Modelling and Assessing Population Dietary Intakes: Methodologies and Case Studies

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Workshop on Dietary Assessment and Food Matching Tools
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Expert Models for Decision Makers™

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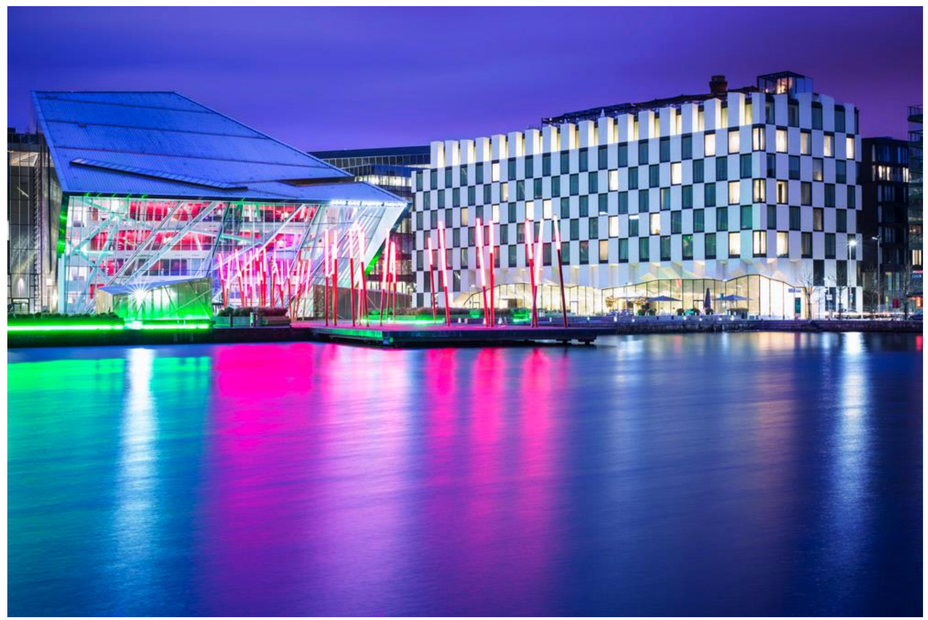
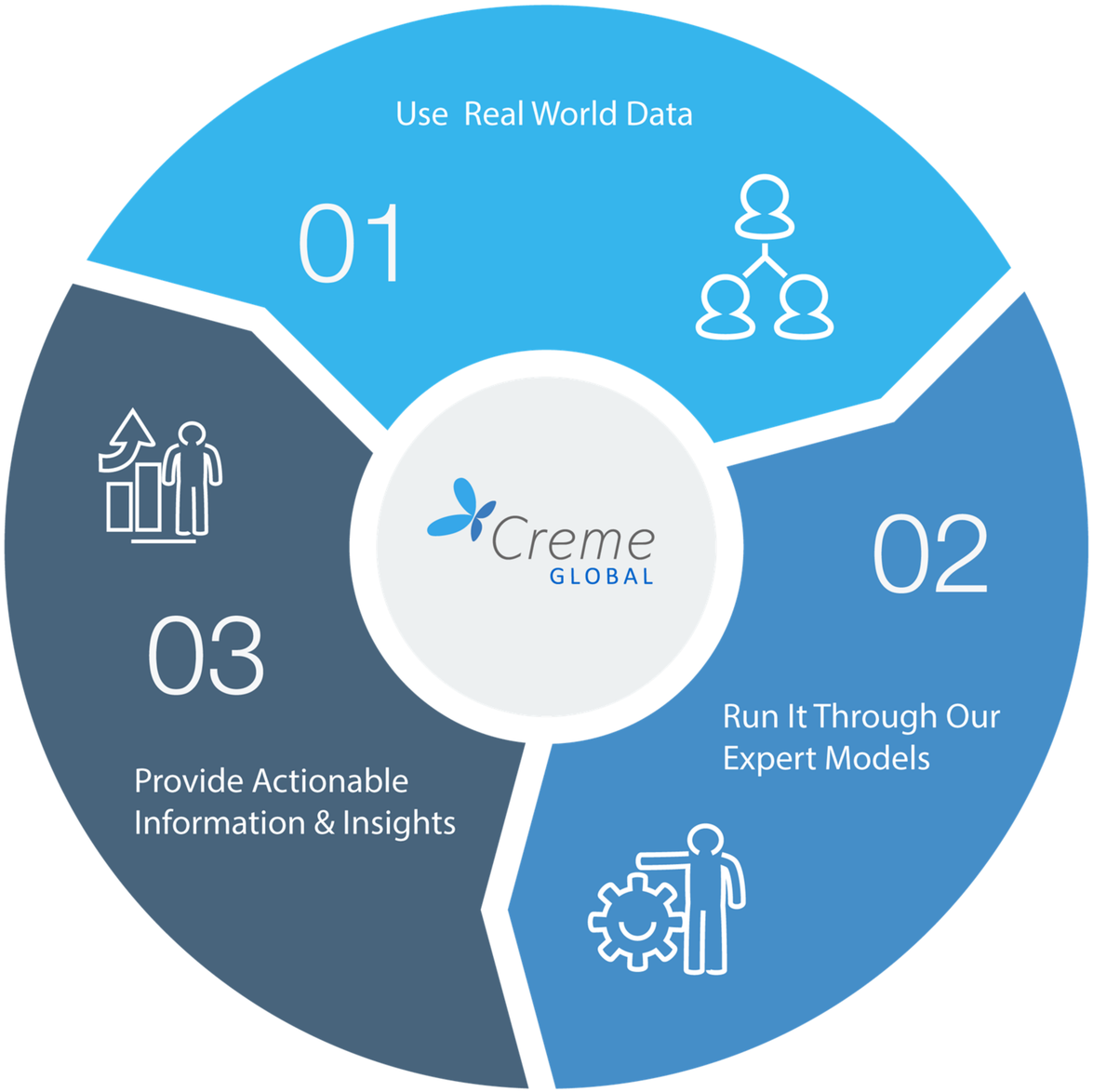
THE DESIGN TOWER



What we do



Use Real-World Data

- Actual Consumer Habits & Practices
- Food/ Product Composition
- Chemical Concentration/ Occurrence
- Market Share & Sales Data
- US, EU, China, Brazil, Mexico, etc.

Run it through our Expert Models

- Probabilistic Exposure Assessment
- Predictive Intake Modelling
- Total Aggregate Exposure
- What-If Scenario Analysis
- Population Dietary Intake

Provide Actionable Information and Insights

- Innovation/ R&D Decisions
- Investment Decisions
- Policy Decisions

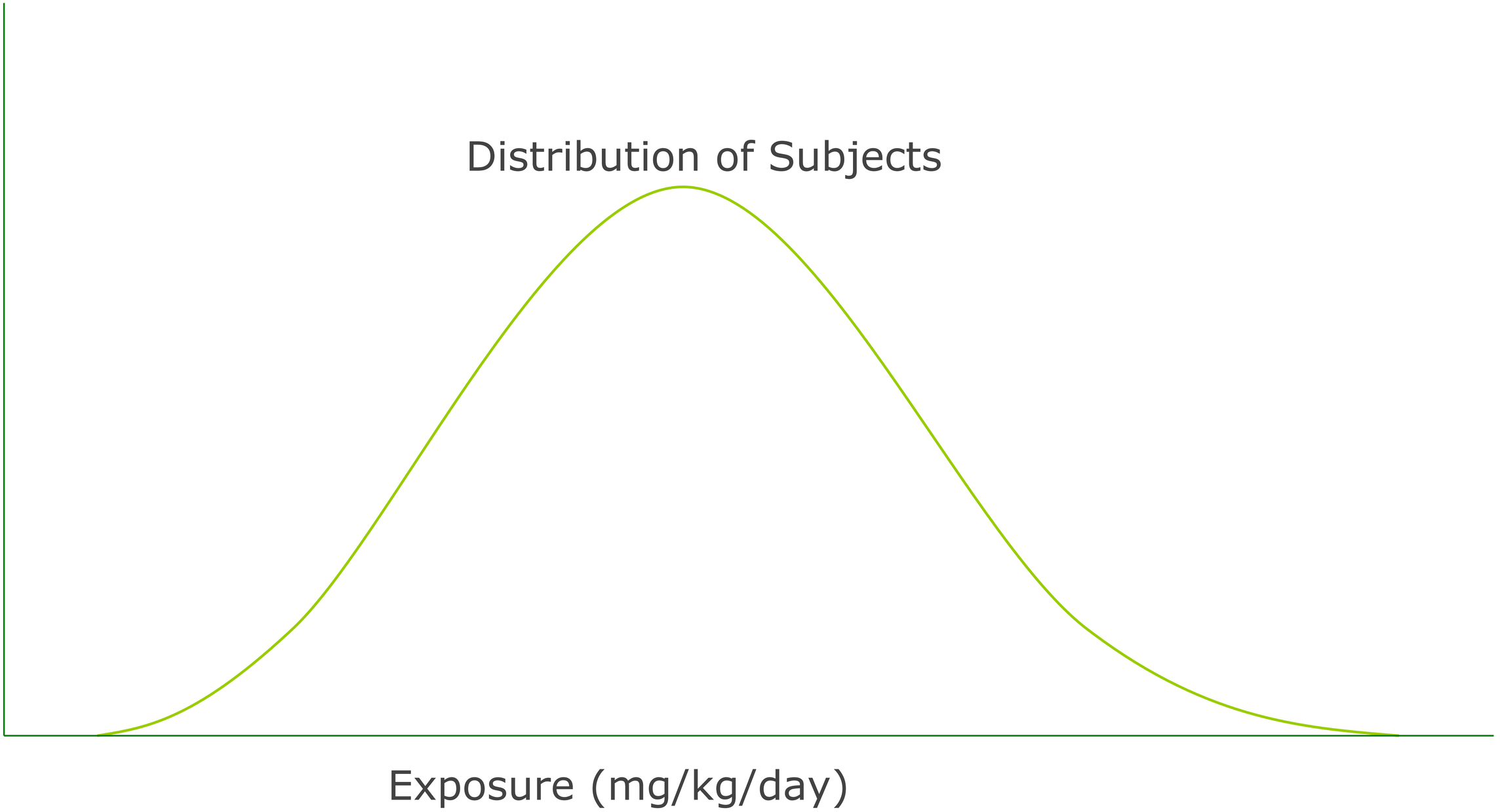
Population Dietary Intake/Exposure

Exposure/Intake Assessment - Aim

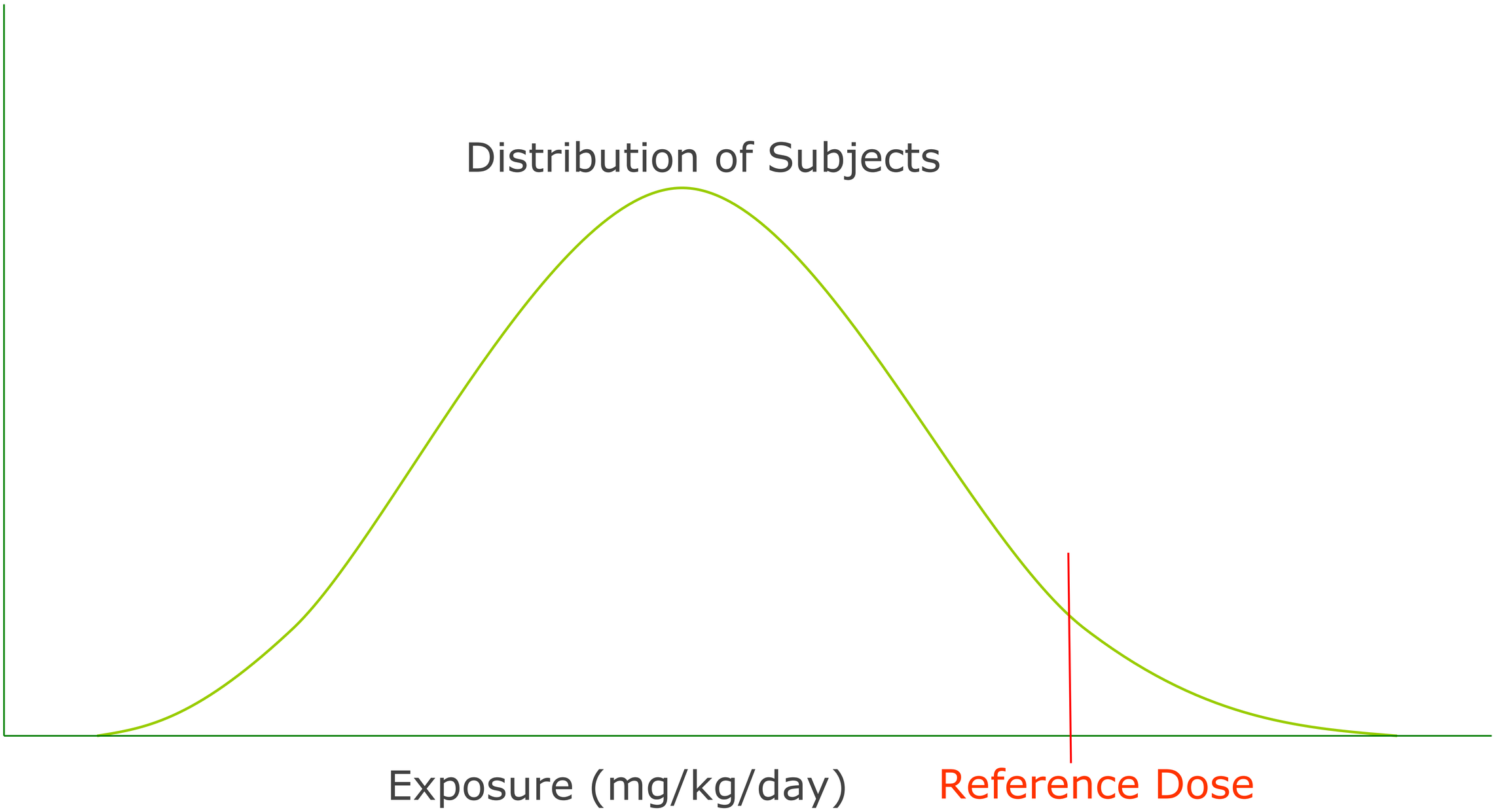
For a given population of consumers, estimate the distribution of intakes of:

- Foods
- Food ingredients
- Nutrients
- Chemicals in foods
- Microbial pathogens
- Any other substance present in food

Exposure Assessment Output



Exposure Assessment Output



Basic Principle

Exposure/Intake

=

Amount Consumed

X

Concentration of Substance

Intake Statistics

The mean is the arithmetic mean or average exposure in the population:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{x_1 + x_2 + \cdots + x_n}{n}$$

Can also be calculated using statistical weights:

$$\bar{x} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i} = \frac{w_1 x_1 + w_2 x_2 + \cdots + w_n x_n}{w_1 + w_2 + \cdots + w_n}$$

Percentile: The value below which a certain percent of observations fall: i.e. the P20 is the value below which 20% of the exposures fall

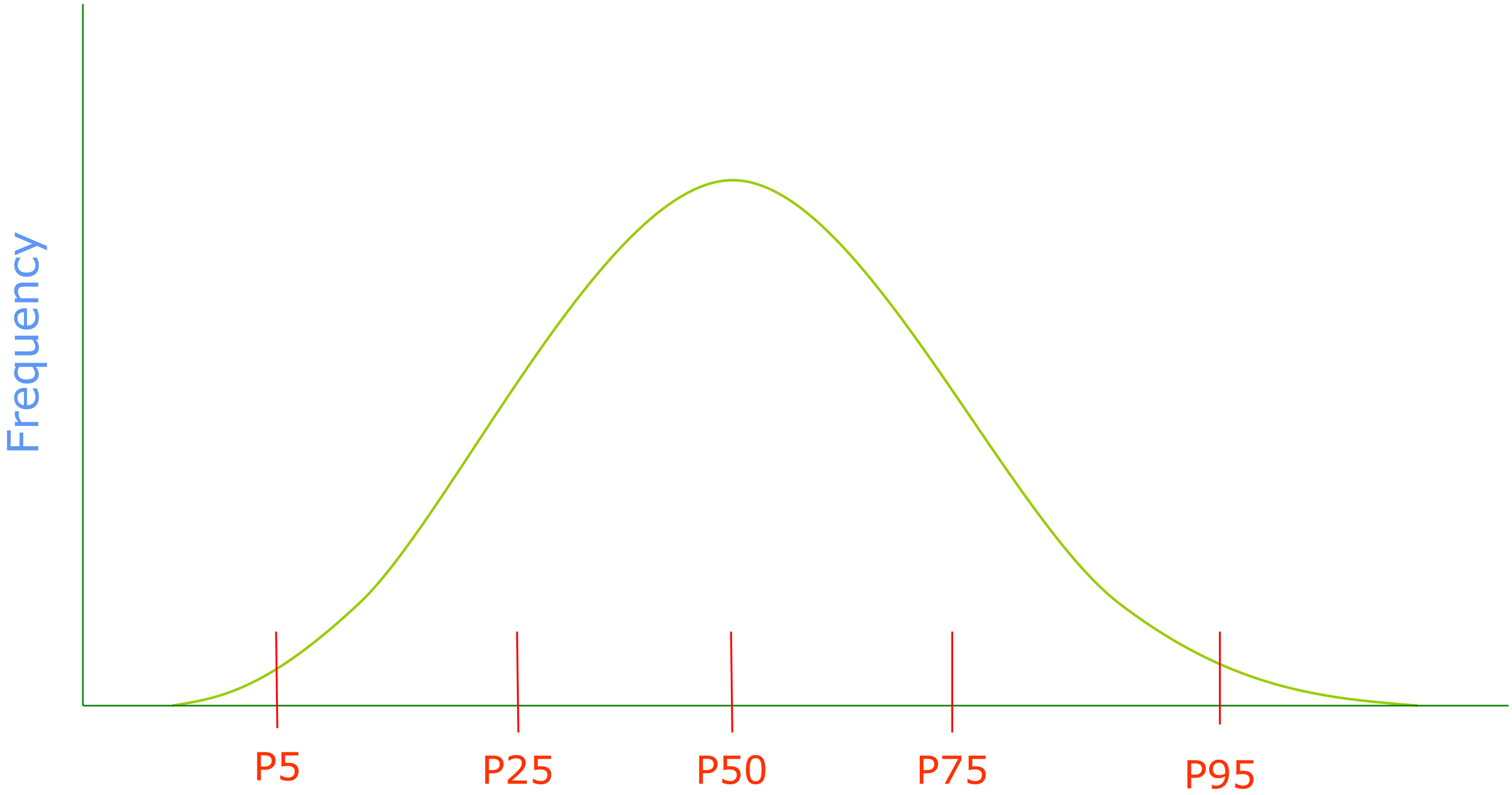
Can also be calculated with statistical weights

In risk assessment, the upper percentiles are typically most important, e.g. the P95 of exposure.

Consumer Type

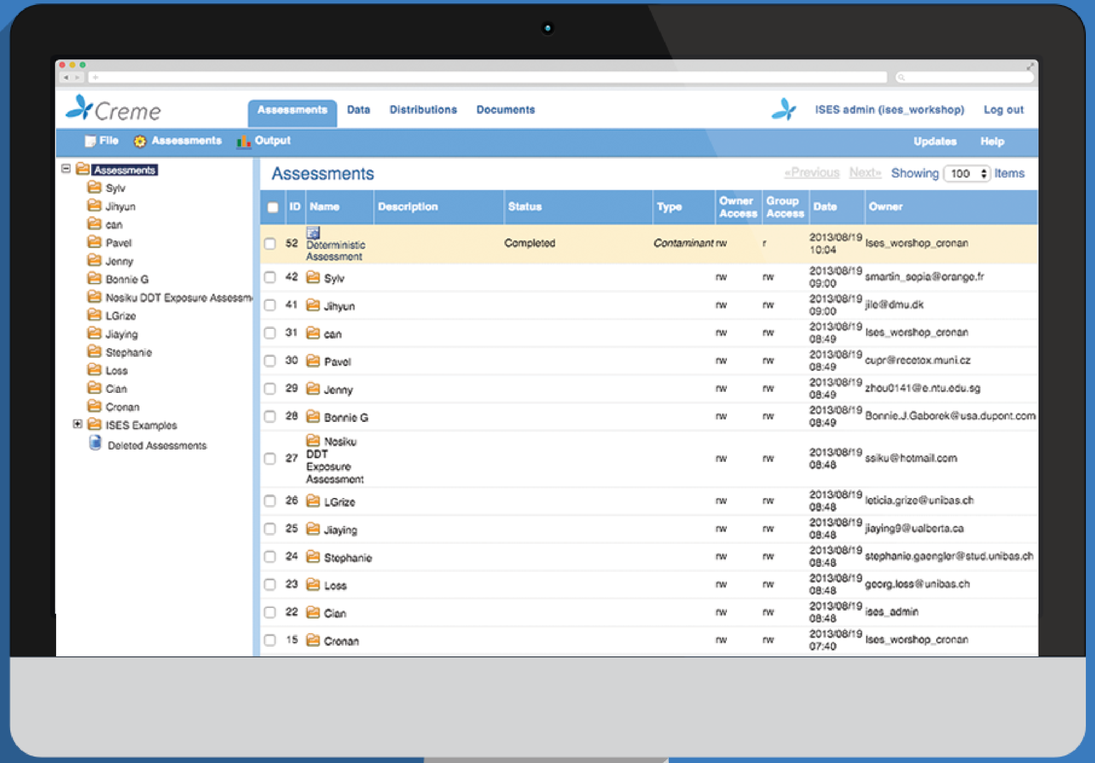
Total Population	
Food Consumers	
Chemical Consumers	

Exposure Percentiles



Predictive intake modelling application

Creme
Nutrition



Population Dietary Intakes - Data

Unlocking the value in data

Required Inputs – Food Consumption Data

- Food consumption diaries/databases
- Nationally representative surveys of food consumption
- Total diet of 1,000+ consumers recorded for 1 or more days
- Typically 100,000+ lines of consumption data
- Subject demographics needed also

Types of Dietary Surveys

- 24 hour recalls (one or more days)
- 3, 4, 5, 6 or 7 day records
- Consecutive and non-consecutive days
- 48 hour recalls
- Weighed vs estimated
- Amounts reported: raw commodities or as consumed
- Food Frequency Questionnaire (FFQ)

NB: Food categories are specific to each database. Levels of aggregation vary

Types of Dietary Surveys

Food record/diaries	does not rely on memory easy to quantify amounts open-ended	high participation burden requires literacy may alter intake behaviour
24 hour recall	little respondent burden no literacy requirement does not alter intake behaviour	relies on memory requires skilled interviewer difficulty to estimate amounts
Food frequency questionnaire (FFQ)	relatively inexpensive preferable method for nutrients with very high day variability does not alter intake behaviour	relies on memory requires complex calculations requires literacy limited flexibility for describing foods
Diet history	no literacy requirement does not alter intake behaviour open-ended	relies on memory requires highly trained interviewer difficulty to estimate amounts
Food habit	rapid and low cost does not alter intake behaviour open-ended	may rely on memory questionnaires may require a trained interviewer

Food Concentration Data /Other Data

Type of Data:

- Point estimates – **at food or food group level**
- Known ranges
- Empirical distributions (e.g. a set of analytical determinations)
- Parametric distributions (derived from a set of data)
- Level of Occurrence
- Can all be used probabilistically

Source of Data:

Survey data

Publications

Proprietary data

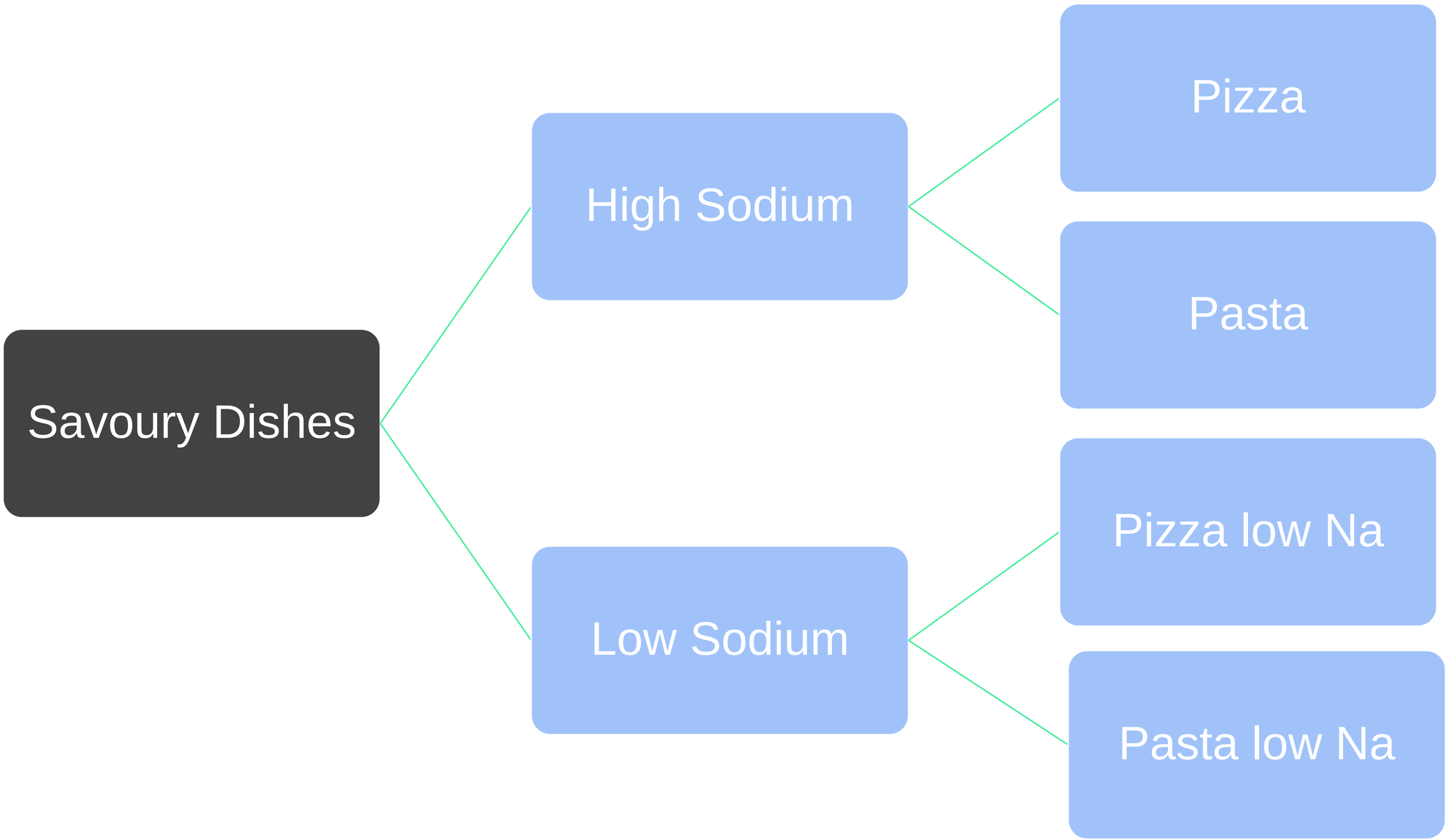
Other databases/reports:

- Linked to the survey
- Not linked to the survey

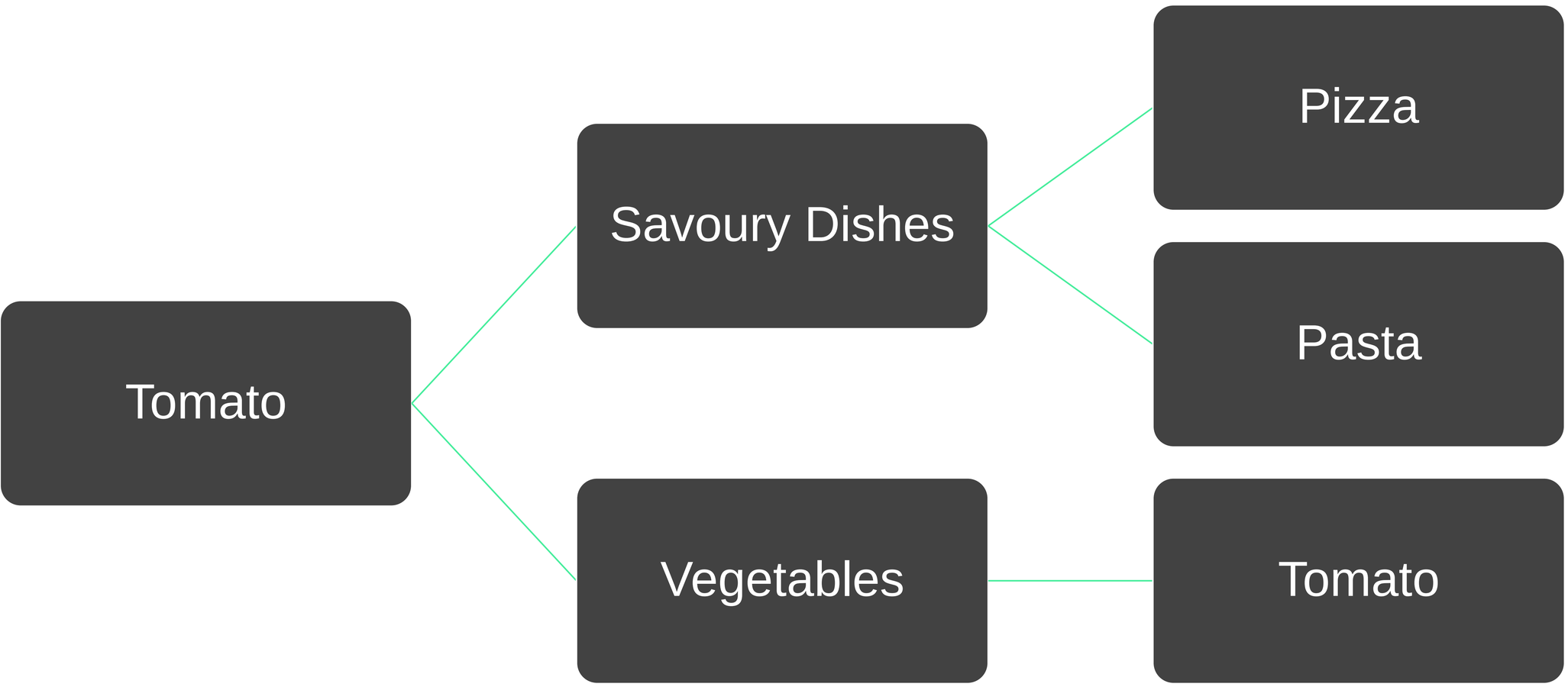
Food Grouping

Fish	
Bread	
Other	
Total Diet/all foods (All inc. Other)	+ +
All foods selected (All exc. Other)	+

Advanced Food Grouping



Advanced Food Grouping



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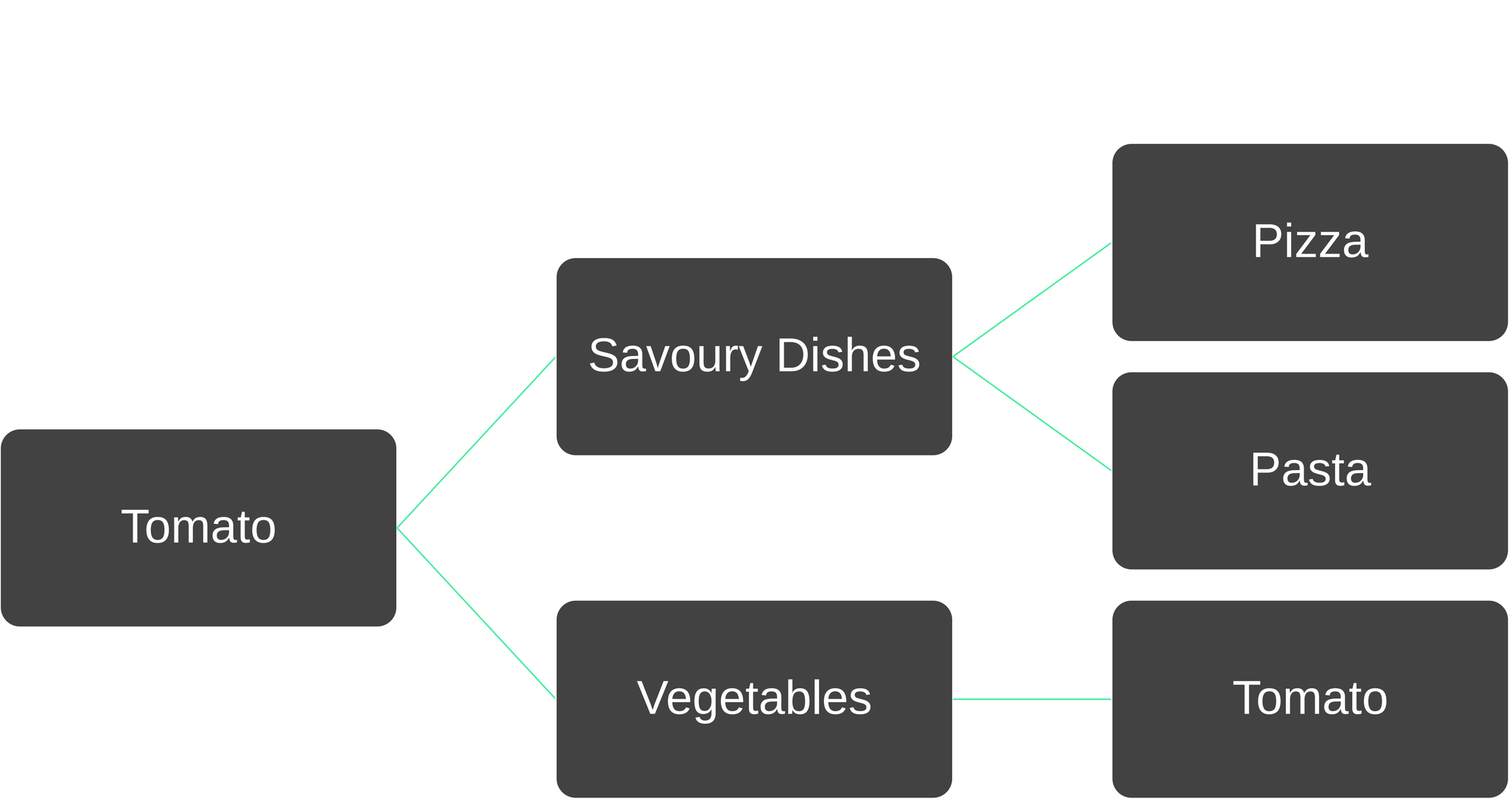

Ingredient Fraction/Recipe Data

0.15

0.2

1.0

Case Studies

BACCHUS FP7

- Flavonoid and bioactive peptide intakes
- Mapping of 2 data sources:
- EuroFIR eBASIS database (Bioactive Substances in Food Information System, http://eBASIS.eurofir.org/)
- Food consumption survey data (UK, Norway, Spain, Ireland)

BACCHUS
Cardiovascular benefits from food bioactives

Plants	Compound classes	Selected Output Fields
Apple	Anthocyanins	Plant
Apricot	Ellagitannins and Ellagic Acids	Compound
Bilberry	Flavanols	Average level
Blackberry	Flavanones	Unit
Blackcurrant	Flavonols	Quality code
Blueberry	Pro(antho)cyanidins	Part
Cherry	Isoflavones	Shape, state or form
Chokeberry		Compound class
Cloudberry		EuroFIR classification
Grape		Heat treatment
Grapefruit		Cooking method
Orange, seville		Treatment applied
Orange, sweet		Preservation method
Pepper, bell		
Plum		
Pomegranate		
Raspberry		
Red currant, garden currant		
Strawberry		
Tea		
Walnut		

Concentration data from eBASIS analysed and formatted into discrete data distributions of concentrations for each food-compound pair, allowing for random sampling of concentrations.

(-)-Epicatechin (Flavanols) - Apple

eBASIS concentration data from apple ranged from 0.005-0.115 mg/g

Table 1: Provisional results for Epicatechin intakes from Apples for UK total population and consumers only

	Total Population			Consumers Only	
	Apple Intake (g/d)	Exposure Range (mg/d)		Apple Intake (g/d)	Exposure Range (mg/d)
P25	0	0-0		25	0.125-2.875
Mean	21	0.105-2.415		45	0.225-5.175
P95	87	0.435-10.01		118	0.59-13.57

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BACCHUS
Cardiovascular benefits from food bioactives

SELECT YOUR INPUT CRITERIA BELOW:

COUNTRY

United Kingdom

STATISTIC

Mean

CONSUMER TYPE

Food Consumers

COMPOUND

Catechin

FOOD

Apple

Submit

Reformulation Project

14 companies – indigenous and multinational

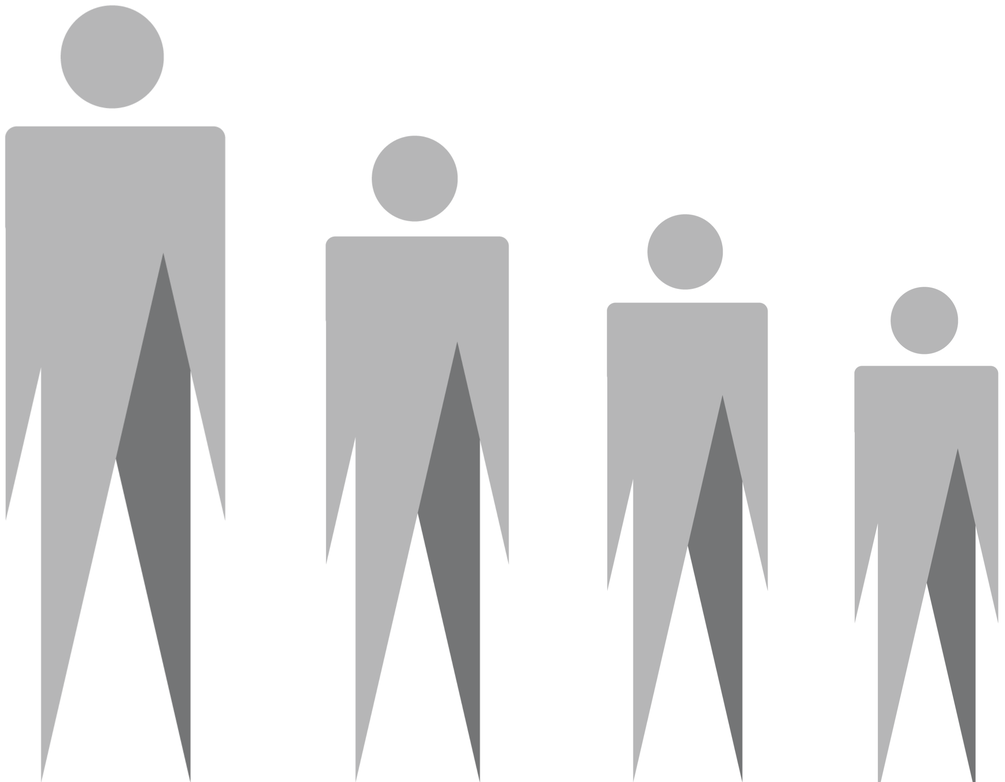
- Focus on ‘reformulation’ – 600 products
- Total fat, saturated fat, sugar, sodium, energy
- Impact on dietary intakes between 2 time points

http://www.fdii.ie/Sectors/FDII/FDII.nsf/vPages/Publications~fdii-creme-global-reformulation-report?OpenDocument

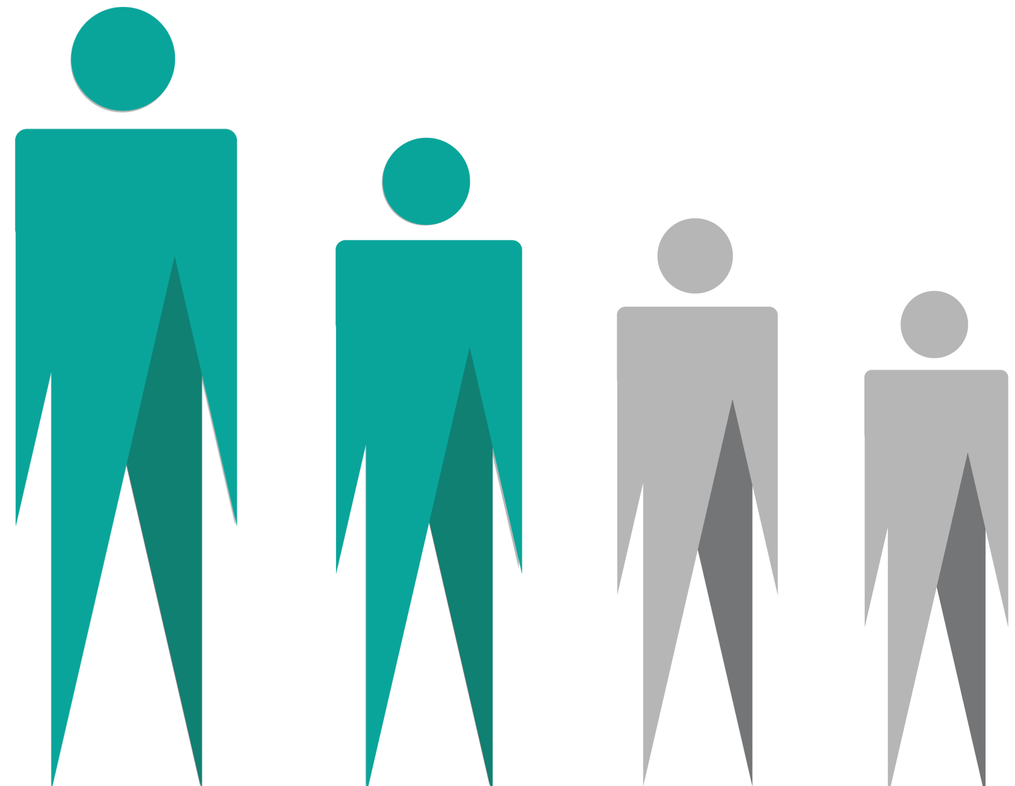
Reformulation Project

3 Data sources:

- IUNA food consumption surveys
- FDII member data on composition of reformulated product portfolios
- Market Share Data from Kantar Worldpanel



Mean Nutrient Intake Reductions



Sodium

-45%

New Products & Predicting Health Outcomes

Brazil and China: 45+ years, Normo-, pre- & hypertensive

Product: high in B2 and Potassium

Baseline Population Intakes: determine Nutritional Status

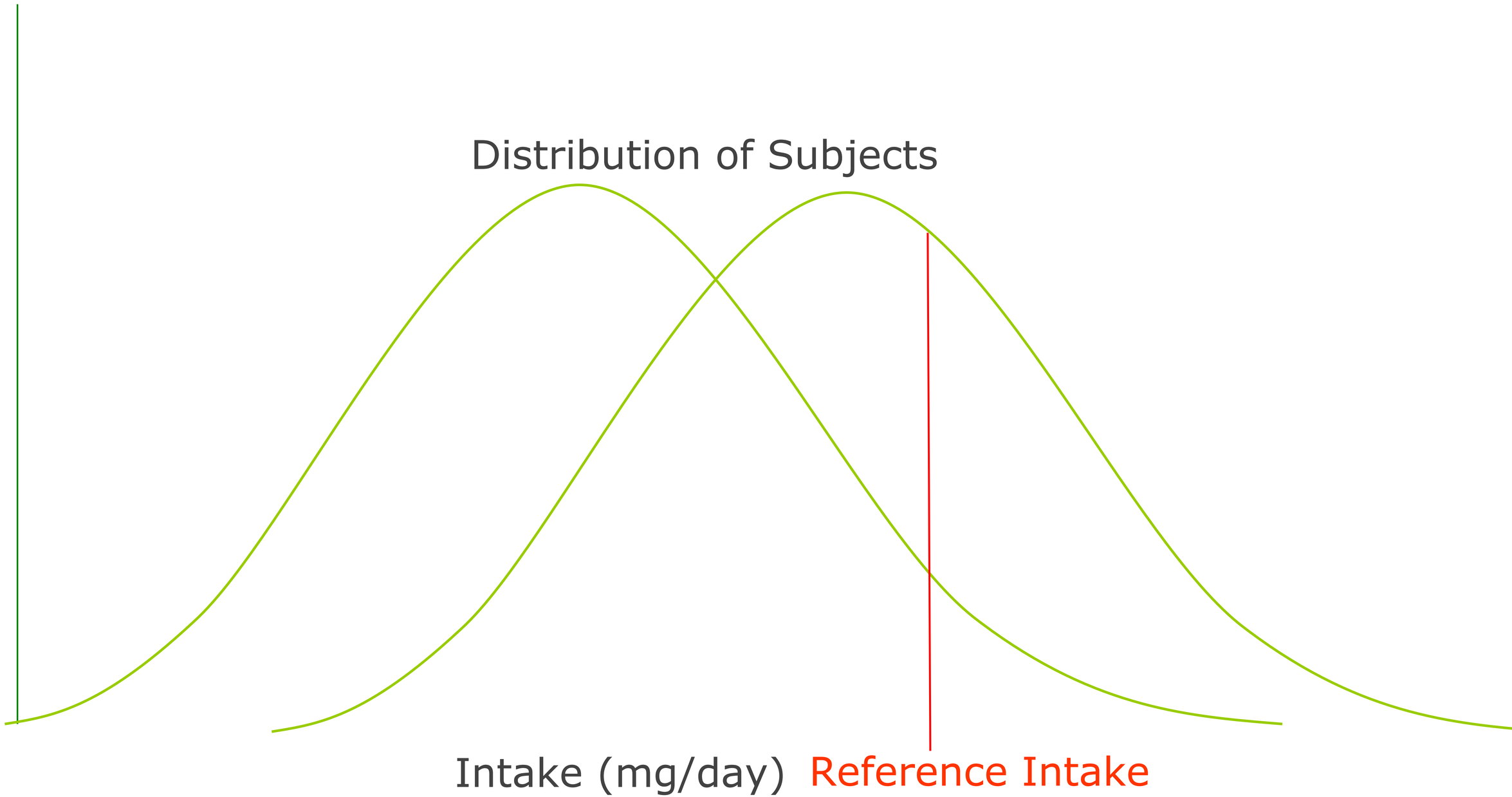
Carry out Intervention – i.e. food replacement, introduction of product into the diet

Impact on Population Intakes

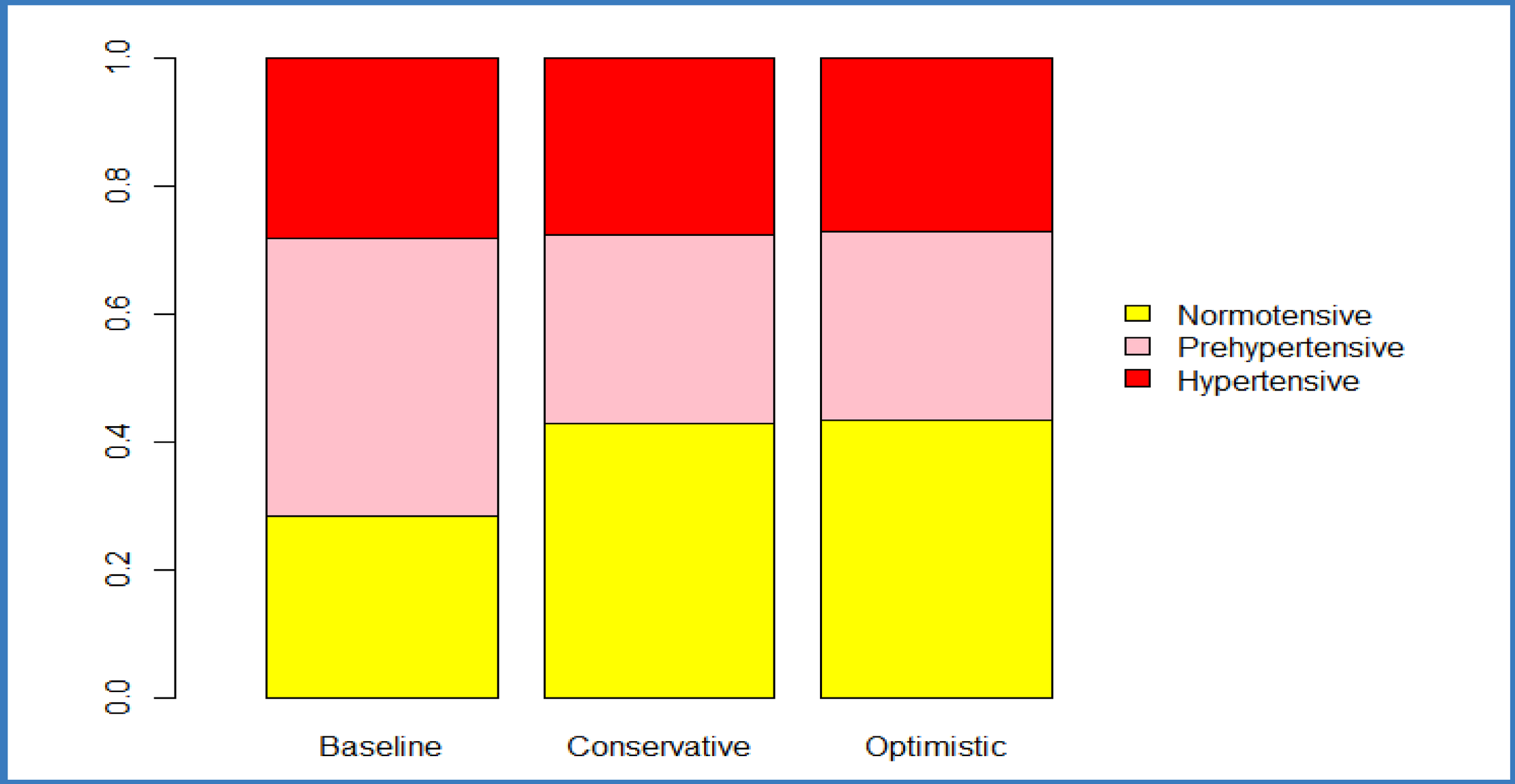
Based on Meta Analysis Studies, Assess **Impact of Intervention on Health Parameter**

Genotype (MTHFR) probabilities, Individual blood pressure data (SBP)

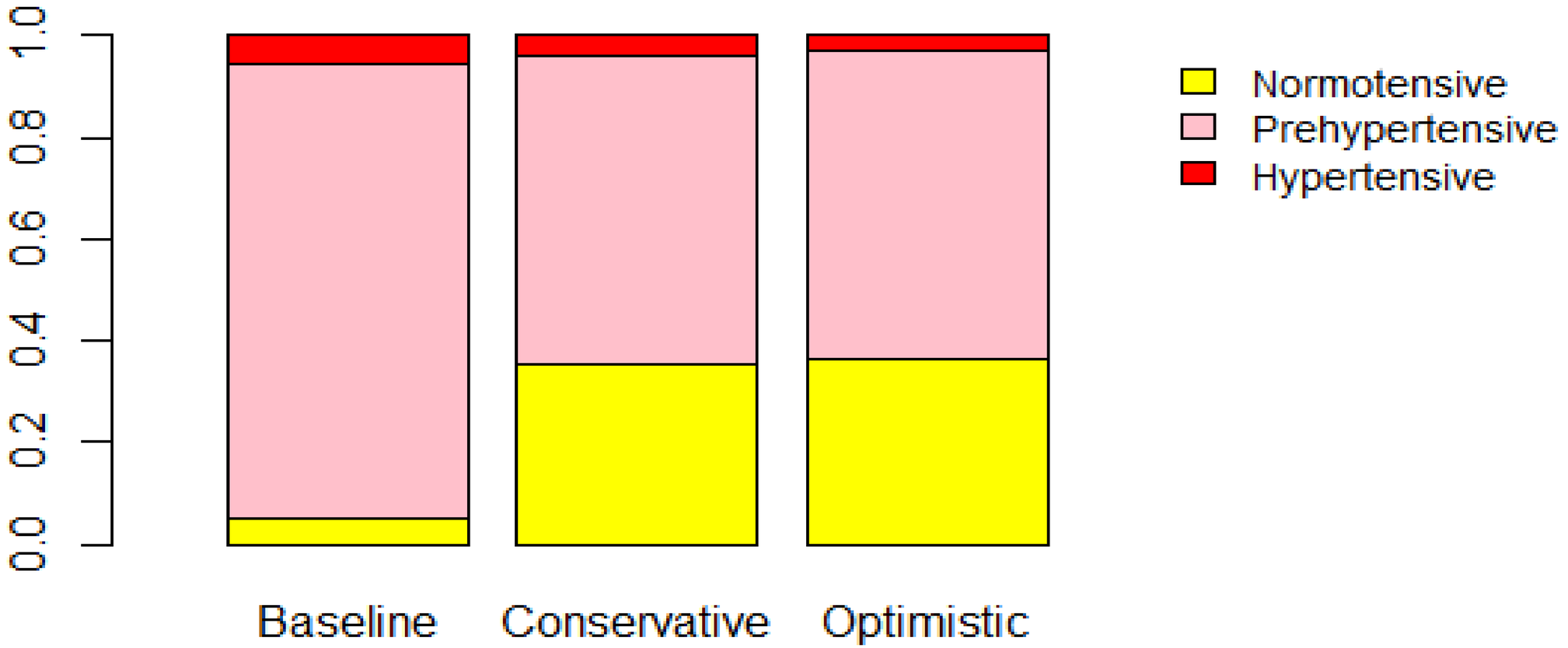
Shift in Nutrient Intake before and after Intervention



Impact on SBP in Total Population

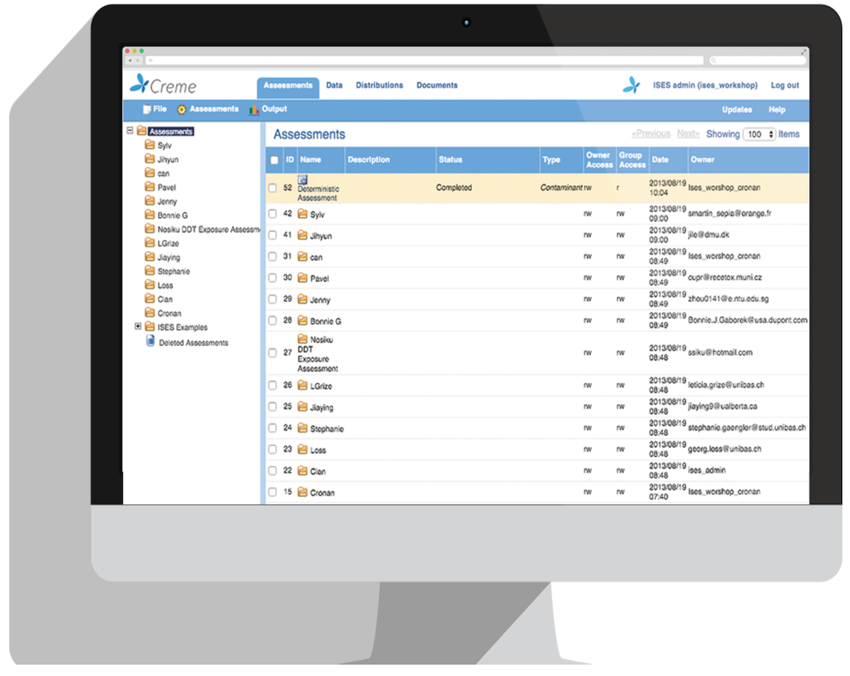


Impact on SBP in Product Consumers



Recap

- Data: Food Consumption, Food Composition, Recipe, Additive, Pesticide, Contaminant, Bioactive, Subject Demographics…
- Tool: (Predictive) Intake Modelling Software
- Probabilistic vs deterministic
- Understand data sources and gaps



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