approaches

Celis-Morales C *et al.* (2015) *Proc. Nutr. Soc.* **74,** 130-138

Personalised nutrition using digital approaches

Advantages:

- ❑ Manage complexity
- ❑ “Built in” behaviour change techniques
- ❑ Reach and scalability
- ❑ Cost-effectiveness
- ❑ May ↓ inequalities
- ❑ Convenience

Celis-Morales C *et al.* (2015) *Proc. Nutr. Soc.* **74,** 130-138

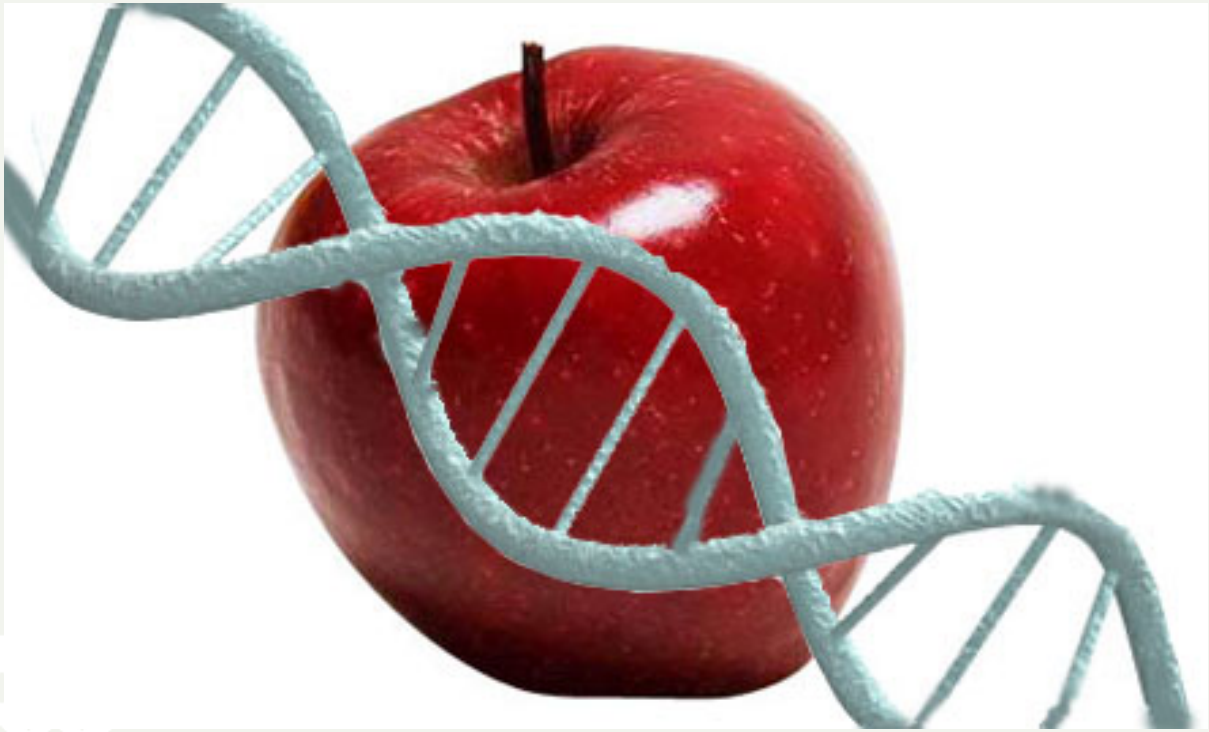
Research questions

Is **personalised nutrition advice more effective** than general healthy eating guidelines?

Is **phenotypic or genotypic information more effective** than diet-based advice alone?

Is the **internet** a successful delivery method?

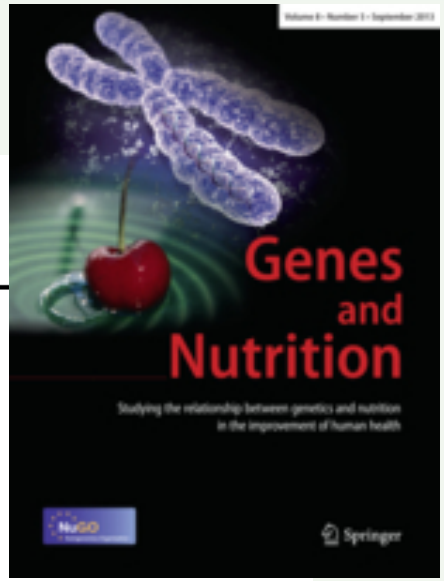
Diet-gene interactions influence health



Genetic information may:

1. **Identify the “right” diet for you and me (personalisation)**
2. **Motivate us to adopt healthier eating patterns**

Study design



Genes Nutr (2015) 10:450
DOI 10.1007/s12263-014-0450-2

RESEARCH PAPER

Design and baseline characteristics of the Food4Me study: a web-based randomised controlled trial of personalised nutrition in seven European countries

Carlos Celis-Morales · Katherine M. Livingstone · Cyril F. M. Marsaux · Hannah Forster · Clare B. O'Donovan · Clara Woolhead · Anna L. Macready · Rosalind Fallaize · Santiago Navas-Carretero · Rodrigo San-Cristobal · Silvia Kolossa · Kai Hartwig · Lydia Tsirigoti · Christina P. Lambrinou · George Moschonis · Magdalena Godlewska · Agnieszka Surwiłło · Keith Grimaldi · Jildau Bouwman · E. J. Daly · Victor Akujobi · Rick O'Riordan · Jettie Hoonhout · Arjan Claassen · Ulrich Hoeller · Thomas E. Gundersen · Siv E. Kaland · John N. S. Matthews · Yannis Manios · Iwona Traczyk · Christian A. Drevon · Eileen R. Gibney · Lorraine Brennan · Marianne C. Walsh · Julie A. Lovegrove · J. Alfredo Martinez · Wim H. M. Saris · Hannelore Daniel · Mike Gibney · John C. Mathers

Received: 18 September 2014 / Accepted: 1 December 2014

Study design

- Randomised Controlled Trial (RCT)
- European adults
- Recruitment target (1540)
- 4 Treatment groups
- Internet-delivered intervention
- Intervention lasted 6 months

Randomised to 4 treatments

Level 0: Generic dietary advice (Control)

Level 1: Personalisation based on **DIETARY** analysis

Level 2: Personalisation based on **DIETARY + PHENOTYPIC** analysis

Level 3: Personalisation based on **DIETARY + PHENOTYPIC + GENOMIC** analysis

Generic advice for Level 0

- ❑ Vegetables and fruits
- ❑ Wholegrains
- ❑ Fish
- ❑ Dairy products
- ❑ Red meat
- ❑ Type of fat
- ❑ Salt






Levels 1 – 3: Personalised nutrition advice

Personalised nutrition advice:

- ❑ Delivered in participant's baseline report and at Month 3.
- ❑ Identified **3 food-based goals**.
- ❑ **Goals** were selected by ranking dietary (+ phenotypic + genotypic) risk markers
- ❑ Risk status shown as red, amber or green – see below

Collection of phenotypic data .2

Metabolic and nutritional markers

- 2 Dry Blood Spot Card (DBS)
- 10 blood circles filled (150µl blood)
- DBS cards posted back to Study Centre
- **35** metabolic & nutritional markers measured (Glucose, Cholesterol, Carotenoids, Vitamin D, Fatty acids…)

Instruction for all measurements provided in video and printed formats

Collection of genomic data

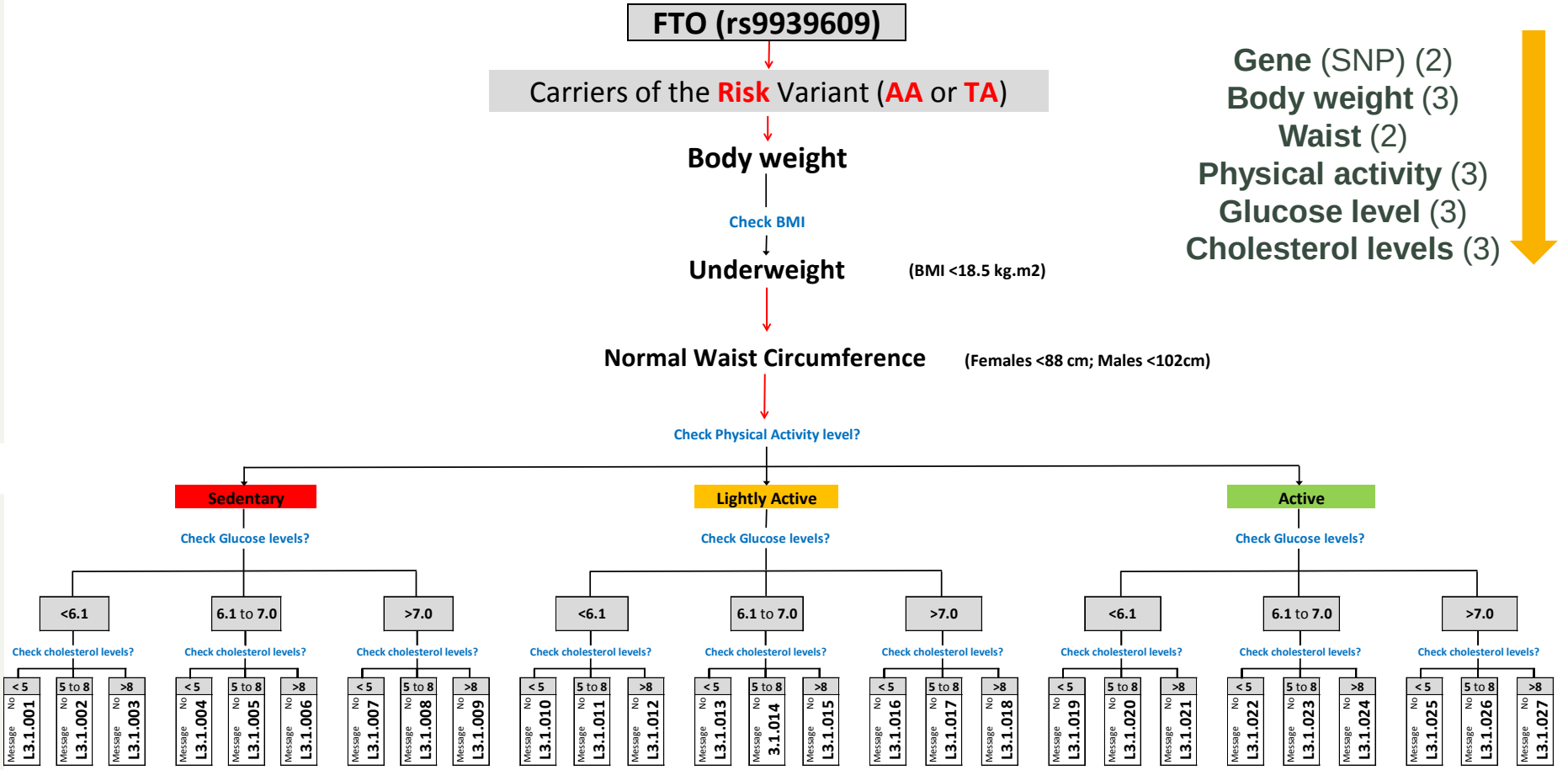
Genetic markers

- Buccal cells collected at home for DNA extraction
- **32** nutrient-related genetic variants genotyped for the Food4Me Study
- Personalised nutrition advice based on 5 nutrient-related genetic variants

Instruction for all measurements provided in video and printed formats

Generating personalised nutrition advice

Algorithms for decision trees



Gene (SNP) (2)
Body weight (3)
Waist (2)
Physical activity (3)
Glucose level (3)
Cholesterol levels (3)

324 possible pieces of personalised nutritional advice

Research question .1

Is personalised nutritional advice more effective than the conventional **'one size fits all'** approach?

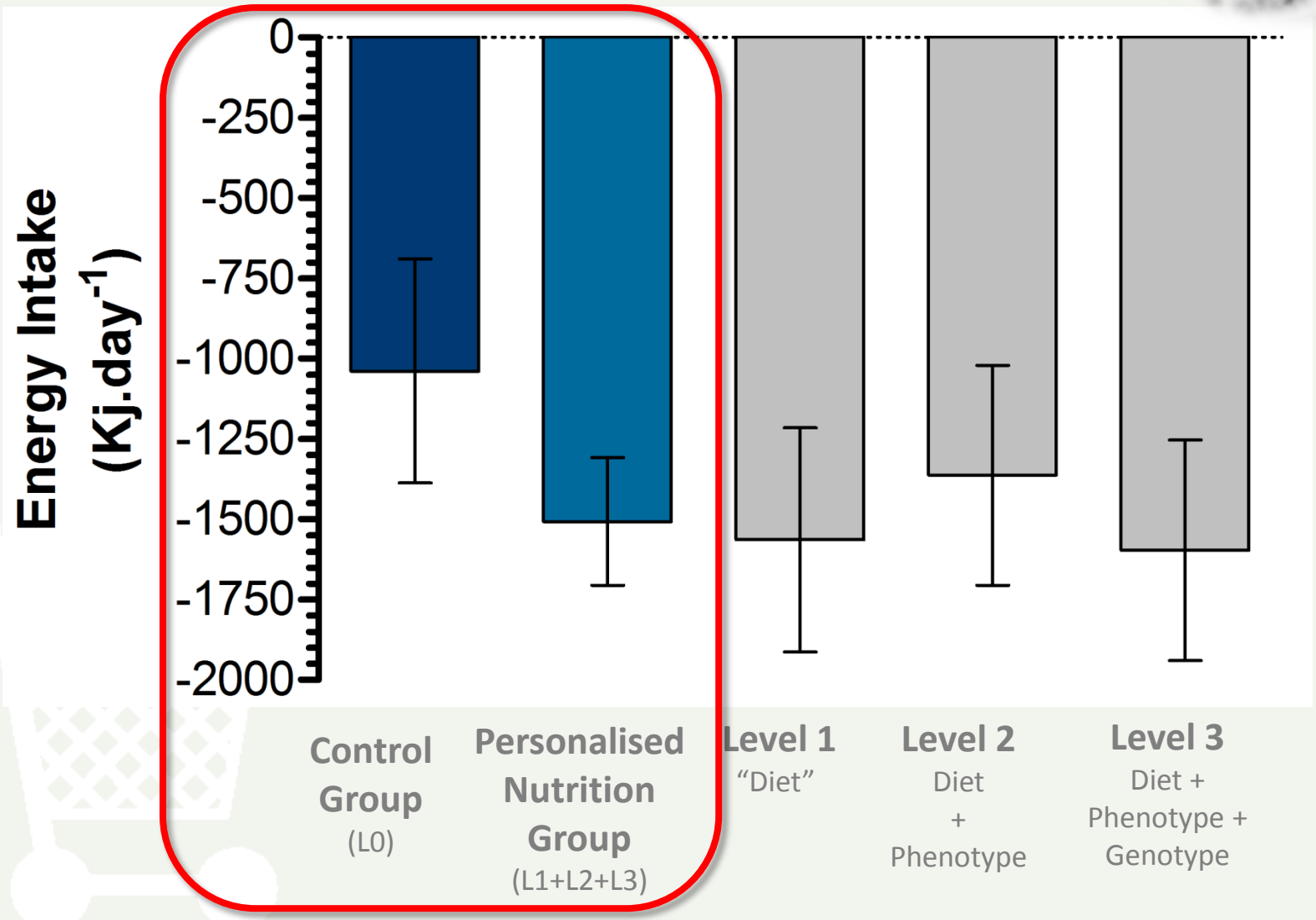
Celis-Morales C *et al.* (2016) *Int J Epidemiol*. PMID: 27524815.

Research question .2

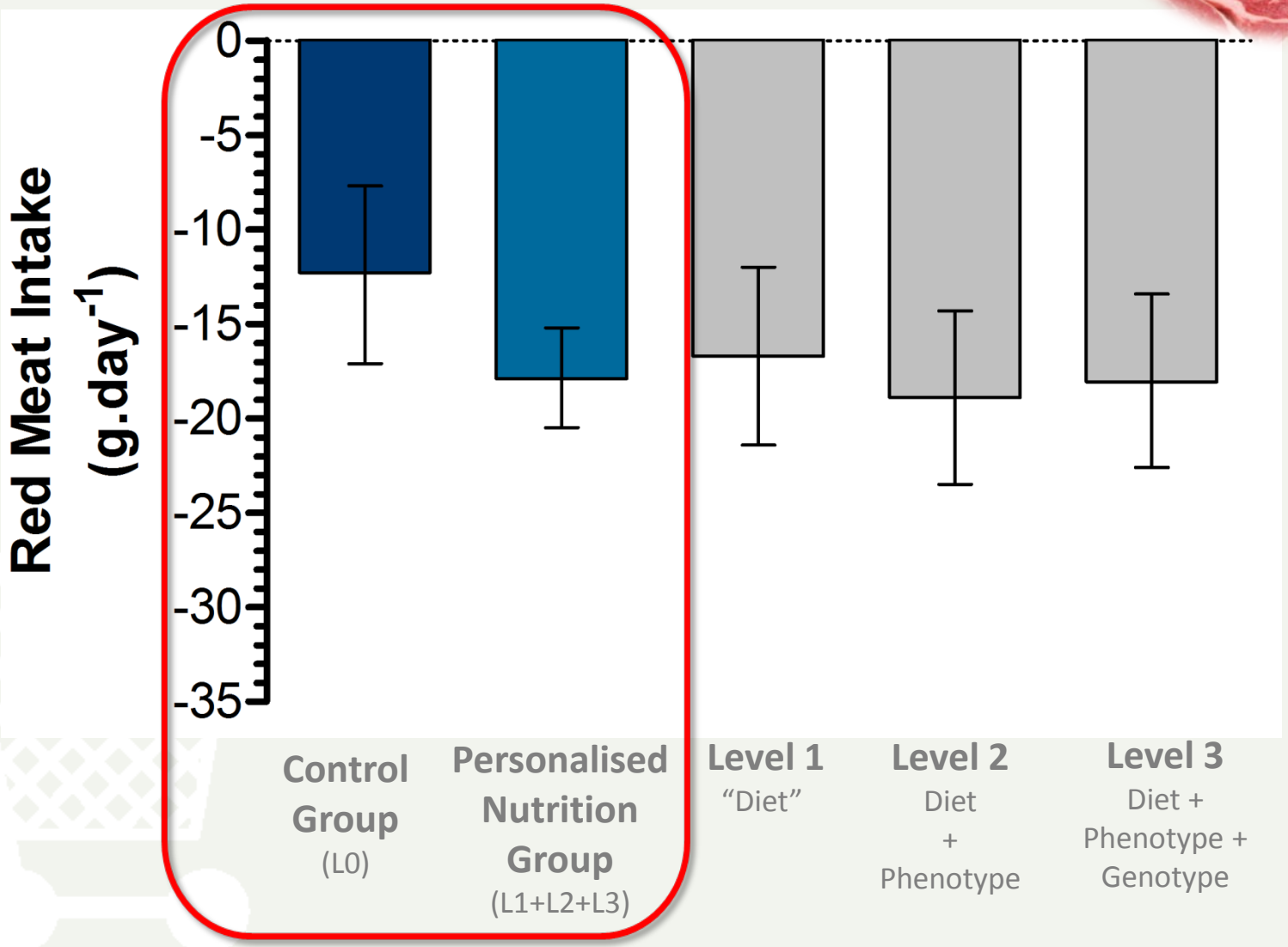
Is **personalisation based on phenotype or genotype more effective** than personalisation based on diet alone?

Celis-Morales C *et al.* (2016) *Int J Epidemiol*. PMID: 27524815.

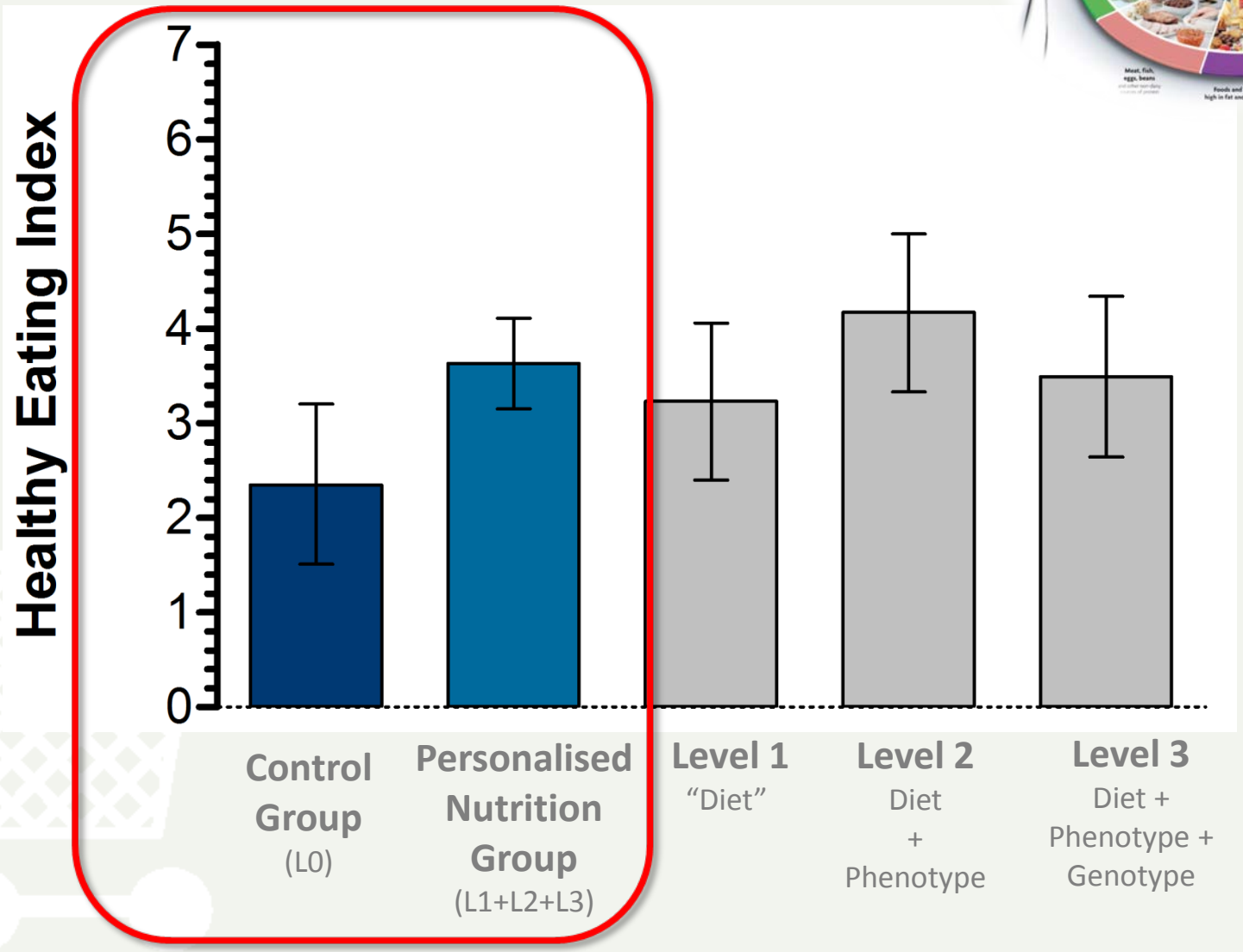
Changes in Energy intake at month 6



Changes in Red Meat intake at month 6



Changes in Healthy Eating at month 6



Take home messages

Personalised nutrition works

No added advantage of phenotypic or genetic information

Internet-based delivery is effective

Introduction to the LiveWell Programme: pilot study

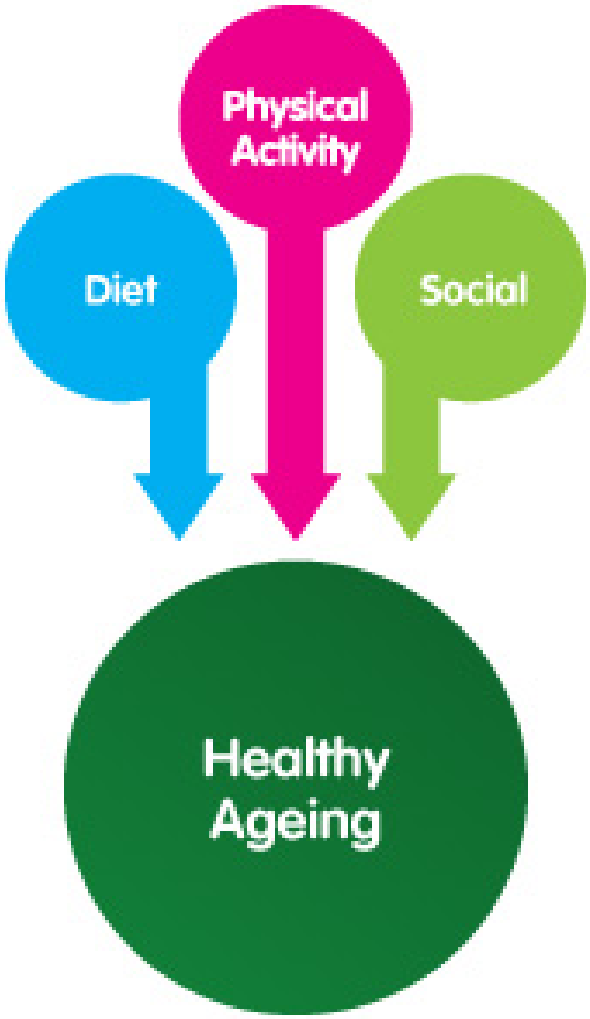
Lifelong Health & Wellbeing
Research for Healthy Ageing

John Mathers

LiveWell

Newcastle University
Human Nutrition Research Centre

Context for project



LiveWell
research today, for tomorrow

Our Aims

- **AIM 1:** Develop and pilot **pragmatic interventions** to promote health and well-being in later life

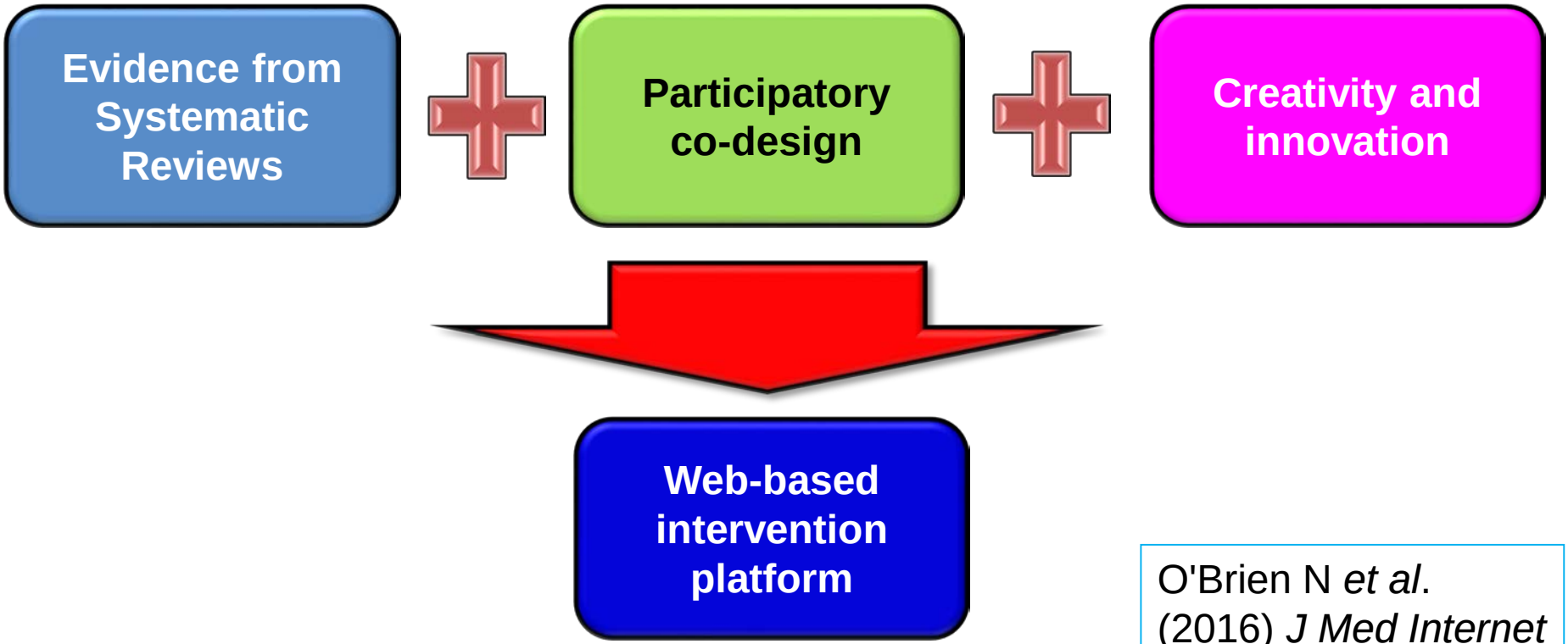
- **AIM 2:** Develop tools to measure healthy ageing

Retirement as the “window of opportunity” for interventions

LiveWell

Newcastle University

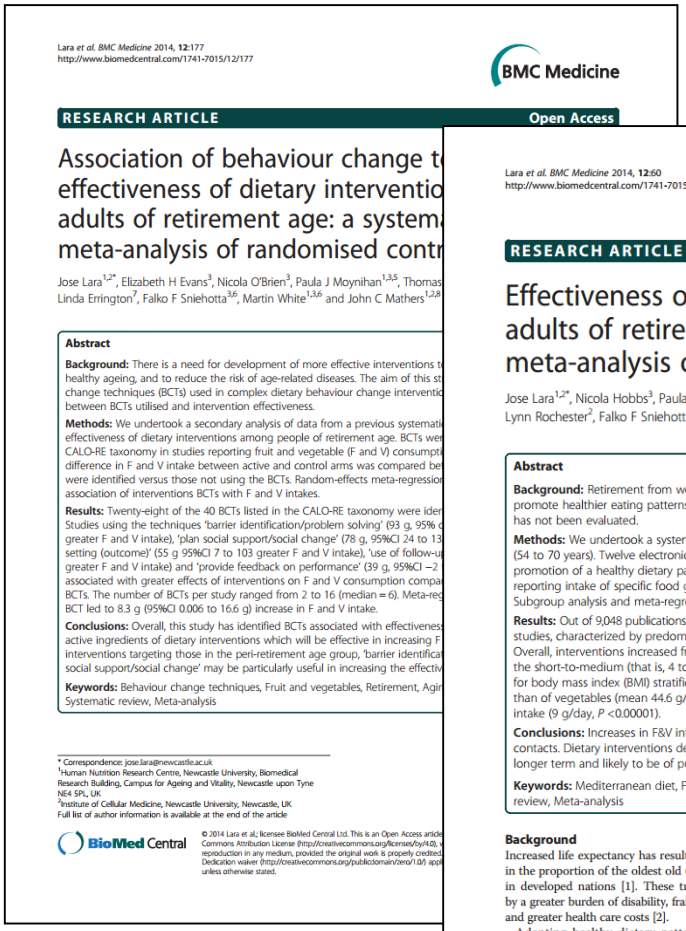
Overview of methodology



O'Brien N *et al*. (2016) *J Med Internet Res*. 18(8):e210.

Assembling the evidence

Systematic reviews of what works!



Lara et al. BMC Medicine 2014, 12:177
http://www.biomedcentral.com/1741-7015/12/177

BMC Medicine

RESEARCH ARTICLE Open Access

Association of behaviour change t
effectiveness of dietary interventio
adults of retirement age: a system
meta-analysis of randomised contr

Jose Lara[1,2*], Elizabeth H Evans[3], Nicola O'Brien[3], Paula J Moynihan[1,3,5], Thomas
Linda Errington[7], Falko F Sniehotta[3,6], Martin White[1,3,6] and John C Mathers[1,2,8]

Abstract

Background: There is a need for development of more effective interventions t
healthy ageing, and to reduce the risk of age-related diseases. The aim of this st
change techniques (BCTs) used in complex dietary behaviour change interventi
between BCTs utilised and intervention effectiveness.

Methods: We undertook a secondary analysis of data from a previous systemati
effectiveness of dietary interventions among people of retirement age. BCTs wer
CALO-RE taxonomy in studies reporting fruit and vegetable (F and V) consumpti
difference in F and V intake between active and control arms was compared be
were identified versus those not using the BCTs. Random-effects meta-regressio
association of interventions BCTs with F and V intakes.

Results: Twenty-eight of the 40 BCTs listed in the CALO-RE taxonomy were ider
Studies using the techniques 'barrier identification/problem solving' (93 g, 95% c
greater F and V intake), 'plan social support/social change' (78 g, 95%CI 24 to 13
setting (outcome)' (55 g 95%CI 7 to 103 greater F and V intake), 'use of follow-u
greater F and V intake) and 'provide feedback on performance' (39 g, 95%CI −2
associated with greater effects of interventions on F and V consumption compa
BCTs. The number of BCTs per study ranged from 2 to 16 (median = 6). Meta-reg
BCT led to 8.3 g (95%CI 0.006 to 16.6 g) increase in F and V intake.

Conclusions: Overall, this study has identified BCTs associated with effectiveness
active ingredients of dietary interventions which will be effective in increasing F
interventions targeting those in the peri-retirement age group, 'barrier identifica
social support/social change' may be particularly useful in increasing the effecti

Keywords: Behaviour change techniques, Fruit and vegetables, Retirement, Agi
Systematic review, Meta-analysis

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Full list of author information is available at the end of the article

BioMed Central

Lara et al. BMC Medicine 2014, 12:60
http://www.biomedcentral.com/1741-7015/12/60

BMC Medicine

RESEARCH ARTICLE Open Ac

Effectiveness of dietary interventions among adults of retirement age: a systematic review a
meta-analysis of randomized controlled trials

Jose Lara[1,2*], Nicola Hobbs[3], Paula J Moynihan[1,2,5], Thomas D Meyer[4], Ashley J Adamson[1,3,6], Linda Errington
Lynn Rochester[2], Falko F Sniehotta[3,6], Martin White[1,3,6] and John C Mathers[1,2,8]

Abstract

Background: Retirement from work involves significant lifestyle changes and may represent an opportunity to
promote healthier eating patterns in later life. However, the effectiveness of dietary interventions during this pe
has not been evaluated.

Methods: We undertook a systematic review of dietary interventions among adults of retirement transition age
(54 to 70 years). Twelve electronic databases were searched for randomized controlled trials evaluating the
promotion of a healthy dietary pattern, or its constituent food groups, with three or more months of follow-up
reporting intake of specific food groups. Random-effects models were used to determine the pooled effect size
Subgroup analysis and meta-regression were used to assess sources of heterogeneity.

Results: Out of 9,048 publications identified, 68 publications reporting 24 studies fulfilled inclusion criteria. Twenty
studies, characterized by predominantly overweight and obese participants, were included in the meta-analys
Overall, interventions increased fruit and vegetable (F&V) intake by 87.5 g/day (P <0.00001), with similar results
the short-to-medium (that is, 4 to 12 months; 85.6 g/day) and long-term (that is, 13 to 58 months; 87.0 g/day)
for body mass index (BMI) stratification. Interventions produced slightly higher intakes of fruit (mean 54.0 g/da
than of vegetables (mean 44.6 g/day), and significant increases in fish (7 g/day, P = 0.03) and decreases in mea
intake (9 g/day, P <0.00001).

Conclusions: Increases in F&V intakes were positively associated with the number of participant intervention
contacts. Dietary interventions delivered during the retirement transition are therefore effective, sustainable in
longer term and likely to be of public health significance.

Keywords: Mediterranean diet, Fruit and vegetables, Retirement, Aging, Randomized controlled trial, Systema
review, Meta-analysis

Background

Increased life expectancy has resulted in the rapid growth in the proportion of the oldest old (>85 years), particularly in developed nations [1]. These trends are accompanied by a greater burden of disability, frailty and chronic disease, and greater health care costs [2].

Adopting healthy dietary patterns can reduce morbidity and mortality risk. For example, the so-called 'Mediterranean' diet (MD), characterized by higher of vegetables, fruit, legumes, cereals and fish, lower of meats and dairy products and moderate intake wine, is a dietary pattern that is associated with risks of all-cause mortality, death from cardiov disease (CVD) and cancers, age-related diseases in Parkinson's and Alzheimer's diseases, obesity and gain [3-9]. Multi-center studies show that country and sex do not affect these findings [3,4,10], sup the hypothesis that the MD benefits may be genera The MD components that are effective in drivin health benefits include moderate consumption of a

* Correspondence: jose.lara@ncl.a.uk
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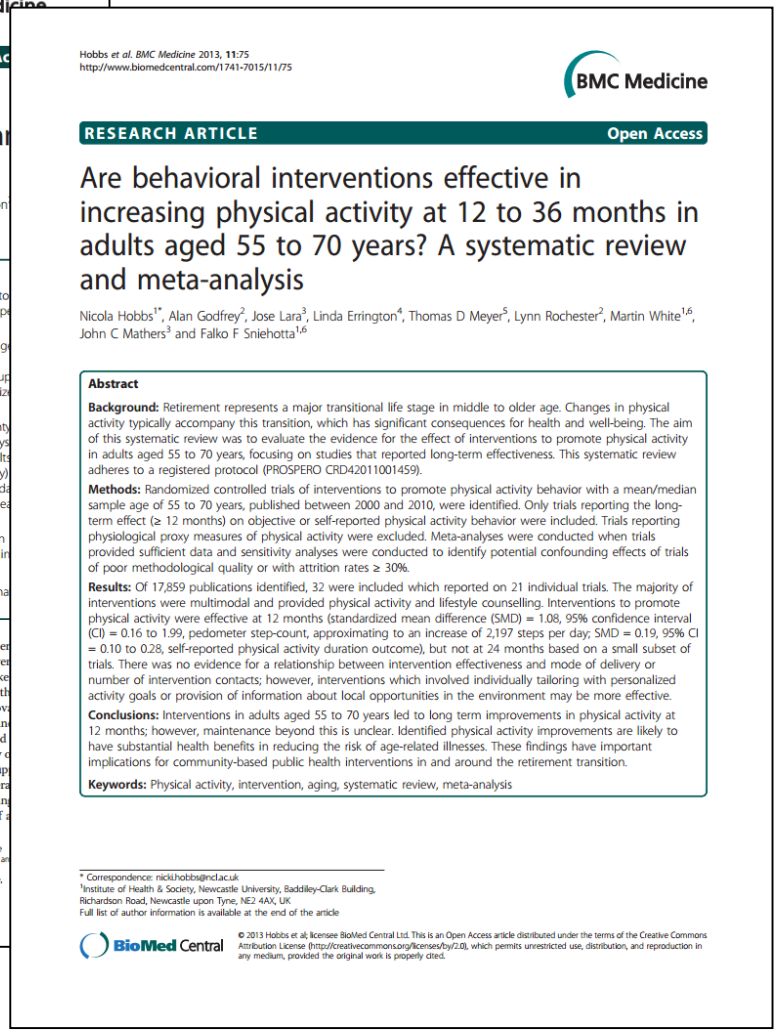

Hobbs et al. BMC Medicine 2013, 11:75
http://www.biomedcentral.com/1741-7015/11/75

BMC Medicine

RESEARCH ARTICLE Open Access

Are behavioral interventions effective in increasing physical activity at 12 to 36 months in adults aged 55 to 70 years? A systematic review and meta-analysis

Nicola Hobbs[1*], Alan Godfrey[2], Jose Lara[3], Linda Errington[4], Thomas D Meyer[5], Lynn Rochester[2], Martin White[1,6], John C Mathers[3] and Falko F Sniehotta[1,6]

Abstract

Background: Retirement represents a major transitional life stage in middle to older age. Changes in physical activity typically accompany this transition, which has significant consequences for health and well-being. The aim of this systematic review was to evaluate the evidence for the effect of interventions to promote physical activity in adults aged 55 to 70 years, focusing on studies that reported long-term effectiveness. This systematic review adheres to a registered protocol (PROSPERO CRD42011001459).

Methods: Randomized controlled trials of interventions to promote physical activity behavior with a mean/median sample age of 55 to 70 years, published between 2000 and 2010, were identified. Only trials reporting the long-term effect (≥ 12 months) on objective or self-reported physical activity behavior were included. Trials reporting physiological proxy measures of physical activity were excluded. Meta-analyses were conducted when trials provided sufficient data and sensitivity analyses were conducted to identify potential confounding effects of trials of poor methodological quality or with attrition rates ≥ 30%.

Results: Of 17,859 publications identified, 32 were included which reported on 21 individual trials. The majority of interventions were multimodal and provided physical activity and lifestyle counselling. Interventions to promote physical activity were effective at 12 months (standardized mean difference (SMD) = 1.08, 95% confidence interval (CI) = 0.16 to 1.99, pedometer step-count, approximating to an increase of 2,197 steps per day; SMD = 0.19, 95% CI = 0.10 to 0.28, self-reported physical activity duration outcome), but not at 24 months based on a small subset of trials. There was no evidence for a relationship between intervention effectiveness and mode of delivery or number of intervention contacts; however, interventions which involved individually tailoring with personalized activity goals or provision of information about local opportunities in the environment may be more effective.

Conclusions: Interventions in adults aged 55 to 70 years led to long term improvements in physical activity at 12 months; however, maintenance beyond this is unclear. Identified physical activity improvements are likely to have substantial health benefits in reducing the risk of age-related illnesses. These findings have important implications for community-based public health interventions in and around the retirement transition.

Keywords: Physical activity, intervention, aging, systematic review, meta-analysis

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BioMed Central

Working together to develop the intervention: co-design workshop

LiveWell

O'Brien N *et al*. (2016) *J Med Internet Res*. 18(8):e210.

Interventions that make a real difference are likely to be...

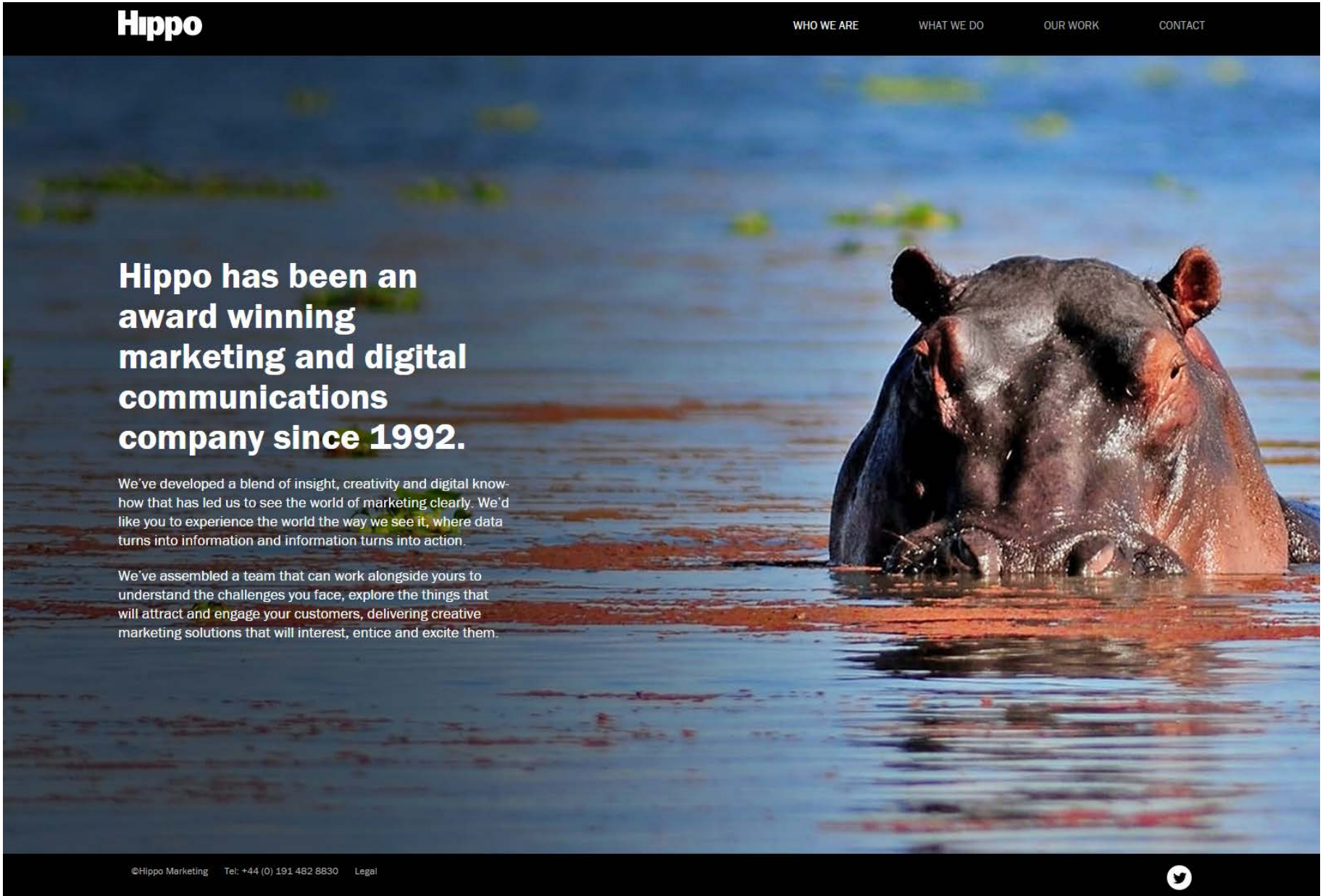
Stratified

Scalable

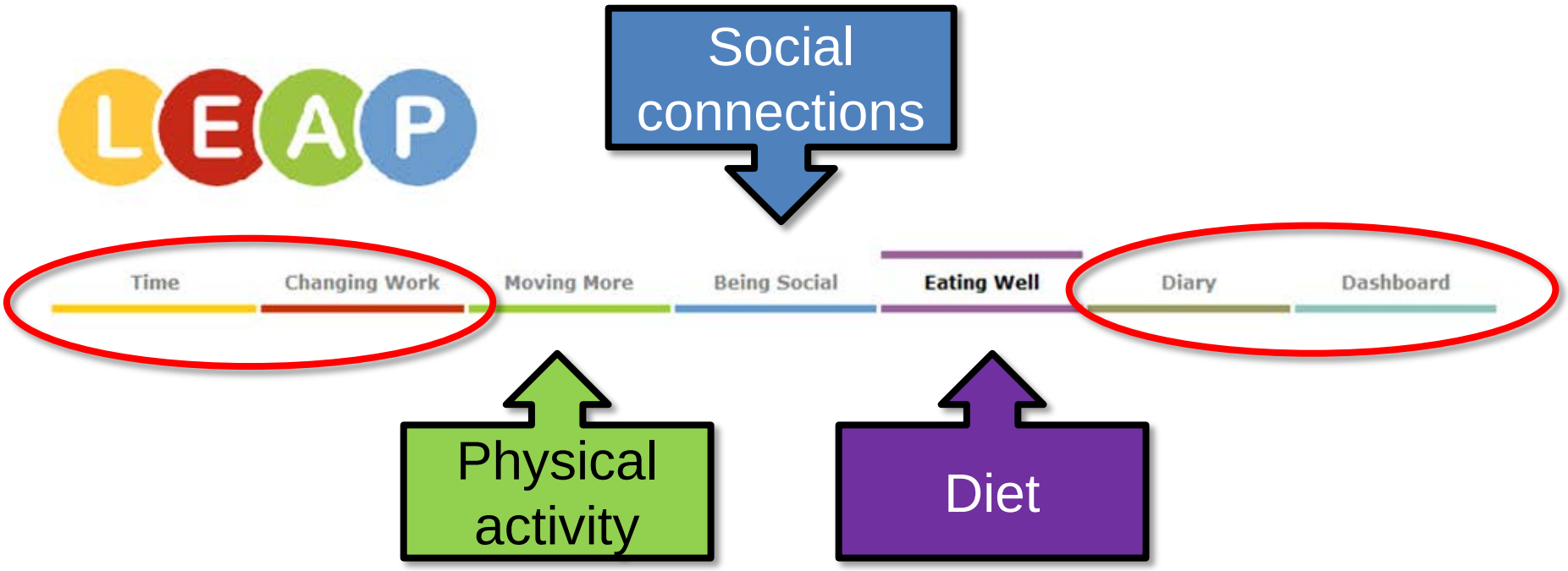
Sustainable

LiveWell

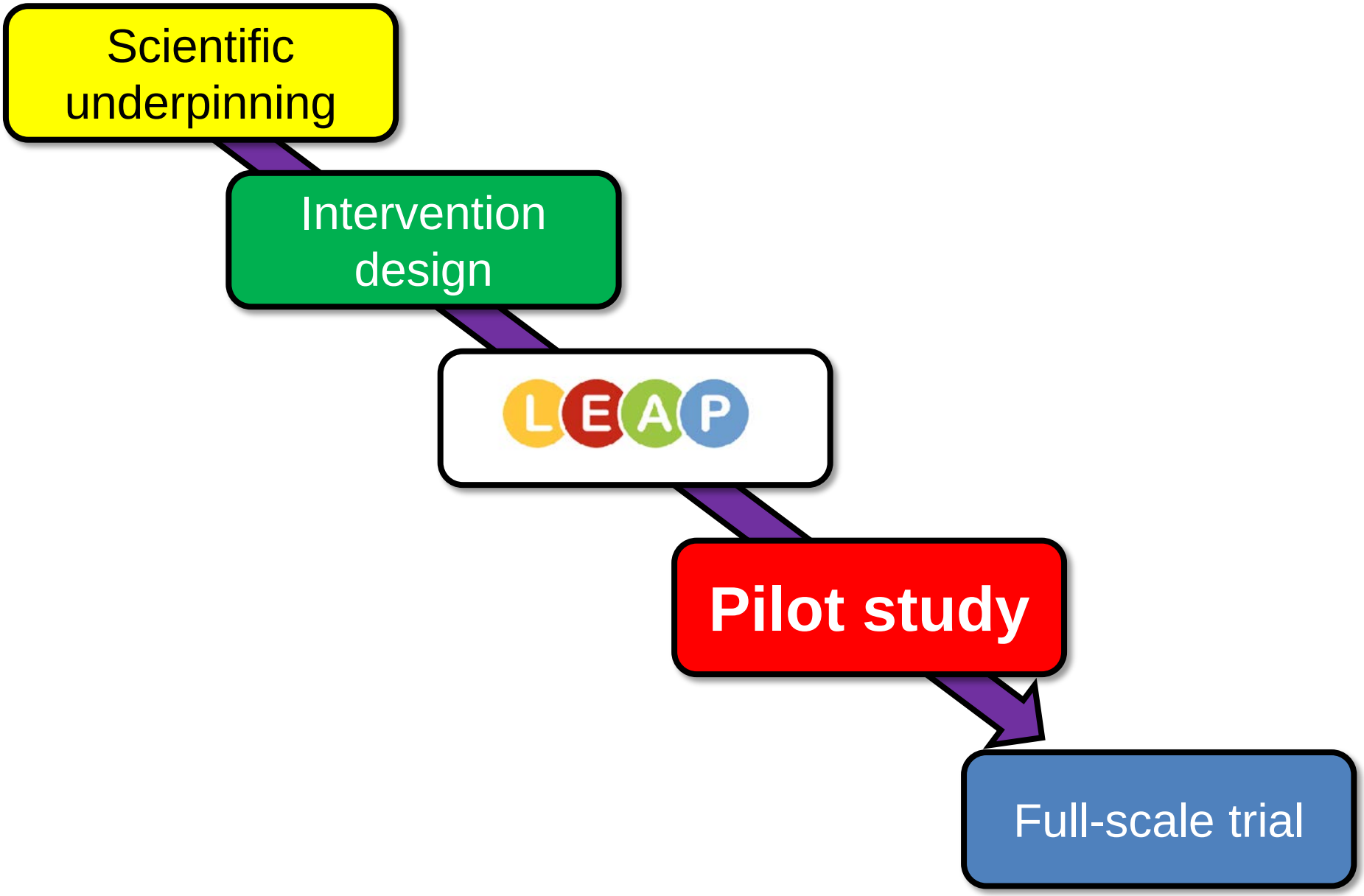
Development of intervention platform



Our digital intervention platform



From theory to practice



Aims of LiveWell pilot study

1. To evaluate the **feasibility** and **acceptability**

of the LEAP intervention

2. To pilot trial procedures

LiveWell

Lara J *et al.* (2016) *PLoS One*. 11(7):e0159703.

Where we worked

Participant recruitment via employers

CONNECT+
INSPIRE

TESCO
Every little helps

REDCAR & CLEVELAND
BOROUGH COUNCIL

HARTLEPOOL
BOROUGH COUNCIL

HM Revenue
& Customs

NEXUS

METRO

Newcastle
University

Taking part in the pilot study – the intervention

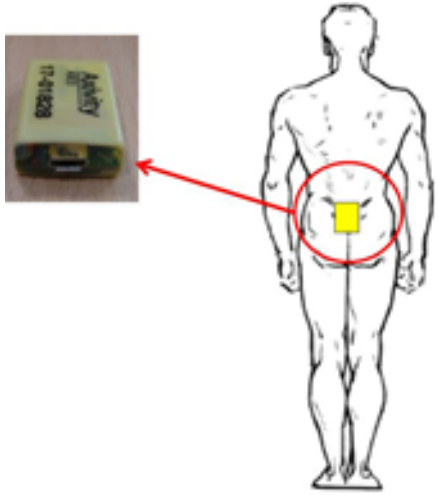
LEAP

or

NHS choices

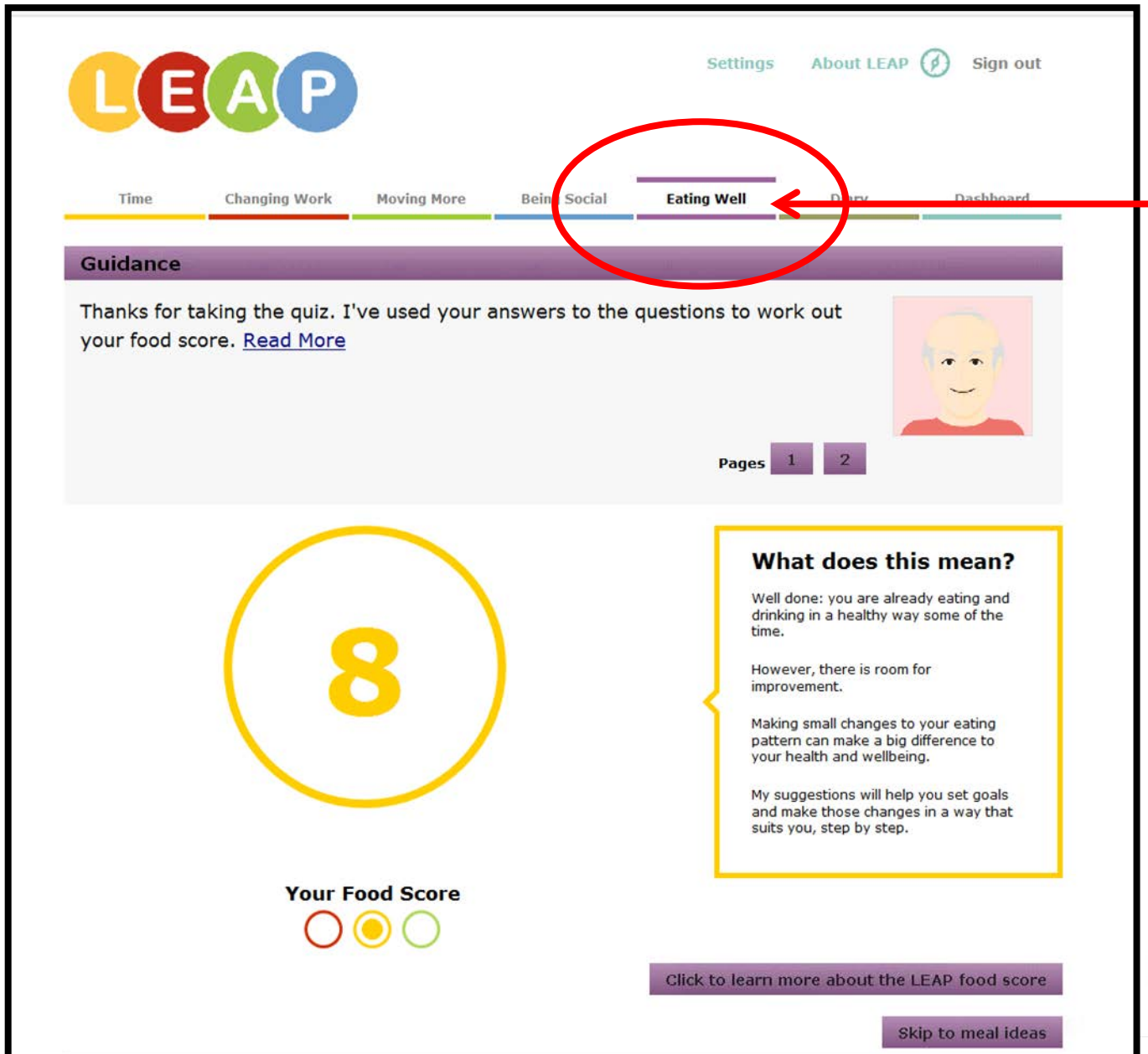
Final measurements

2 months



Interview with Ben Heaven

Intervention group - LEAP



Mediterranean diet

LiveWell

What did we measure?

1. **Recruitment and retention in study**

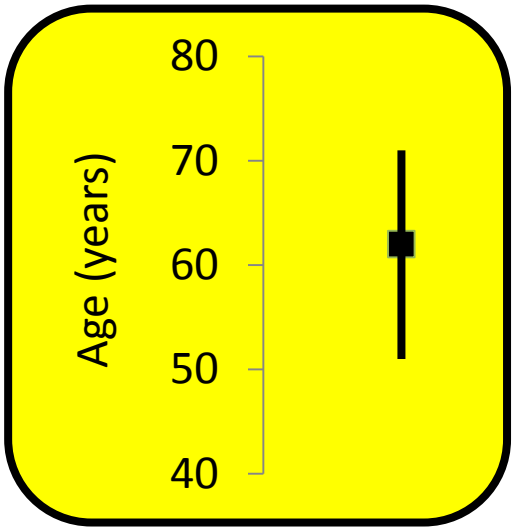
2. Experiences of participants

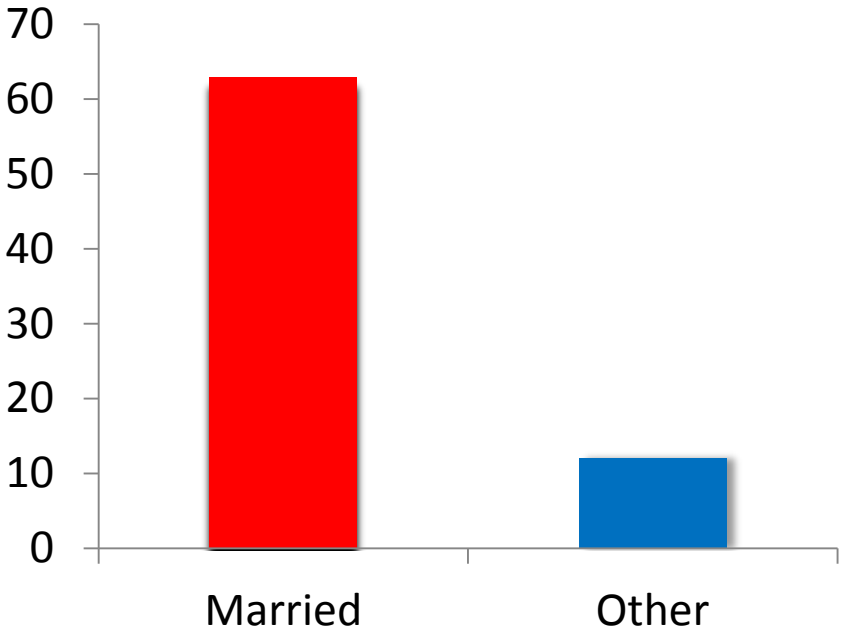
3. Use of LEAP website

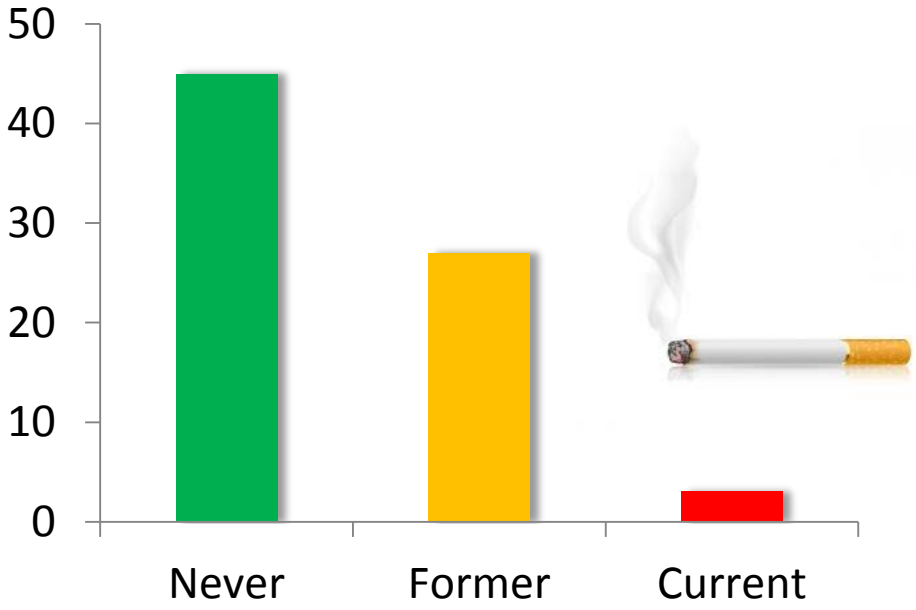
4. Behaviours: diet and physical activity

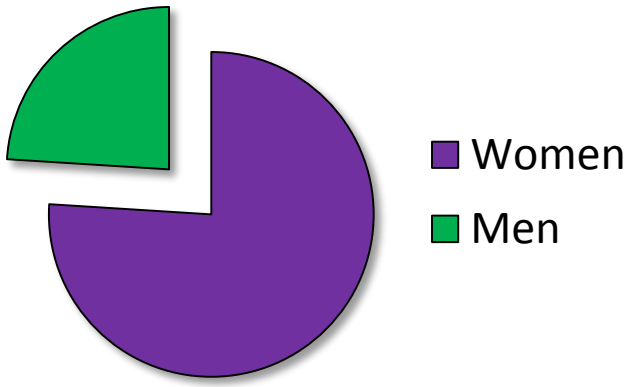
5. Markers of Healthy Ageing

Who joined the pilot study?









93% of participants completed the study!!

Lara J *et al.* (2016) *PLoS One*. 11(7):e0159703.

Summary

- ❑ Nutrition is a major modulator of ageing process
- ❑ Changing eating patterns is challenging
- ❑ Personalised nutrition may improve motivation and induce bigger, more sustainable, changes
- ❑ Internet (digital) approaches are effective in engaging participants and delivering personalised nutrition
- ❑ Retirement transition may be window of opportunity for nutritional interventions

Lifelong Health & Wellbeing
Research for Healthy Ageing

Newcastle University
Human Nutrition Research Centre