Health promotion and disease prevention within complex systems: diet, physical activity, and obesity
BMI distribution: Reception children
National Child Measurement Programme 2007/08 to 2009/10 (pooled)
BMI distribution: Year 6 children
National Child Measurement Programme 2007/08 to 2009/10 (pooled)

- England
- 1990 Baseline
Adult (aged 18+) BMI distribution
Health Survey for England 1991-94 and 2007-09

Underweight: <18.5kg/m²
Healthy weight: 18.5 to <25kg/m²
Overweight: 25 to <30 kg/m²
Obese: 30 to <40 kg/m²
Morbidly obese: ≥40kg/m²


Underweight
<18.5kg/m²
Healthy weight
18.5 to <25kg/m²
Overweight
25 to <30 kg/m²
Obese
30 to <40kg/m²
Morbidly obese
≥40kg/m²
Why is this happening?
EIGHT GUIDELINES FOR A HEALTHY DIET

Enjoy your food

Eat a variety of different foods

Eat the right amount to be a healthy weight. Try to keep a healthy weight for your height. Stopping at the right time.

Eat plenty of fruits and vegetables

Eat plenty of starchy foods, bread, rice, pasta and potatoes. Choose wholegrain varieties more often.

Eat plenty of dairy foods

Eat plenty of fish. Try to eat at least five portions a week. Include plenty of oily fish.

Eat plenty of fruit and vegetables

Eat plenty of fruit. Include at least five different kinds a week.

Don't eat too many foods that contain a lot of fat

Reducing fat, particularly saturates, decreases your risk of heart disease. Cutting down fat also helps prevent weight gain.

Don't have sugary foods and drinks too often

To help prevent tooth decay, keep your teeth clean and freshen your breath.

If you drink alcohol, drink sensibly

Drinking too much, particularly if you're a woman, increases your risk of breast cancer.
The bigger picture
United Nations high-level meeting on noncommunicable disease prevention and control

NCD summit to shape the international agenda

Date: 19-20 September 2011
Place: New York, USA

Noncommunicable diseases - or NCDs - like heart attacks and strokes, cancers, diabetes and chronic respiratory disease account for over 63% of deaths in the world today. Every year, NCDs kill 9 million people under 60. The socio-economic impact is staggering. Global leaders will meet at the United Nations in New York from 19-20 September 2011 to set a new international agenda on NCDs.

This is only the second time in the history of the UN that the General Assembly meets on a health issue (the last issue was AIDS). The aim is for countries to adopt a concise, action-oriented outcome document that will shape the global agendas for generations to come.

Meeting outcomes

Political declaration adopted at the UN General Assembly - 18 September 2011

Statements, speeches

Opening remarks by the President of the General Assembly
pdf, 36kb

Closing remarks by the President of the General Assembly
pdf, 41kb
How do we respond?
<table>
<thead>
<tr>
<th>Breakfast Sandwiches</th>
<th>Calories</th>
<th>meal**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacon &amp; Egg</td>
<td>300</td>
<td>450</td>
</tr>
<tr>
<td>Cheese &amp; Egg</td>
<td>450</td>
<td>600</td>
</tr>
<tr>
<td>Cheese &amp; Egg</td>
<td>430</td>
<td>580</td>
</tr>
<tr>
<td>Cheese &amp; Egg</td>
<td>510</td>
<td>660</td>
</tr>
<tr>
<td>Cheese &amp; Egg</td>
<td>460</td>
<td>560</td>
</tr>
<tr>
<td>Cheese &amp; Egg</td>
<td>420</td>
<td>570</td>
</tr>
<tr>
<td>Hot Cakes</td>
<td>450</td>
<td>600</td>
</tr>
<tr>
<td>Hot Cakes</td>
<td>580</td>
<td>660</td>
</tr>
<tr>
<td>Big Breakfast</td>
<td>510</td>
<td>660</td>
</tr>
<tr>
<td>Deluxe Breakfast</td>
<td>460</td>
<td>560</td>
</tr>
<tr>
<td>Cinnamon Roll</td>
<td>420</td>
<td>570</td>
</tr>
</tbody>
</table>

Grilled Chicken Salad

Available with Grilled or Crispy Chicken and your choice of Caesar or Balsamic dressing.

What’s your favourite McDonald’s salad?

- Chicken  Vote
- Chicken & Bacon  Vote

About the Grilled Chicken Salad

The only meat we use across our entire chicken range is succulent chicken breast meat.

See all ingredients
How **should** we respond?
LURPAK
DANSK SMØR
SALTET
250g
How do we know what to do?
Evidence trajectories

- Hunch-based
- Evidence-based

Level of activity vs. Time
Standard Evaluation Framework
for weight management interventions
Learn from success
Celebrate failure
Complicated v Complex Systems
\[ \frac{dm}{m} = \frac{dm_c}{\sqrt{1 - \frac{v^2}{c^2}} \left( \sqrt{1 - \frac{v^2}{c^2}} \right) m_c} = \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv, \text{ substituting from earlier above relations} \]

\[ \Rightarrow \frac{d}{\left( \frac{m_c}{\sqrt{1 - \frac{v^2}{c^2}}} \right) \left( \sqrt{1 - \frac{v^2}{c^2}} \right) m_e} = \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv \]

\[ \Rightarrow d \left( m_c \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{1}{2}} \right) \left( \sqrt{1 - \frac{v^2}{c^2}} \right) m_e \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{1}{2}} \right) = \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv \]

\[ \Rightarrow \left( dm_c \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{1}{2}} \right) - \frac{1}{2} m_e \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{3}{2}} \cdot d \left[ 1 - \frac{v^2}{c^2} \right] = \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv \]

\[ \Rightarrow \left( dm_c \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{1}{2}} \right) - \frac{1}{2} m_e \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{3}{2}} \cdot 0 - \frac{2 v}{c^2} \, dv \right) = \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv \]

\[ \Rightarrow \left( dm_c \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{1}{2}} \right) + m_e \frac{v}{c^2} \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{3}{2}} \, dv \right) = \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv \]

\[ \Rightarrow \frac{dm}{m} = \left( \frac{dm_c}{\sqrt{1 - \frac{v^2}{c^2}} \left( \sqrt{1 - \frac{v^2}{c^2}} \right) m_c} + m_v/c^2 \right) \left( \sqrt{1 - \frac{v^2}{c^2}} \right) m_e \left[ 1 - \frac{v^2}{c^2} \right]^{-\frac{3}{2}} \, dv \]

\[ = \left( \frac{dm_c}{m_e} + \frac{v/c^2}{\left( 1 - \frac{v^2}{c^2} \right) m_e} \right) \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv \]

\[ - \left( \frac{dm_e}{m_e} + \frac{v/c^2}{\left( 1 - \frac{v^2}{c^2} \right) m_e} \right) \frac{1 - \frac{v u_e}{c^2}}{-u_e(1 - \frac{v^2}{c^2})} \, dv \text{ multiplying by unity } u_e \]

\[ \text{terms multiplying by unity } u_e \]
How do we know what works?
Riding my bike
Riding my bike

Doughnuts off the menu
Riding my bike

Doughnuts off the menu

Eating biscuits

Riding my bike
Riding my bike

Doughnuts off the menu

Eating biscuits

Woops!
Riding my bike
doughnuts off the menu

So did the cycling infrastructure intervention work?

So did the social marketing intervention work?

So did the front of pack labelling intervention work?

Eating biscuits

Woops!
Riding my bike

Doughnuts off the menu

Eating biscuits

So did the social marketing intervention work?

So did the front of pack labelling intervention work?

How do we measure the interactions between them?

Riding my bike

So did the cycling infrastructure intervention work?
So did the cycling infrastructure intervention work?

So did the social marketing intervention work?

So did the front of pack labelling intervention work?

- Individuals/populations/environments
- Small effect sizes
- Important interactions
- Compensatory behaviours
- Emergence
- Flows, feedbacks...
- Etc etc

- Analytical / modelling techniques
- Novel research approaches
- Steal ideas from other sectors

- What is (are) the most appropriate research paradigm(s)?
What do we do about this?
Do seatbelts promote obesity?

座belt usage → vehicle speeds

risk compensation (Peltzman, Adams)

seatbelt usage ↓

perceived danger

constant travel time budget (Marchetti, Zahavi)

vehicle speeds → danger

walking & cycling

physical activity → Obesity + NCDs

sprawl

trip length → sprawl

Obesity + NCDs

constant travel time budget (Marchetti, Zahavi)
Do seatbelts promote obesity?

Is \( x > y + z \)?

**Diagram:**
- **Seatbelt usage** increases**vehicle speeds**.
  - Risk compensation (Peltzman, Adams)
- **Danger** increases**perceived danger**.
- **Walking & cycling** decreases**physical activity**.
  - Sprawl increases
  - Trip length is constant travel time budget (Marchetti, Zahavi)
- **y: life years lost**
- **z: life years lost**
- **Obesity + NCDs**
- **x: life years gained**

**Equation:**
\[
x > y + z
\]
Do seatbelts promote obesity?

Is \( x > y + z \)?

What about quality of life effects such as:
- Happy petrolheads
- Frustrated cyclists
- Scared pedestrians
Places to Intervene in Complex Systems

1. Power to transcend paradigms
2. Paradigm that the system arises out of
3. Goals of the system
4. Power to add, change, evolve or self-organize system structure
5. Rules of the system
6. Structure of information flow
7. Gain around driving positive feedback loops
8. Strength of negative feedback loops
9. Length of delays
10. Structure of material stocks and flows
11. Size of buffers and other stabilizing stocks
12. Constants, parameters, numbers

Source: Leverage Points: place to intervene in a system. Donella Meadows, The Sustainability Institute 1999
# The Intervention Level Framework

<table>
<thead>
<tr>
<th>Intervention Level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradigm</td>
<td>System’s deepest held beliefs. System goals, rules and structure arise out of the paradigm.</td>
</tr>
<tr>
<td>Goals</td>
<td>The aim/priorities of the system.</td>
</tr>
<tr>
<td>System structure</td>
<td>All of the elements that make up the system as a whole including the subsystems, actors and interconnections between these elements.</td>
</tr>
<tr>
<td>Feedback &amp; Delays</td>
<td>Loops that cause an action by one element of the system to in turn affect the flows into or out of that same element.</td>
</tr>
<tr>
<td>Structural elements</td>
<td>Subsystems, actors and the physical elements of the system.</td>
</tr>
</tbody>
</table>

Source: Johnston, Matteson, Finegood, Simon Fraser University: personal communication
Obesity strategy analysis

Source: Johnston, Matteson, Finegood, Simon Fraser University: personal communication
Cost-effectiveness
Cost effectiveness grid

1. Ineffective and costly: Don’t do, and stop if doing already

2. Effective but costly: Probably avoid, but consider options

3. Effective but cost saving: Avoid, but consider potential to tweak

4. Effective and cost saving: Continue, and start if not doing already

Cost-effectiveness threshold
Hedgehogs and foxes
Social silences

"... one of the things I learned as an anthropologist is that to understand how a society works you need not just to look at the areas of what we call 'social noise' - ie what everyone likes to talk about...you need to look at the social silences as well."

Gillian Tett: http://www.guardian.co.uk/business/2008/oct/31/creditcrunch-gillian-tett-financial-times
The real world
Welcome to the WHO/Europe Health Economic Assessment Tool (HEAT).

This tool is designed to help you conduct an economic assessment of the health benefits of walking or cycling by estimating the value of reduced mortality that results from specified amounts of walking or cycling.

The tool can be used in a number of different situations, for example:

1. When planning a new piece of cycling or walking infrastructure.

HEAT attaches a value to the estimated level of cycling or walking when the new infrastructure is in place. This can be compared to the costs of implementing different interventions to produce a benefit-cost ratio (and help to make the case for investment), or as an input into a more comprehensive economic appraisal exercise.

2. To value the reduced mortality from current levels of cycling or walking, such as to a specific workplace, across a city or in a country. It can also be used to illustrate economic consequences from a potential future change in levels of cycling or walking.
Acknowledgements

Health Economic Assessment Tool for walking

This tool has been developed from an original idea of Harry Rutter, National Obesity Observatory England, United Kingdom and it is based on the principles of the Health Economic Assessment Tool for Cycling first published in 2007.

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HEAT for walking

Q1: Your data: amount of walking from a single point in time, or before and after an intervention

- Single
- Before and after

Next step
- Next question
- Back

Hints & Tips
If you select 'Single', you will be asked to enter data on levels of walking only once.

If you select 'Before and after', the tool will prompt you to enter two sets of walking data. The difference in levels of walking between the pre- and post- measures will be used to calculate the health benefits and associated financial savings.
HEAT for walking

Q2: Enter your walking data

The HEAT model requires an estimate of the average duration spent walking in the study population in order to calculate the corresponding health benefit (based on a relative risk from a review of the epidemiological literature on the health benefits of walking). This duration can be entered directly, if available (and this is the most direct data entry route), or calculated based on the distance, number of steps, or number of trips.

- Duration (average time walked per person)
- Distance (average distance walked per person)
- Steps (average number of steps taken per person)
- Trips (average per person or total observed across a population)

Next step
- Next question
- Back
HEAT for walking

Q12: Value of life

What is the value of a statistical life?

The value of a statistical life is derived with a methodology called "willingness to pay" to avoid death in relation to the years this person can expect to live according to the statistical life expectancy. The willingness to pay represents how much a representative sample of the population (who in this instance are potential victims) would be willing to pay (in monetary terms) to avoid a specific risk such as the risk of a road crash.

Enter the standard value of a statistical life used in the country of study (and select your currency). This will form the basis of the financial savings shown in the model. If not known, use the default value of €1.5 million, which is the standard value used across Europe.

Please enter the local value of statistical life:

1500000 European euro (EUR)

Next step
- Next question
- Back

Hints & Tips

According to economic theory, the willingness to pay comprises lost consumption, immaterial costs (e.g. suffering) and the share of health costs paid directly by the victims.
HEAT estimate

Reduced mortality as a result of changes in cycling behaviour

The walking data you have entered corresponds to an average of 30 minutes per person per day.
This level of walking provides an estimated protective benefit of: 22.67% (compared to persons not walking regularly)
From the data you have entered, the number of individuals who benefit from this level of walking is: 10,000
Out of this many individuals, the number who would be expected to die if they were not walking regularly would be: 72.71
The number of deaths per year that are prevented by this level of walking is: 16.48

Financial savings as a result of walking

Currency: EUR

The value of statistical life in your population is: 1,500,000 EUR
The annual benefit of this level of walking, per year, is: 24,721,000 EUR
The total benefits accumulated over 10 years are: 247,208,000 EUR
When future benefits are discounted by 5% per year,
The current value of the average annual benefit, averaged across 10 years is: 19,089,000 EUR
The current value of the total benefits accumulated over 10 years is: 190,888,000 EUR