Plant-based diets: any key benefits?

Dr Marco Springmann
James Martin Fellow
University of Oxford
Plant-based diets in the news

What would happen if the world suddenly went vegetarian?
20 Celebs Who Traded in Cheese For a Vegan Diet

1 November 2016 by MICHELE POLEY

Photo 1 of 18

Image Source: Getty / Gregg DeGuire
Hillary: Bill’s not a ‘smug vegan’

BY MARK HENSCH - 04/19/16 09:49 AM EDT

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Stephen Interviews Hillary Clinton At Carnegie Deli
Plant-based diets in the news

So what’s the matter with all those plant-eaters?

- Health implications
- Environmental implications
- Future food systems
Health implications

Imbalanced diets are responsible for the greatest health burden globally and in most regions (Lim et al, 2013).

Leading risk factors for death in 2010 (GBD, 2013)
## Associations of risk factors and disease mortality:

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Statistics</th>
<th>CHD</th>
<th>Stroke</th>
<th>Cancer</th>
<th>T2DM</th>
<th>Other</th>
<th>Colon and rectum cancers</th>
<th>Mouth and oropharynx cancers</th>
<th>Oesophagus cancer</th>
<th>Stomach cancer</th>
<th>Trachea, bronchus, lung cancers</th>
</tr>
</thead>
<tbody>
<tr>
<td>red meat</td>
<td>mean</td>
<td>1.00</td>
<td>1.13</td>
<td>1.00</td>
<td>1.13</td>
<td>1.00</td>
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<tr>
<td>red meat</td>
<td>high</td>
<td>1.00</td>
<td>1.23</td>
<td>1.00</td>
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<td>red meat</td>
<td>low</td>
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<td>1.03</td>
<td>1.00</td>
<td>1.03</td>
<td>1.00</td>
<td>1.04</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td>processed meat</td>
<td>mean</td>
<td>2.02</td>
<td>1.23</td>
<td>1.00</td>
<td>1.74</td>
<td>1.00</td>
<td>1.46</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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<td>processed meat</td>
<td>high</td>
<td>3.57</td>
<td>1.44</td>
<td>1.00</td>
<td>2.19</td>
<td>1.00</td>
<td>2.02</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td>processed meat</td>
<td>low</td>
<td>1.15</td>
<td>1.04</td>
<td>1.00</td>
<td>1.42</td>
<td>1.00</td>
<td>1.08</td>
<td>1.00</td>
<td>1.00</td>
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<td>1.00</td>
</tr>
<tr>
<td>fruit</td>
<td>mean</td>
<td>0.93</td>
<td>0.90</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.72</td>
<td>0.56</td>
<td>0.67</td>
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<td>0.93</td>
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<td>fruit</td>
<td>high</td>
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<td>0.93</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.87</td>
<td>0.74</td>
<td>0.76</td>
<td>0.76</td>
<td>0.96</td>
</tr>
<tr>
<td>fruit</td>
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<td>1.00</td>
<td>0.59</td>
<td>0.42</td>
<td>0.59</td>
<td>0.59</td>
<td>0.88</td>
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<tr>
<td>vegetable</td>
<td>mean</td>
<td>0.90</td>
<td>1.00</td>
<td>1.00</td>
<td>0.88</td>
<td>1.00</td>
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<td>0.48</td>
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<tr>
<td>vegetable</td>
<td>high</td>
<td>0.95</td>
<td>1.00</td>
<td>1.00</td>
<td>0.99</td>
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<td>0.67</td>
<td>0.69</td>
<td>0.62</td>
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<tr>
<td>vegetable</td>
<td>low</td>
<td>0.84</td>
<td>1.00</td>
<td>1.00</td>
<td>0.77</td>
<td>1.00</td>
<td>0.40</td>
<td>0.34</td>
<td>0.38</td>
<td>0.38</td>
<td>1.00</td>
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</table>
### Table 2. Health effects of sustainable dietary patterns.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Sustainable diet type</th>
<th>Health Indicator</th>
<th>Change in health indicator (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabate 2015</td>
<td>US/Canada</td>
<td>Vegan</td>
<td>All-cause mortality rate</td>
<td>19.2%</td>
</tr>
<tr>
<td>Soret 2014</td>
<td>US/Canada</td>
<td>Vegetarian</td>
<td>All-cause mortality risk</td>
<td>9% (0-17)</td>
</tr>
<tr>
<td>Tilman 2014</td>
<td>Globally</td>
<td>Vegetarian</td>
<td>All-cause mortality risk</td>
<td>&lt;1% (0-2)**</td>
</tr>
<tr>
<td>Sabate 2015</td>
<td>US</td>
<td>Vegetarian</td>
<td>All-cause mortality rate</td>
<td>15.9%</td>
</tr>
<tr>
<td>Aston 2012</td>
<td>UK</td>
<td>Meat partially replaced by mixed food</td>
<td>CHD risk (men)</td>
<td>9.7% (-3.5-22)</td>
</tr>
<tr>
<td>Aston 2012</td>
<td>UK</td>
<td>Meat partially replaced by mixed food</td>
<td>CHD risk (women)</td>
<td>6.4% (-1.8-14.3)</td>
</tr>
<tr>
<td>Aston 2012</td>
<td>UK</td>
<td>Meat partially replaced by mixed food</td>
<td>Diabetes mellitus risk (men)</td>
<td>12% (-4.5-22.7)</td>
</tr>
<tr>
<td>Aston 2012</td>
<td>UK</td>
<td>Meat partially replaced by mixed food</td>
<td>Diabetes mellitus risk (women)</td>
<td>7.5% (0.5-14.5)</td>
</tr>
<tr>
<td>Aston 2012</td>
<td>UK</td>
<td>Meat partially replaced by mixed food</td>
<td>Colorectal cancer risk (men)</td>
<td>12.2% (6.4-13.9)</td>
</tr>
<tr>
<td>Aston 2012</td>
<td>UK</td>
<td>Meat partially replaced by mixed food</td>
<td>Colorectal cancer risk (women)</td>
<td>7.7% (4.0-11.3)</td>
</tr>
<tr>
<td>Soret 2014</td>
<td>US/Canada</td>
<td>Meat partially replaced by mixed food</td>
<td>All-cause mortality risk</td>
<td>14% (4-23)</td>
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<tr>
<td>Sabate 2015</td>
<td>US/Canada</td>
<td>Meat partially replaced by mixed food</td>
<td>All-cause mortality rate</td>
<td>7.2%</td>
</tr>
<tr>
<td>Blesbroek 2014</td>
<td>Netherlands</td>
<td>Meat partially replaced by plant-based food</td>
<td>All-cause mortality risk</td>
<td>10% (3-16)</td>
</tr>
<tr>
<td>Blesbroek 2014</td>
<td>Netherlands</td>
<td>Meat partially replaced by dairy</td>
<td>All-cause mortality risk</td>
<td>6% (-4-14)</td>
</tr>
<tr>
<td>Tilman 2014</td>
<td>Globally</td>
<td>Mediterranean</td>
<td>All-cause mortality risk</td>
<td>19% (17-19)</td>
</tr>
<tr>
<td>Sabate 2015</td>
<td>US/Canada</td>
<td>Pescatarian</td>
<td>All-cause mortality rate</td>
<td>17.6%</td>
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<tr>
<td>Milner 2015</td>
<td>UK</td>
<td>Healthy guidelines</td>
<td>Years of life lost*</td>
<td>6%</td>
</tr>
<tr>
<td>Milner 2015</td>
<td>UK</td>
<td>Healthy guidelines + further optimisation</td>
<td>Years of life lost*</td>
<td>7%</td>
</tr>
<tr>
<td>Scarbrough 2012</td>
<td>UK</td>
<td>Meat, dairy partially replaced by plant-based food</td>
<td>Deaths averted</td>
<td>6%</td>
</tr>
<tr>
<td>Scarbrough 2012</td>
<td>UK</td>
<td>Ruminants replaced by monogastric</td>
<td>Deaths averted</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

* Percentages refer to reductions in health indicators, except for deaths averted

** Mortality risk reduction by cause: cancer 10%, coronary heart disease 20%, type 2 diabetes 42%

* Years of life lost, at year 30 (after adoption of the sustainable diet scenario)
Statement of the American Dietetic Association (2009):

ABSTRACT
It is the position of the American Dietetic Association that appropriately planned vegetarian diets, including total vegetarian or vegan diets, are healthful, nutritionally adequate, and may provide health benefits in the prevention and treatment of certain diseases. Well-planned vegetarian diets are appropriate for individuals during all stages of the life cycle, including pregnancy, lactation, infancy, childhood, and adolescence, and for athletes. A vegetarian diet is defined
Environmental implications

The food system is responsible for > 25% of all GHG emissions (Vermeulen et al, 2012).

Total GHG emissions (IPCC AR5, 2015), including agriculture, forestry and other land use (AFOLU)
Environmental implications

Most food-related emissions are associated with livestock production (Steinfeld et al, 2006; Tubiello et al, 2014).

Greenhouse gas emissions intensities (Tilman and Clark, 2014)
Environmental implications

Where do livestock emissions come from (Gerber et al, 2013)?
Environmental implications

GHG emissions reductions associated with dietary change (Aleskandrowicz et al, 2016)

Fig 2. Relative differences in GHG emissions (kg CO$_2$eq/capita/year) between current average diets and sustainable dietary patterns. Note: n = number of studies, mdn = median.

doi:10.1371/journal.pone.0165797.g002
Environmental implications

Land-use change associated with dietary change (Aleskandrowicz et al, 2016)

- Vegan (n=6, mdn=-55)
- Vegetarian (n=7, mdn=-51)
- Pescatarian (n=4, mdn=-39)
- Ruminants replaced by monogastric (n=3, mdn=-37)
- Healthy guidelines + further optimisation (n=5, mdn=-34)
- Mediterranean (n=5, mdn=-27)
- Healthy guidelines (n=10, mdn=-20)
- New Nordic Diet (n=1, mdn=-18)
- Meat + dairy partially replaced by plant-based food (n=3, mdn=-16)
- Meat partially replaced by plant-based food (n=4, mdn=-10)
- Meat partially replaced by dairy products (n=1, mdn=-4)
- Meat partially replaced by mixed food (n=1, mdn=-3)
- Balanced energy intake (n=2, mdn=-3)

Fig 3. Relative differences in land use (m²/capita/year) between current average diets and sustainable dietary patterns. Note: n = number of studies, mdn = median.

doi:10.1371/journal.pone.0165797.g003
Take-away message so far:

- (Well-planed) plant-based diets are more environmentally friendly and likely healthier than omnivorous diets.
- Future socio-economic developments could change plant-based diets from a luxury and personal choice to a necessity.
Analysis and valuation of the health and climate change cobenefits of dietary change

Marco Springmann\textsuperscript{a,b,1}, H. Charles J. Godfray\textsuperscript{a,c}, Mike Rayner\textsuperscript{a,b}, and Peter Scarborough\textsuperscript{a,b}

\textsuperscript{a}Oxford Martin Programme on the Future of Food, Department of Zoology, University of Oxford, Oxford OX1 3PS, United Kingdom; \textsuperscript{b}British Heart Foundation Centre on Population Approaches for Non-Communicable Disease Prevention, Nuffield Department of Population Health, University of Oxford, Headington, Oxford OX3 7LF, United Kingdom; and \textsuperscript{c}Department of Zoology, University of Oxford, Oxford OX1 3PS, United Kingdom
Observations and projections:

- Globalization and urbanization have led to Western dietary habits, and to greater availability of energy-dense foods and more sedentary lifestyles (Popkin, 2006).
- Population and income growth will require 60% more food to be produced in 2050, and result in continued dietary changes (FAO, 2012):
Future of Food: Health Implications

Less countries expected to meet basic dietary guidelines:
Future of Food: Environmental Implications

Harder to keep global warming to below 2 degrees C:
## Dietary scenarios for 2050

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Features</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference (REF)</td>
<td>Global energy intake per capita increases by 13% between 2005/07 and 2050; per-capita consumption (in grams) increases by 15% for fruits and vegetables, 15% for sugar, 35% for oils, 13% for red meat, 63% for poultry, 19-21% for eggs and dairy, 14% for roots and pulses, 20% for maize, and 32% for other grains, except wheat and rice whose consumption stays constant (wheat) or decreases by by 5% (rice).</td>
<td>Based on projections by the Food and Agriculture Organization of the United Nations (FAO) (26), adjusted for food waste and food conversion into edible parts (27).</td>
</tr>
<tr>
<td>Global dietary guidelines (HGD)</td>
<td>Min five portions per day of fruits&amp;veg, max 300 grams per week of red meat, less than 50 grams per day of sugar, total energy intake as recommended for moderately active population (2200-2300 kcal per day).</td>
<td>Based on global dietary recommendations by the World Cancer Research Fund (28) and WHO/FAO Expert Consultations on diet and nutrition (16) and human energy requirements (29).</td>
</tr>
<tr>
<td>Vegetarian (VGT)</td>
<td>Min six portions per day of fruits&amp;veg, one portion per day of legumes, no red meat or poultry (or fish), sugar and total energy intake as recommended in HGD scenario.</td>
<td>Based on observed dietary patterns (30-31).</td>
</tr>
<tr>
<td>Vegan (VGN)</td>
<td>Min seven portions per day of fruits&amp;veg, one portion per day of legumes, no red meat, poultry, dairy, or eggs (or fish), sugar and total energy intake as recommended in HGD scenario.</td>
<td>Based on observed dietary patterns (30-31).</td>
</tr>
</tbody>
</table>
This study:
- Link and compare the health and environmental consequences of changing diets on a region, risk factor, and commodity-specific level.

Methods:
1. Health analysis:
   - Global comparative risk assessment of changes in dietary and weight-related risk factors (fruit & veg, red meat, overweight, obesity) on NCD mortality (CHD, stroke, cancer, T2DM);

2. Environmental analysis:
   - Life-cycle analysis of food consumption based on a recent meta-analysis (Tilman and Clark, 2014);

3. Economic valuation:
   - Social cost of carbon (IAM comparison), value of statistical life (OECD review), cost-of-illness studies (EU-level)
Avoided deaths globally:
Results: Health Analysis

Avoided deaths by region:

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Results: Health Analysis

Avoided deaths by region per capita:
Results: Environmental Analysis

Food-related GHG emissions:

- Plant-based diets

[Bar chart showing food-related GHG emissions for different diets and categories]
Results: Environmental Analysis

Food-related GHG emissions per capita (HGD vs REF):

- Small GHG increases (≈ 2% of all changes) in developing countries due to increased energy intake in regions with undernourishment.

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Results: Environmental Analysis

Food-related GHG emissions per capita (VGT vs REF):

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Results: Environmental Analysis

Food-related GHG emissions per capita (VGN vs REF):

- Small GHG increases narrow in VGT and VGN scenarios.
Value of environmental and health benefits:
Take-away messages:

- Dietary change towards more plant-based diets could be beneficial for health and the environment, and necessary for avoiding dangerous levels of climate change.
- The size of the projected benefits should encourage individuals, industry, and policy makers to act decisively to make sure that what we eat preserves our environment and our health.
- Not a small task: to achieve minimum global dietary guidelines (HGD) would require 25% increase in global fruit & veg consumption, 56% reduction in red meat consumption, and 15% reduction in energy intake.
If you consider to adopt a plant-based diet, don’t be stupid...
Thank you for your attention.

Comments and suggestions:

- marco.springmann@dph.ox.ac.uk
Health analysis

Comparative risk assessment model:
- 4 risk factors (fruit&veg, red meat, overweight, obesity)
- 5 causes of death (CHD, stroke, cancer, T2DM, other)
- mortality and weight data from UNPD and WHO
- relative risks from meta-analyses of cohort studies

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Relative risk per cause of death</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHD</td>
</tr>
<tr>
<td>Fruit and vegetable consumption</td>
<td>0.96 (0.93-0.99)</td>
</tr>
<tr>
<td>Red meat consumption</td>
<td>1.25 (1.21-1.29)</td>
</tr>
<tr>
<td>Overweight</td>
<td>1.31 (1.24-1.39)</td>
</tr>
<tr>
<td>Obese</td>
<td>1.78 (1.64-1.92)</td>
</tr>
</tbody>
</table>

* global average, actual relative risk is region-specific.

Life-cycle analysis:

- Use of commodity-specific GHG emissions factors from meta-analysis of life-cycle analyses (Tilman and Clark, 2014);
- Excludes land-use emissions and post-farm gate activities;
- Adjusted for future productivity improvements based on FAO data from 1961-2010.
Economic analysis

Environmental valuation:
- Social cost of carbon estimates with discount rates 2.5%, 3%, 5%, 95th percentile of 3% from IA model comparison for US Gov;

Health evaluation:
2. Cost of illness estimates based on EU-wide assessment of CVD and cancer; use of cost transfer method with health expenditure projections for direct costs and GDP projections for indirect costs.

⇒ Exploratory approach; not full economic analysis (prices, supply-demand interactions).
Dietary changes towards more plant-based diets could:

- Reduce mortality by 6-10% compared to what would be expected in 2050;
- Reduce food-related GHG emissions by 30-70%;
- Result in avoided climate damages and healthcare savings of up to USD 1.5 trillion.

Implications:

- The size of the projected benefits should encourage individuals, industry, and policy makers to act decisively to make sure that what we eat preserves our environment and our health.
- Not a small task: to achieve minimum global dietary guidelines (HGD) would require 25% increase in global fruit & veg consumption, 56% reduction in red meat consumption, and 15% reduction in energy intake.
- The regional detail of our study can be used to identify the most appropriate interventions for both the production and consumption sides of the food system.