The future(s) of food

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Food systems are spatial: the UK imports from 168 countries around the world
WHY OUR FOOD SYSTEM MUST CHANGE (1): HEALTH COSTS
Theory of comparative advantage leads to global homogenisation

Over 50% of the world’s crop calories come from wheat, rice and maize, adding sugar, barley, soy, palm, potato gets to 76%

Increasing homogeneity in global food supplies and the implications for food security
### Associations of fats and carbohydrate intake with cardiovascular disease and mortality in 18 countries from five continents (PURE): a prospective cohort study

**Methods** The Prospective Urban Rural Epidemiology (PURE) study is a large, epidemiological cohort study of individuals aged 35–70 years (between Jan 1, 2004, and March 31, 2015) in 18 countries with a median follow-up of 7–4 years (Fig 3–5). Dietary intake of 135 351 individuals was recorded using validated food-frequency questionnaires. The primary outcomes were total mortality and major cardiovascular events (fatal cardiovascular disease, non-fatal myocardial infarction, stroke, and heart failure). Secondary outcomes were all-cause mortality, stroke, cardiac disease mortality, and non-cardiac disease mortality. Participants were categorized into quintiles of nutrient intake (cardioresilence, fat, and protein) based on percentage of energy provided by nutrients. We assessed the associations between consumption of carbohydrate, total fat, and each type of fat with cardiovascular disease and total mortality. We calculated hazard ratios (HRs) using a multivariable Cox frailty model with random intercepts to account for cluster clustering.

**Findings** During follow-up, we documented 5796 deaths and 4748 major cardiovascular disease events. Higher carbohydrate intake was associated with an increased risk of total mortality (highest quintile vs lowest quintile [13%] RR 1.12 (95% CI 1.04–1.19); p=0.003) but not with the risk of cardiovascular disease or cardiovascular disease mortality. Intake of total fat and each type of fat was associated with lower risk of total mortality (quintile 5 vs quintile 1: total fat HR 0.87 (95% CI 0.82–0.93), p=0.0008; saturated fat, HR 0.87 (95% CI 0.79–0.94), p=0.0008; monounsaturated fat: HR 0.81 (95% CI 0.74–0.90), p=0.0008; polyunsaturated fat: HR 0.80 (95% CI 0.73–0.89), p=0.0008). Higher saturated fat intake was associated with lower risk of stroke (quintile 5 vs quintile 1: HR 0.79 (95% CI 0.64–0.98), p=0.0499). Total fat and saturated and unsaturated fats were not significantly associated with risk of myocardial infarction or cardiovascular disease mortality.

**Interpretation** High carbohydrate intake was associated with higher risk of total mortality, whereas total fat and individual types of fat were related to lower total mortality. Total fat and types of fat were not associated with cardiovascular disease, myocardial infarction, or cardiovascular disease mortality, whereas saturated fat had an inverse association with mortality. Of the different dietary patterns described, the Mediterranean Diet had the highest association with health benefits compared to other diets.

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### What we are actually producing (According to 2011 FAO)

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits &amp; Vegetables</td>
<td>11%</td>
<td>Oils &amp; Fats</td>
</tr>
<tr>
<td>Meat, fish, eggs, beans</td>
<td>11%</td>
<td>Sugar</td>
</tr>
<tr>
<td>Cereals and Starches</td>
<td>47%</td>
<td>Cereals and Starches</td>
</tr>
<tr>
<td>Milk and Milk Products</td>
<td>4%</td>
<td>Milk and Milk Products</td>
</tr>
<tr>
<td>Oils &amp; Fats</td>
<td>16%</td>
<td>Sugar</td>
</tr>
</tbody>
</table>

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**Summary**

- **Background** The association between intake of fruits, vegetables, and legumes with cardiovascular disease and deaths has been investigated extensively in Europe, the USA, Japan, and China, but little is known from data available from the Middle East, South America, Africa, or other regions.

- **Methods** We did a prospective cohort study (Prospective Urban Rural Epidemiology [PURE]) in 135 351 individuals aged 35 to 70 years without cardiovascular disease from 430 communities in 18 low-income, middle-income, and high-income countries in seven geographical regions: North America and Europe, South America, the Middle East, South Asia, China, southern Asia, and Africa. We documented their diet using country-specific food frequency questionnaires at baseline. Standardized questionnaires were used to collect information about demographic factors, socioeconomic status (education, income, and employment), lifestyle (smoking, physical activity, and alcohol intake), health history and medication use, and family history of cardiovascular disease. The follow-up period varied based on the data when recruitment began in each country or continent. The main clinical outcomes were major cardiovascular disease (defined as death from cardiovascular causes and non-fatal myocardial infarction, stroke, and heart failure), fatal and non-fatal myocardial infarction, fatal and non-fatal strokes, cardiovascular mortality, non-cardiovascular mortality, and total mortality. Cox frailty models with random effects were used to assess associations between fruit, vegetable, and legume consumption with risk of cardiovascular disease events and mortality.

- **Findings** Participants were enrolled in the study between Jan 1, 2004, and March 31, 2015. For the current analysis, we included all outcome events in the PURE study database through March 31, 2017. Overall, combined means of fruit and vegetable intake were 3.8 (SD 2.7) servings per day. During a median 6.4 years (5.3–9.3) of follow-up, 4748 major cardiovascular disease events, 369 cardiac deaths, and 5796 total deaths were documented. Higher total fruit, vegetable, and legume intake was associated with major cardiovascular disease, myocardial infarction, cardiac deaths, and total mortality in the models adjusted for age, sex, and center (random effect). The estimates were substantially attenuated in the multivariable adjusted models for major cardiovascular disease (HR 0.78, 95% CI 0.73–0.83; 369 cardiac deaths, 0.81; 0.74–0.88), cardiac mortality (HR 0.73, 95% CI 0.68–0.78; 369 cardiac deaths, 0.81; 0.74–0.88), and total mortality (HR 0.81, 95% CI 0.76–0.87). The HR for total mortality was lowest for three servings per day (0.78, 95% CI 0.80–0.83) compared with the reference group, with no further apparent decrease in HR with higher consumption. When consumption was stratified, total intake was associated with lower risk of cardiovascular, non-cardiovascular, and total mortality, while legume intake was inversely associated with non-cardiovascular death and total mortality (fully adjusted models). For vegetables, one vegetable intake was strongly associated with a lower risk of total mortality, whereas cooked vegetable intake showed a modest benefit against mortality.

- **Interpretation** Higher fruit, vegetable, and legume consumption was associated with a lower risk of non-cardiovascular, and total mortality. Benefits appear to be maximum for both non-cardiovascular mortality and total mortality at three to four servings per day (equivalent to 375–589 g/day).

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**Evan Fraser, Guelph, FBS analysis, 2015**
Global malnourishment: the food system doesn’t deliver health through diets

Trends in age-standardised prevalence of BMI categories in women, global

*The Lancet* Volume 387, Issue 10026, Pages 1377-1396 (April 2016)
By 2025, over 700m people will have diabetes.
- UK health costs for 3.5m people are £13.75 bn, ~£4000 per cap per ann
- 700m at UK health costs=£2.75tn=$3.58 tn
- Global GDP (2014) was $76tn
- Diabetes costs ~4-5% GDP
WHY OUR FOOD SYSTEM MUST CHANGE (2): ENVIRONMENTAL COSTS
Per capita footprint of intensification

- 0.7-0.85 ha land
- 776 m³ water
- 15.3 kg N
- 299 kg CO₂eq

*Fig 2.9. Some trends in world agriculture: (a) the cultivation area of major crops (Ha), (b) the yields of major crop types (Hg/ha), (c) livestock numbers (in millions) and (d) kg of fertiliser per ha and kg of pesticide active ingredient per ha. Data from FAOSTAT, 2017: http://www.fao.org/faostat/en/#data/OA*
Forest loss, Rondonia, Amazonia 1984-2006
GHG emissions by service (50.6 Gt CO2e total)

- Personal travel: 30%
- Commuting: 9%
- Thermal comfort: 15%
- Lighting: 10%
- Industrial equipment: 9%
- Construction: 9%
- Freight: 3%
- Washing: 9%
- Communications: 3%
- Textiles: 3%
- Agri-food: 3%
- Waste: 1%

Baizeli et al (2013)
WHY OUR FOOD SYSTEM MUST CHANGE (3): SYSTEMIC RISKS
Supply chain logistics

- 60% US grain export
- 11% cereals trade
- 26% cereals trade
- ~20% fertilisers
- 14% cereals trade
- 14% cereals trade
- ~25% fertilisers
- (50% China’s soy and wheat)

courtesy of http://rsif.royalsocietypublishing.org/content/early/2010/01/19/rsif.2009.0495.full
Fig. 3. The 2008 food-energy crisis. SS = simultaneous stresses; LFBB = long fuse big bang; RC = ramifying cascade.
Climate change in the Fertile Crescent and implications of the recent Syrian drought

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Before the Syrian uprising that began in 2011, the greater Fertile Crescent experienced the most severe drought in the instrumental

Syria’s water security by exploiting limited land and water resources without regard for sustainability (10).

International Affairs

FIG. 1: Time dependence of FAO Food Price Index from January 2004 to May 2011. Red dashed vertical lines correspond to beginning dates of "food riots" and protests associated with the major recent unrest in North Africa and the Middle East. The overall death toll is reported in parentheses [26–55]. Blue vertical line indicates the date, December 13, 2010, on which we submitted a report to the U.S. government, warning of the link between food prices, social unrest and political instability [56]. Inset shows FAO Food Price Index from 1990 to 2011.
INTERNATIONAL AGREEMENTS IMPLY CHANGE
People

We are determined to end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment.

Planet

We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.

Obersteiner et al 2016 Science Advances 2 show food price potent policy lever to manage trade-offs
Dietary change more important for reducing emissions than farming change

The population of all Asia is 4.2bn

Figure 1. Calorie delivery fraction per hectare. The proportions of produced calories that are delivered as food are shown.

THE FUTURES OF FOOD
Alternative futures

Free trade, global markets

Carbon tax; “polluter pays”; education; climate costs mount: Food becomes more expensive

Unsustainable and unhealthy diets

Food tax; healthy eating incentive schemes; health insurance; public health education

Local or regional markets

sustainable and healthy diets
Future food

- Unsustainable and unhealthy diets
- Sustainable and healthy diets

Free trade, global markets

Growing corporate power (TTIP); drive for economic growth; stable world and governance; strong international co-op

Local or regional markets

Protectionism; nationalism
Break-up of rules-based international cooperation
War/terrorism; climate migrants
Lack of resilience in trade due to climate/extreme weather

Futures of food

Unsustainable and unhealthy diets

- Growing ill-health
- More climate change
- More natural resources required
- MNC interests dominate politics

Free trade, global markets

- Global innovations and tech platforms
- High efficiency
- App-driven personalised nutritious diets
- Consumers buy attributes

Money talks most

- Disconnected world with weak economic growth
- “post war economy”
- Unsustainable production to meet demands locally
- “spatial inequality”

Local or regional markets

- Sustainable nutrition drives local industry
- “local food” SMES and artisanal food valued
- Holistic economies – low waste, high health and well being
- “spatial inequality”

Local is lovely

- Sustainable, high-tech world
- Money talks most

What role for technology?

- Commodity crops
- Biotechnology and biofortification
- Ultra-processed foods
- Long supply chains

Sustainable, high-tech world
- Global innovations and tech platforms
- High efficiency
- App-driven personalised nutritious diets
- Consumers buy attributes

Local is lovely
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More varied diets to provide nutrients
More varied farming systems
Whole foods, cooked at home
Short supply chains
Conclusions: the past and future will be radically different

- The current food system is globally unsustainable, externalising costs to health and environment
- The future and recent past are likely to diverge (and perhaps suddenly) depending on geopol stability, climate risks and healthcare costs
- The potential role of particular technologies in delivering the triple wins (health, economy, environment) depends on e.g. supply chain length, price vs convenience trade-offs, dietary choices etc
- Systemic risks are increasing and there is potential for sudden policy shifts that may change social preferences

Thank you!

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