Analysis of dietary patterns in the Swiss population – the menuCH study

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Schweizer Ernährungsgewohnheiten*

Süsses, Salziges & Alkoholisches – – – –
Täglich werden rund 4 statt 1 Portion verzehrt.

Öle, Fette & Nüsse ★★★–
Täglich werden dabei jedoch zu viele tierische Fette verzehrt.

Milchprodukte, Fleisch, Fisch, Eier & Tofu ★– – –
Täglich werden nur 2 statt 3 Portionen Milchprodukte verzehrt, dafür zu viel Fleisch.

Getreideprodukte, Kartoffeln & Hülsenfrüchte ★★★–
Täglich werden 2,4 statt 3 Portionen verzehrt.

Gemüse & Früchte ★★– –
Täglich werden rund 3-4 statt 5 Portionen verzehrt.

Getränke ★★★★
Täglich werden 1-2 Liter Getränke (Wasser, Kaffee, Tee) getrunken.

*Gemäss nationaler Ernährungserhebung menuCH

This is for the average Swiss.
To find patterns, we need to look at the raw data.

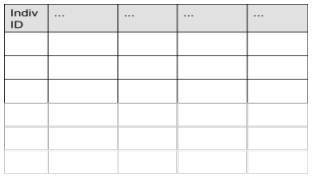
MenuCH: what are the available data?

Data structure of MenuCH

24HR data

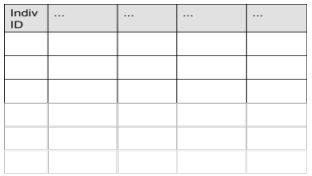
Contains minimal info about the participants (sex, age, language region)

Dietary behavior & physical activity questionnaire



A lot of data about usual diet, cooking, food intolerance/allergies, physical activity, morphology, income, ...

Data Federal Statistical Office



Demographic data used to establish the sample. Has more detailed data on certain variables (ie canton instead of language region, etc)

Data structure of MenuCH (2x 24HR)

Indiv ID	Interview # (2x 24h)	IsRecipe?	Food / Recipe name	Food / Recipe Category	Amount (g)	Cat ...	Day	Place ...
1	1st	No	Tomatoes	Vegetables	102			
1	1st	No	Vinegar	Sauce and spices	14			
1	1st	Yes	Pizza w. ham & cheese	Based on dough	250			
...								
1	2nd	No	...	...	...			
1	2nd	No	...	...	...			

1st 24 HR

2nd 24 HR

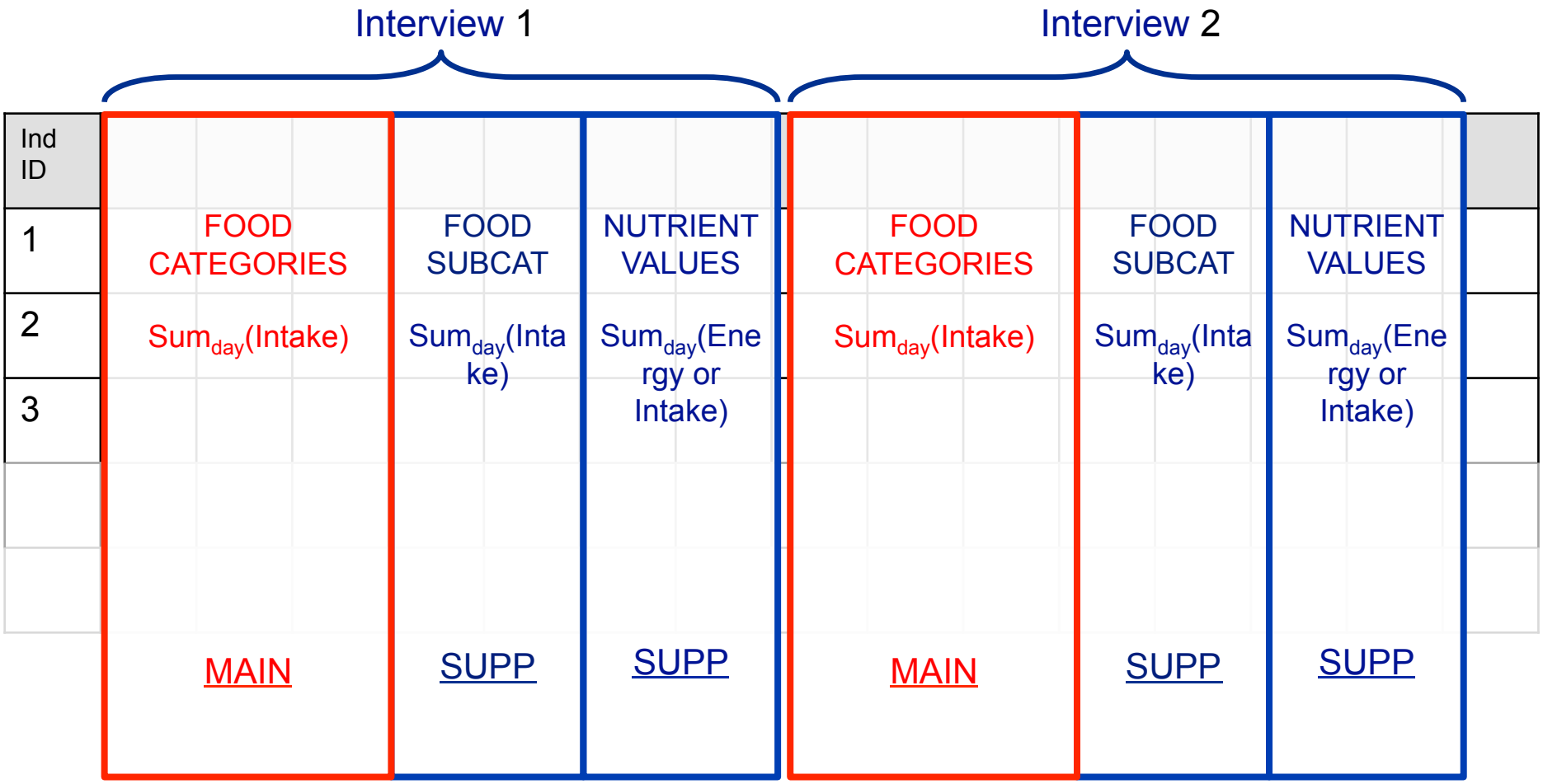
Description of each food item

- ... - Food name ...
- Food category / subcat / subsubcat
- Energy and nutrient values

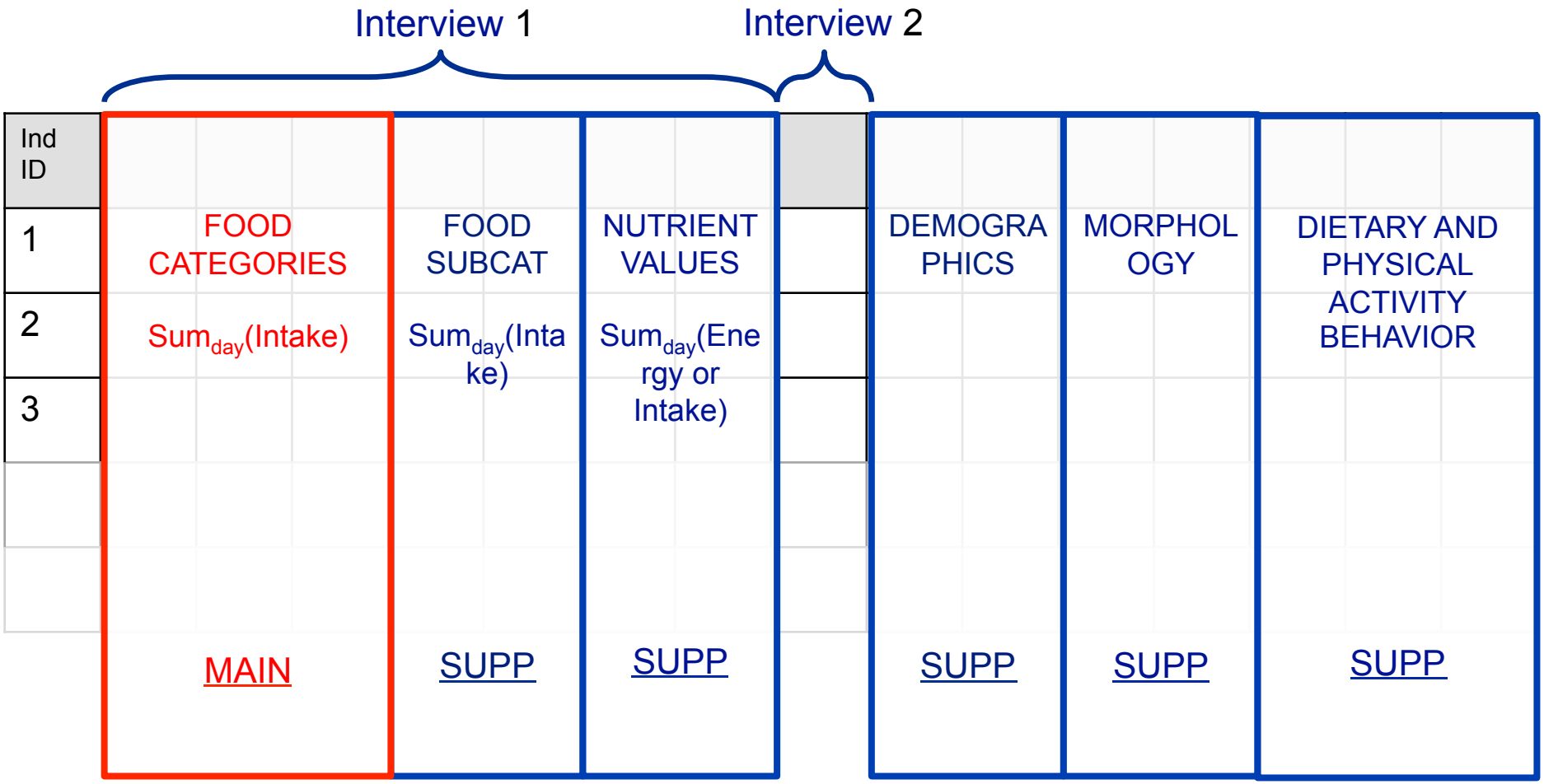
Supp info about the recall

- Day of the week
- Type of day
- Time, place, ...

Structuring data for dietary pattern analysis



Structuring data for dietary pattern analysis



Dietary patterns: a priori vs. a posteriori

- **A priori (hypothesis-driven)**
  - Mediterranean Diet Score
  - Healthy Eating Index
  - ...

- **A posteriori (data-driven)**
  - Principal component methods
  - Clustering
  - ...

Diet quality scores

- Mediterranean Diet Score (MDS)
  - “Original” Mediterranean Diet Score
  - “Swiss” Mediterranean Diet Score

- Healthy Eating Index (HEI)
  - HEI 1995
  - HEI 2010

"Original " Mediterranean Diet Score

Component	Range of score	Criteria for maximum score of 1[a]	Criteri for minimum score of 0[a]
Vegetables	0-1	Above the median	Below the median
Legumes	0-1	Above the median	Below the median
Fruits and nuts	0-1	Above the median	Below the median
Cereal	0-1	Above the median	Below the median
Fish	0-1	Above the median	Below the median
Meat	0-1	Below the median	Above the median
Dairy products	0-1	Below the median	Above the median
Alcohol	0-1	5 - 25 g/day for women 10 - 50 g/day for men	< 5 or > 25 g/day for women < 10 or > 50 g/day for men
Fat intake	0-1	Above the median	Below the median

[a]Median are sex-specific

Reference: Trichopoulou et al. 2003

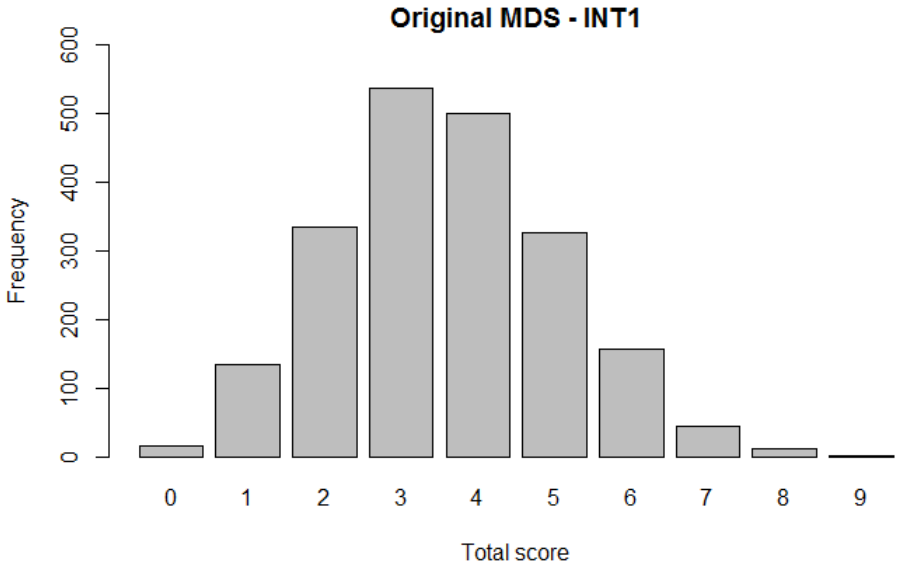
"Swiss" Mediterranean Diet Score

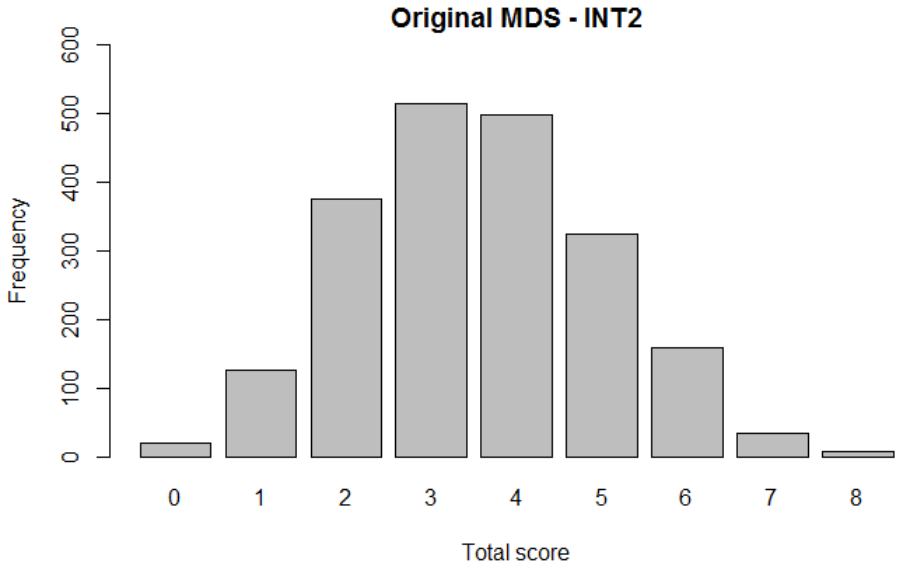
Component	Range of score	Criteria for maximum score of 1[a]	Criteri for minimum score of 0[a]
Vegetables	0-1	Above the median	Below the median
Legumes	0-1	Above the median	Below the median
Fruits and nuts	0-1	Above the median	Below the median
Cereal	0-1	Above the median	Below the median
Fish	0-1	Above the median	Below the median
Meat	0-1	Below the median	Above the median
Dairy products	0-1	Above the median	Below the median
Alcohol	0-1	5 - 25 g/day for women 10 - 50 g/day for men	< 5 or > 25 g/day for women < 10 or > 50 g/day for men
Fat intake	0-1	Above the median	Below the median

[a]Median are sex-specific

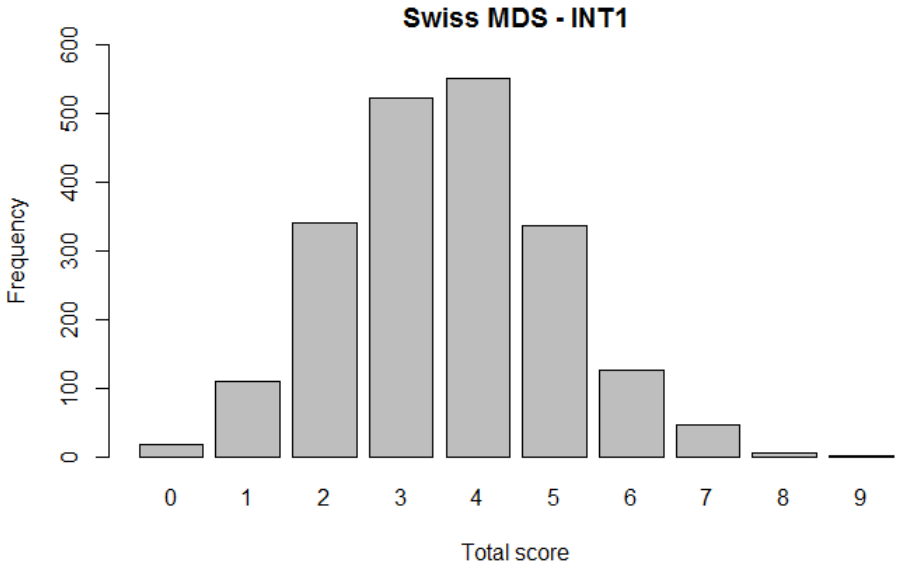
Reference: Vormund et al. 2015

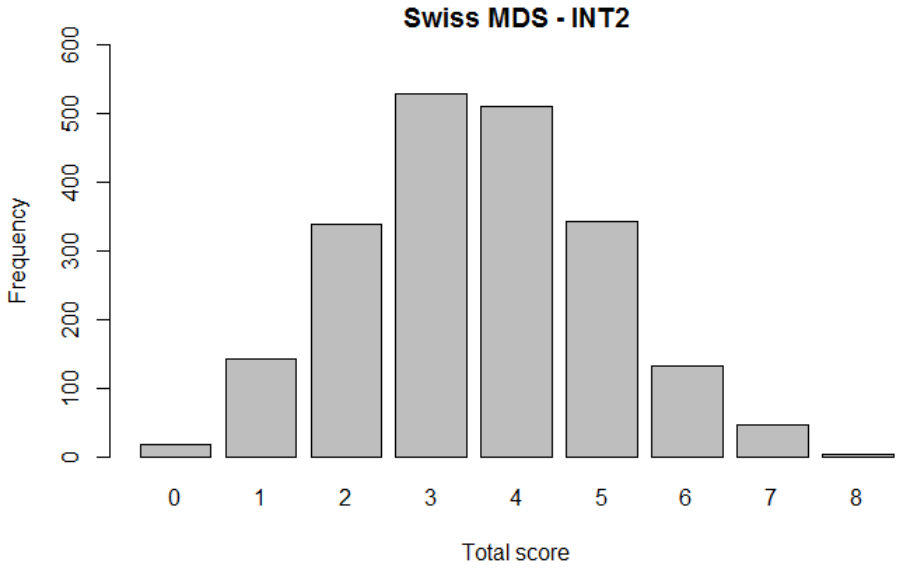
Results "Original " Mediterranean Diet Score





Results "Swiss" Mediterranean Diet Score





Healthy Eating Index 1995

Component	Range of score	Criteria for perfect score of 10[a]	Criteria for minimum score of 0
Food group			
1. Grains	0 to 10	6-11 servings[b]	0 servings
2. Vegetables	0 to 10	3-5 servings[b]	0 servings
3. Fruits	0 to 10	2-4 servings[b]	0 servings
4. Milk	0 to 10	2 to 3 servings[bc]	0 servings
5. Meat	0 to 10	2 to 3 servings[b]	0 servings
Dietary guidelines			
6. Total fat	0 to 10	30% or less energy from fat	45% or greater energy from fat
7. Saturated fat	0 to 10	Less than 10% energy from saturated fat	15% or greater energy from saturated fat
8. Cholesterol	0 to 10	Less than 300 mg	Greater than or equal to 450 mg
9. Sodium	0 to 10	Less than 2,400 mg	Greater than or equal to 4,800 mg
10. Variety	0 to 10	16 different kinds of food items over 3-day period	6 or fewer food items over a 3-day period

	Servings				
Kilocalories	Grains	Vegetables	Fruits	Milk[a]	Meat
1,600	6	3	2	2	2
2,200	9	4	3	2	2.4
2,800	11	5	4	2	2.8

Reference: Kennedy et al. 1995

Healthy Eating Index 2010

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
HEI-2010[a]			
Adequacy:			
Total Fruit[b]	5	≥0.8 cup equivalent per 1,000 kcal	No Fruit
Whole Fruit[c]	5	≥0.4 cup equivalent per 1,000 kcal	No Whole Fruit
Total Vegetables[d]	5	≥1.1 cup equivalents per 1,000 kcal	No Vegetables
Greens and Beans[d]	5	≥0.2 cup equivalent per 1,000 kcal	No Dark Green Vegetables or Beans and Peas
Whole Grains	10	≥1.5 oz equivalents per 1,000 kcal	No Whole Grains
Dairy[e]	10	≥1.3 cup equivalents per 1,000 kcal	No Dairy
Total Protein Foods[f]	5	≥2.5 oz equivalents per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins[fg]	5	≥0.8 oz equivalent per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids[h]	10	(PUFAs+MUFAs)/SFAs >2.5	(PUFAs+MUFAs)/SFAs ≤1.2
Moderation:			
Refined Grains	10	≤1.8 oz equivalents per 1,000 kcal	≥4.3 oz equivalents per 1,000 kcal
Sodium	10	≤1.1 g per 1,000 kcal	≥2.0 g per 1,000 kcal
Empty Calories[i]	20	≤19% of energy	≥50% of energy

Reference: Guenther et al. 2013

Recommendations SGE

Getränke

Täglich 1 – 2 Liter, bevorzugt in Form von ungesüssten Getränken, z. B. Hahnen-/Mineralwasser oder Früchte-/Kräutertee. Koffeinhaltige Getränke wie Kaffee, schwarzer und grüner Tee können zur Flüssigkeitszufuhr beitragen.

Gemüse & Früchte

Täglich 5 Portionen in verschiedenen Farben, davon 3 Portionen Gemüse und 2 Portionen Früchte. 1 Portion entspricht 120 g. Pro Tag kann eine Portion durch 2 dl Gemüse-/Fruchtsaft (ohne Zuckerzusatz) ersetzt werden.

Getreideprodukte, Kartoffeln & Hülsenfrüchte

Täglich 3 Portionen. Bei Getreideprodukten Vollkorn bevorzugen. 1 Portion entspricht: ▶ 75 – 125 g Brot/Teig oder ▶ 60 – 100 g Hülsenfrüchte (Trockengewicht) oder ▶ 180 – 300 g Kartoffeln oder ▶ 45 – 75 g Knäckebrot/Vollkornkräcker/Flocken/Mehl/Teigwaren/Reis/Mais/andere Getreidekörner (Trockengewicht).

Milchprodukte, Fleisch, Fisch, Eier & Tofu

Täglich 3 Portionen Milch/Milchprodukte. 1 Portion entspricht: ▶ 2 dl Milch oder ▶ 150 – 200 g Joghurt/Quark/Hüttenkäse/andere Milchprodukte oder ▶ 30 g Halbhart-/Hartkäse oder ▶ 60 g Weichkäse.
Täglich zusätzlich 1 Portion eines weiteren proteinreichen Lebensmittels (z. B. Fleisch, Geflügel, Fisch, Eier, Tofu, Quorn, Seitan, Käse, Quark). Zwischen diesen Proteinquellen abwechseln. 1 Portion entspricht: ▶ 100 – 120 g Fleisch/Geflügel/Fisch/Tofu/Seitan/Quorn (Frischgewicht) oder ▶ 2 – 3 Eier oder ▶ 30 g Halbhart-/Hartkäse oder ▶ 60 g Weichkäse oder ▶ 150 – 200 g Quark/Hüttenkäse.

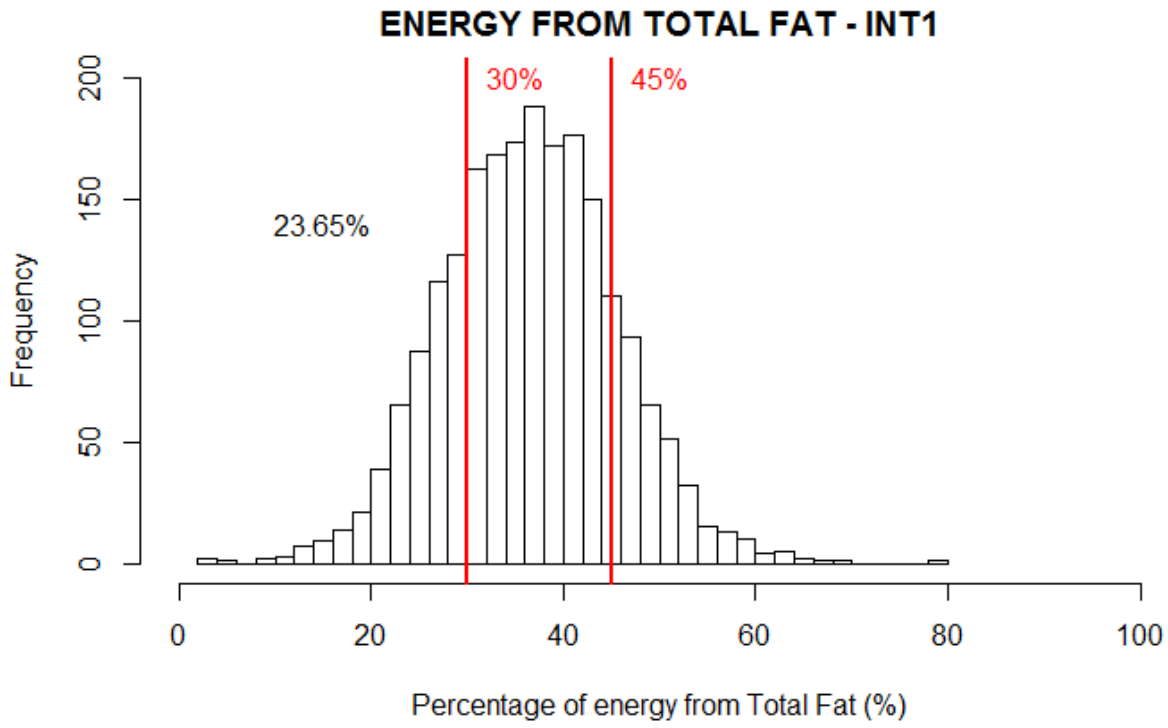
Öle, Fette & Nüsse

Täglich 2 – 3 Esslöffel (20 – 30 g) Pflanzenöl, davon mindestens die Hälfte in Form von Rapsöl.
Täglich 1 Portion (20 – 30 g) ungesalzene Nüsse, Samen oder Kerne. Zusätzlich können **sparsam** Butter, Margarine, Rahm etc. verwendet werden (ca. 1 EL = 10 g pro Tag).

Süsses, Salziges & Alkoholisches

Süssigkeiten, gesüsste Getränke, salzige Knabbereien und alkoholhaltige Getränke **mit Mass** geniessen.

Total Fat



≤ 30% = 10 points
≥ 45% = 0 points

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- **A priori (hypothesis-driven)**
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  - ...

- **A posteriori (data-driven)**
  - Principal component methods
  - Clustering
  - ...

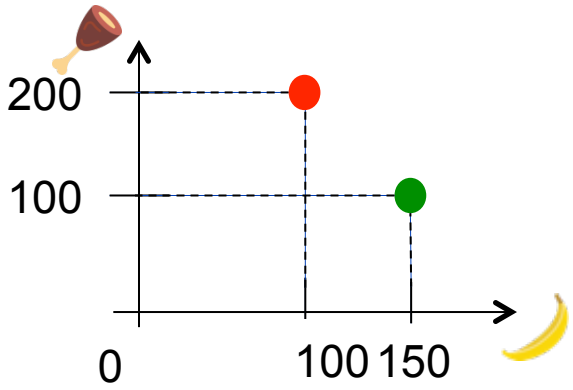
Methods: Multiple Factorial Analysis as a method of choice to handle the 2x24HR

Problem with lots of quantitative food data

For 1 24HR:

Case 1: only 2 groups.

- John (100,200)
- Helen (150,100)



2D-graph

Case 2: 18 food groups!

- John (100,200,25,....,10,24)
- Helen (150,100,42,.....,11,32)

No graph possible but each point as a unique position in a 18th-dimensional space

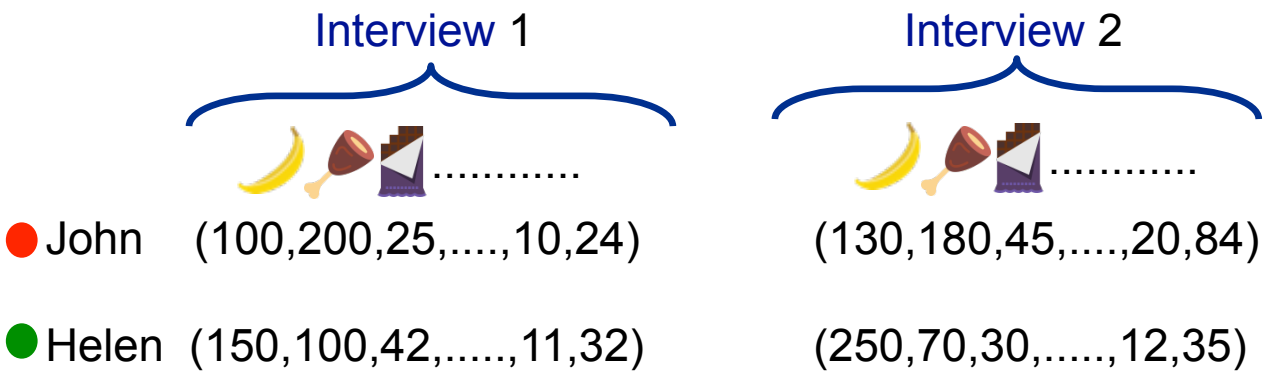
Can we summarize this highly dimensional point cloud into a lower dimensional space, so that we can graph and interprete the data?

Finding principal components: example 3D>2D

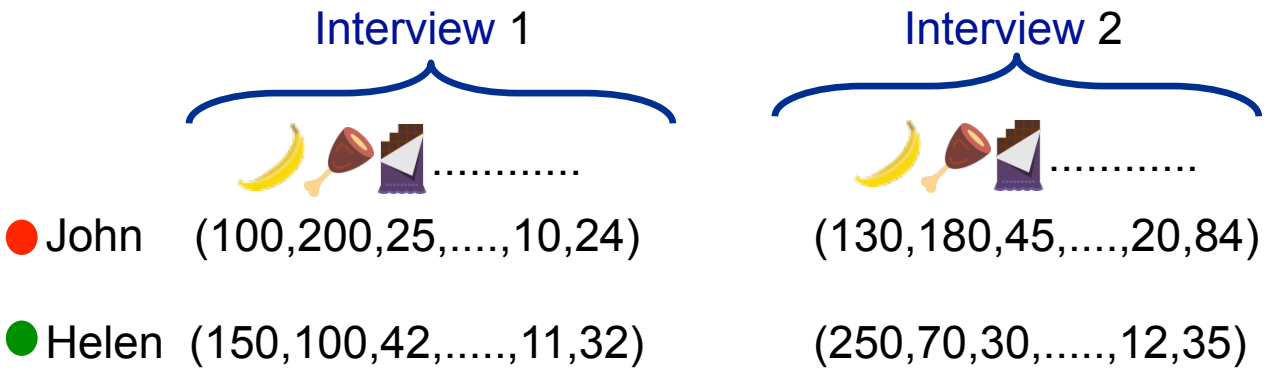
Limits of PCA for our problem

BUT!!! PCA has some limitations!

Here, data is structured in 2 x 24HR, ie, in 2 groups of identical variables that refer to the 2 different interviews.



Limits of PCA for our problem



SOLUTIONS?

✗ **1. Average the values of 1 ind over the 2 24HR?**

We lose the internal structure of each 24HR.

✗ **2. Do a PCA for each observation (1 24HR/1 ind)?**

We lose the info that 2 24HR are from the same person.

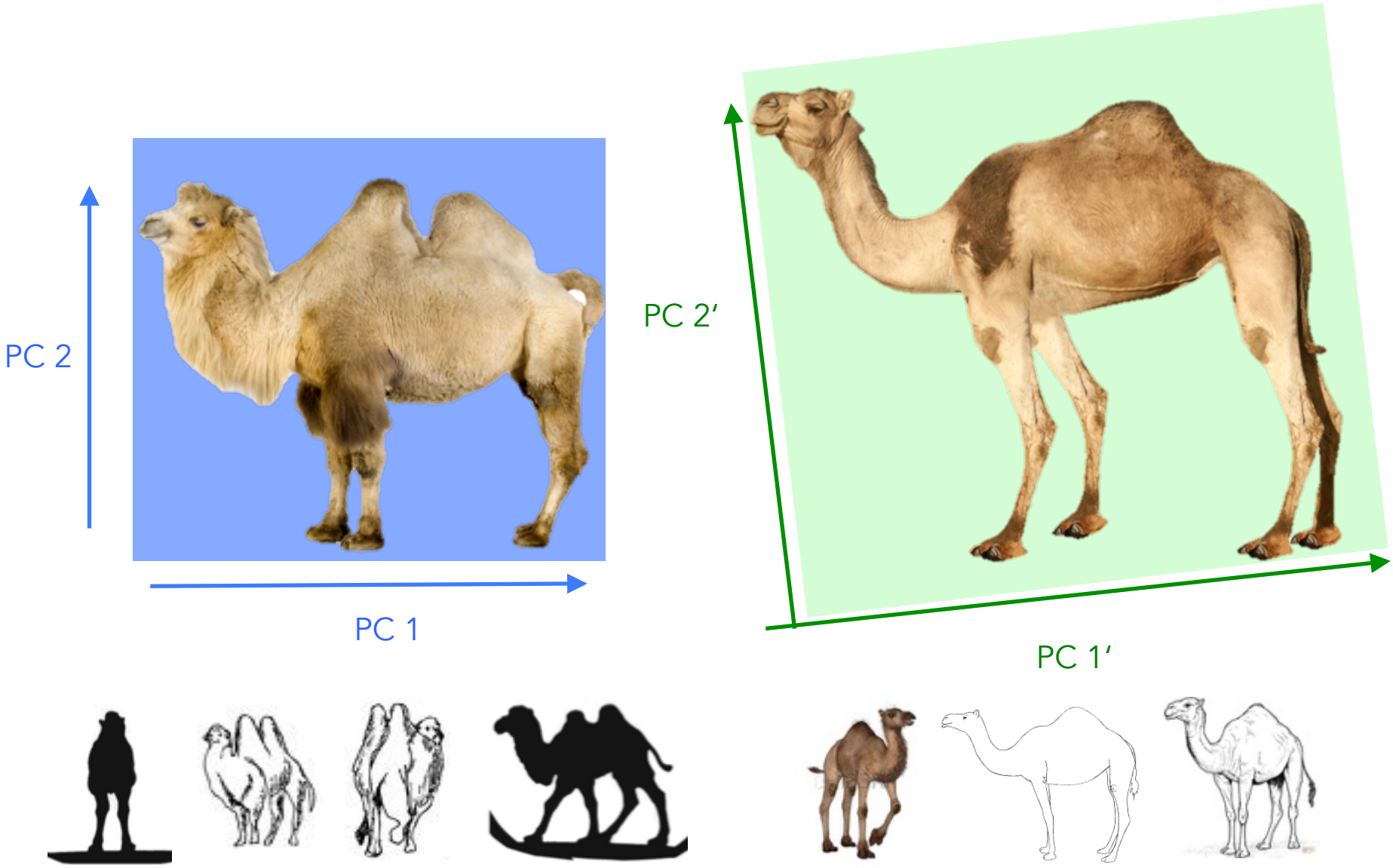
✗ **3. Code the food groups as Fruits_int1 and Fruits_int2?**

We lose the internal structure of each 24HR.

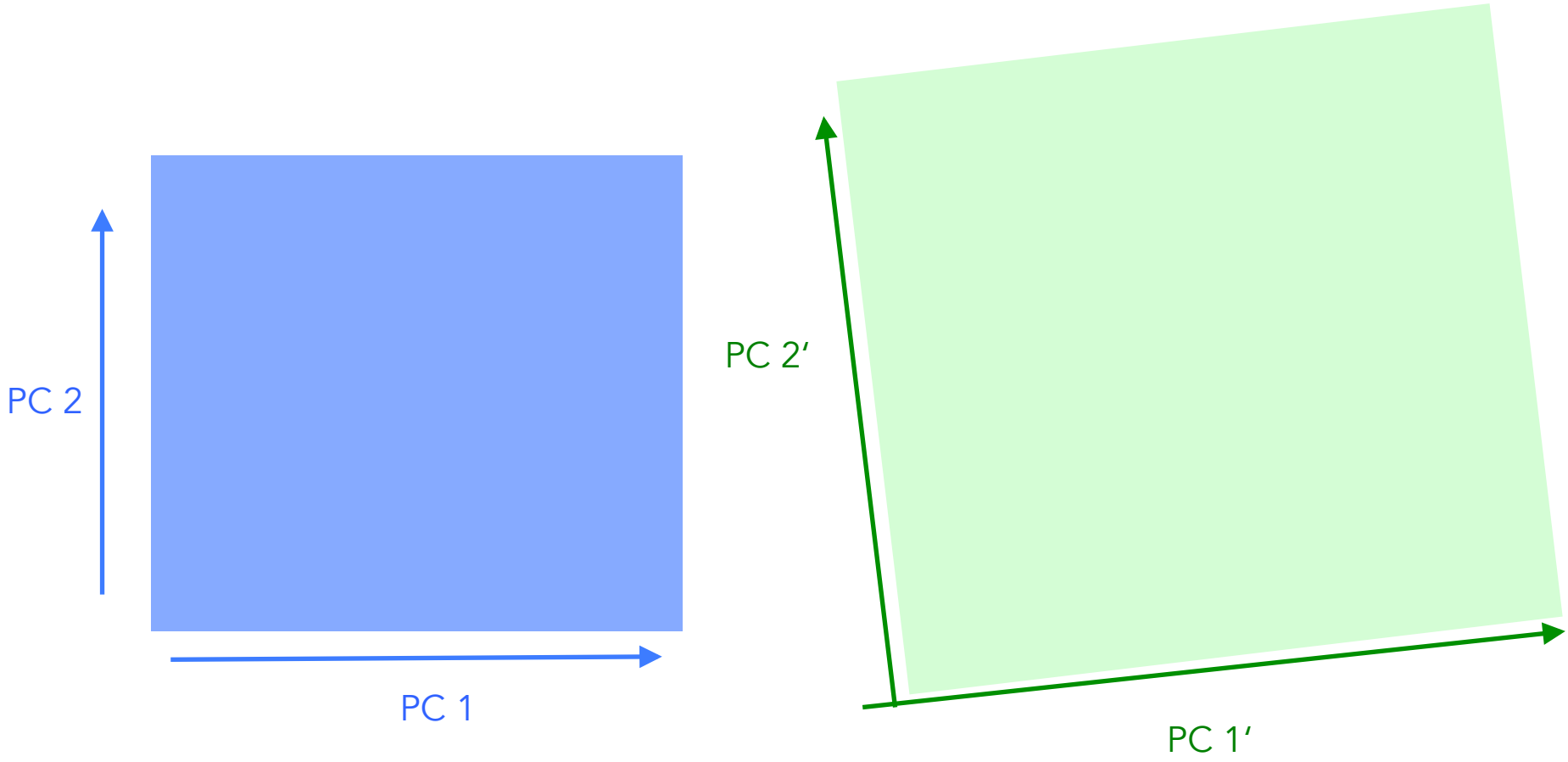
✓ **4. Run PCA on interview 1 and interview 2, „average“ the principal components, and plot ind in the new dimensions.**

=> MULTIPLE FACTORIAL ANALYSIS

Multiple Factorial Analysis: intuition



Multiple Factorial Analysis: new dimensions!



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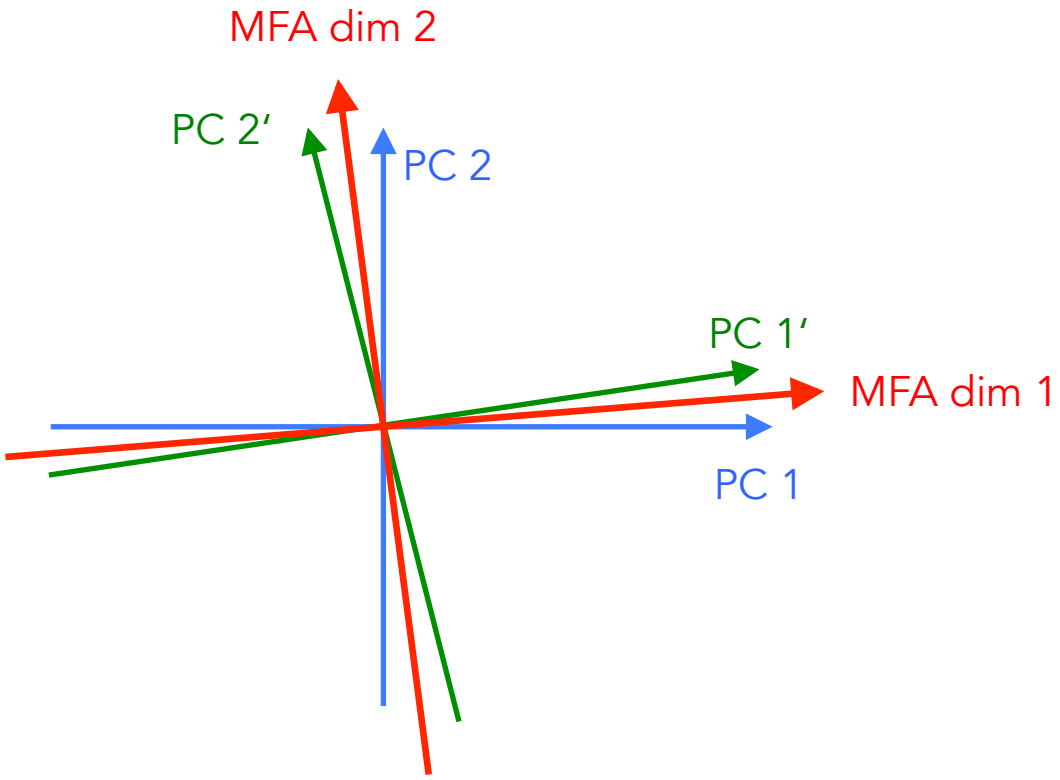
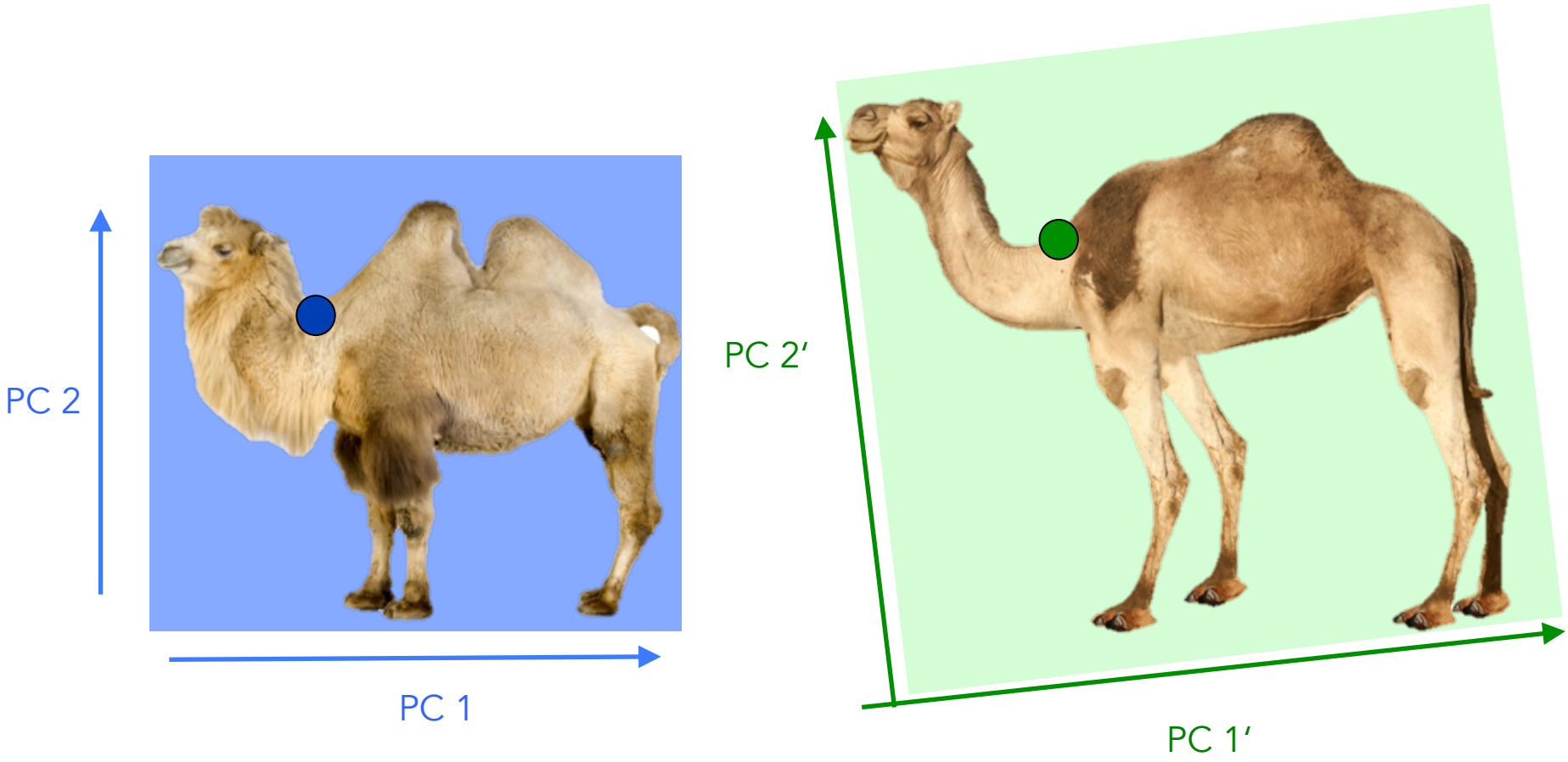
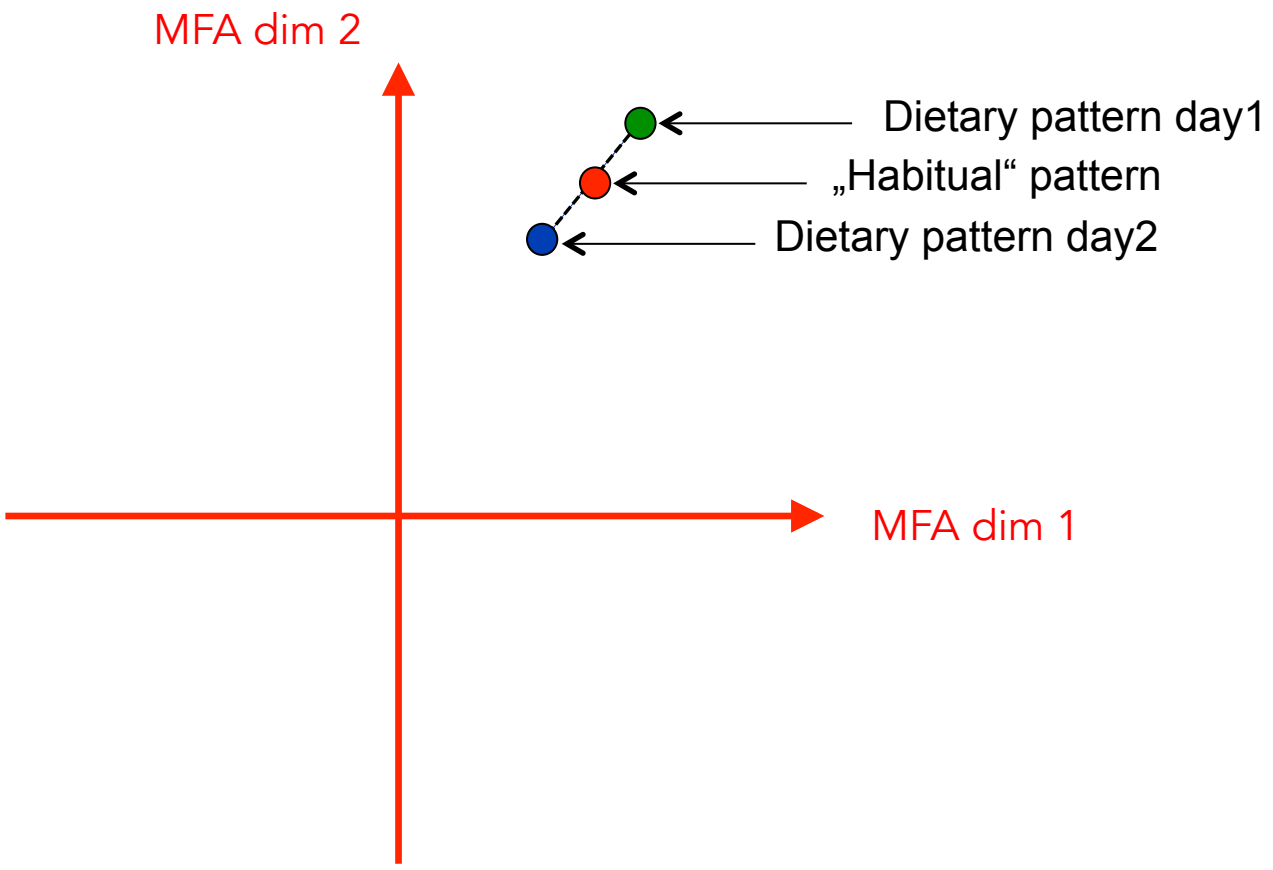


The new principal components show the best representation possible of the two interviews taken together.

Multiple Factorial Analysis: intuition

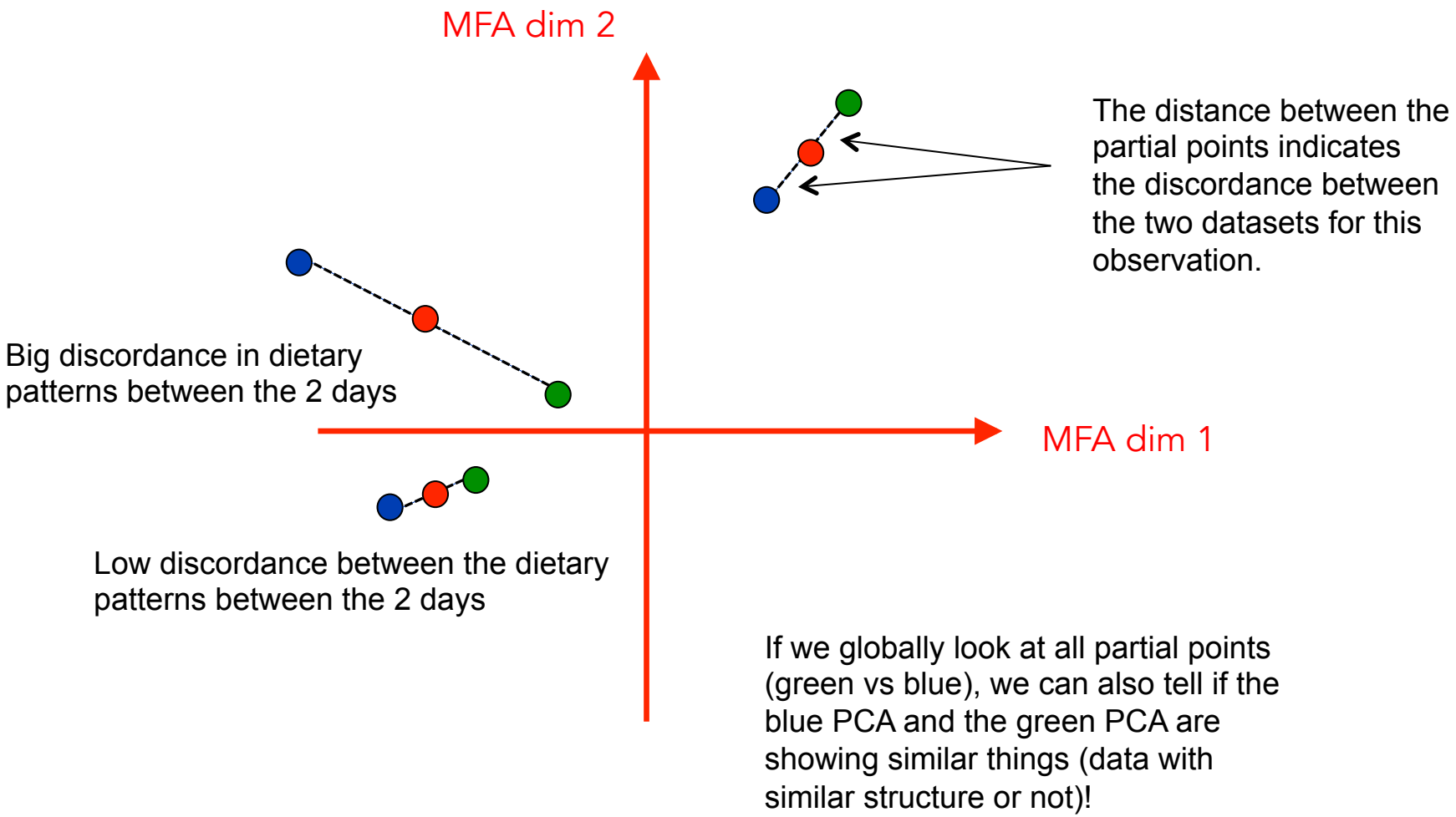


Multiple Factorial Analysis: representing individuals



Each individual is in the middle of the positions that he would have if only one of the two PCA was taken into account.

Multiple Factorial Analysis: other advantages



Multiple Factorial Analysis: summary

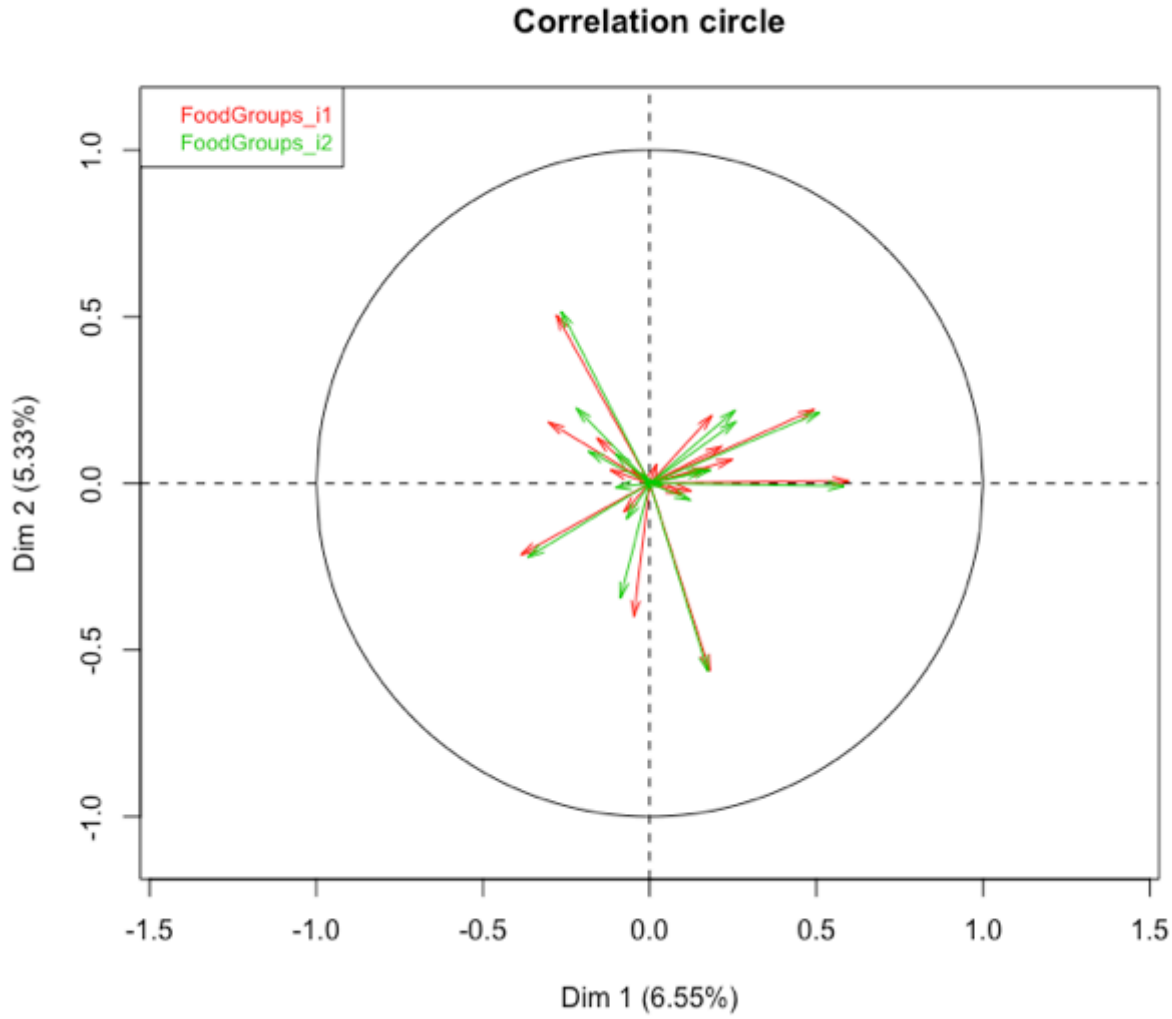
- MFA is applied on food categories in the MenuCH data.
- 2 groups of variables are considered:
  - Food categories related to the 1st interview
  - Food categories related to the 2nd interview
- MFA allows to visualize „habitual“ dietary patterns...
- ...but also indicates discrepancies between the 2 interviews for each individual ...
- ...and also indicates whether the 2 interviews are showing similar things

- Like for other principal component methods, other variables can be used as supplementary variables: subcategories, nutrients, demographics, morphology, data from the dietary and physical activity questionnaire...

Preliminary results: Dietary patterns in the Swiss population

Q1: Do interviews 1 and 2 similarly represent people‘s nutrition (globally)?

MFA similarly represents the components of interviews 1 and 2



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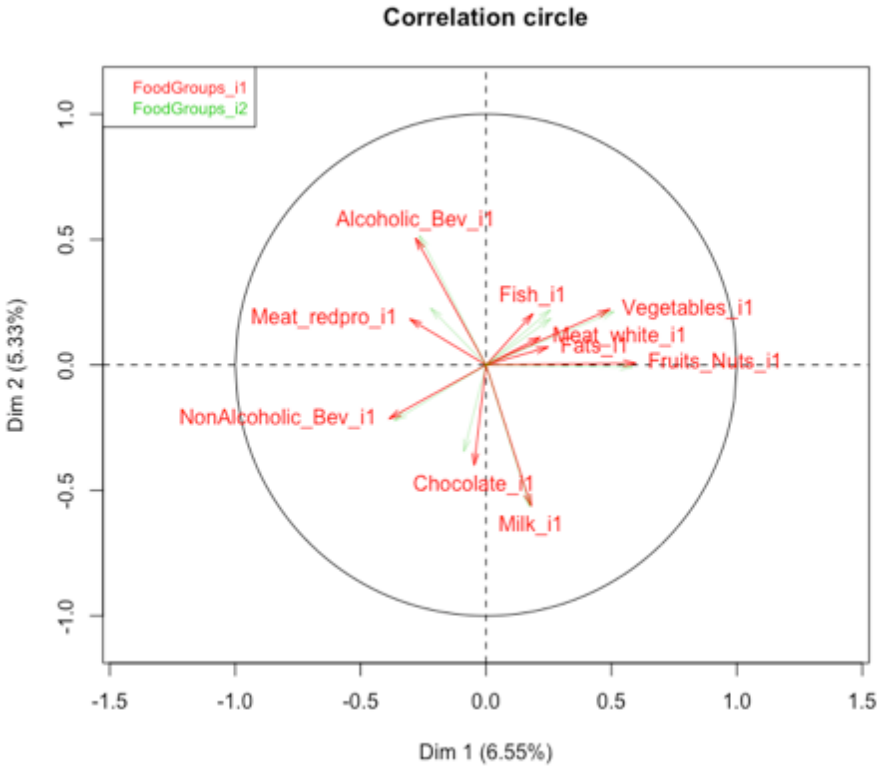
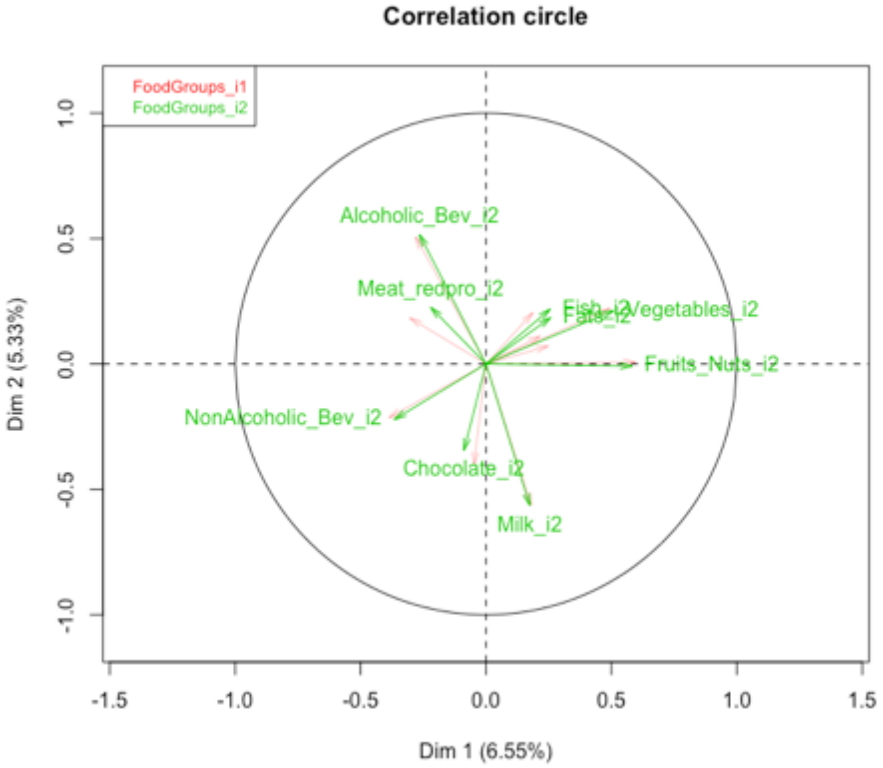
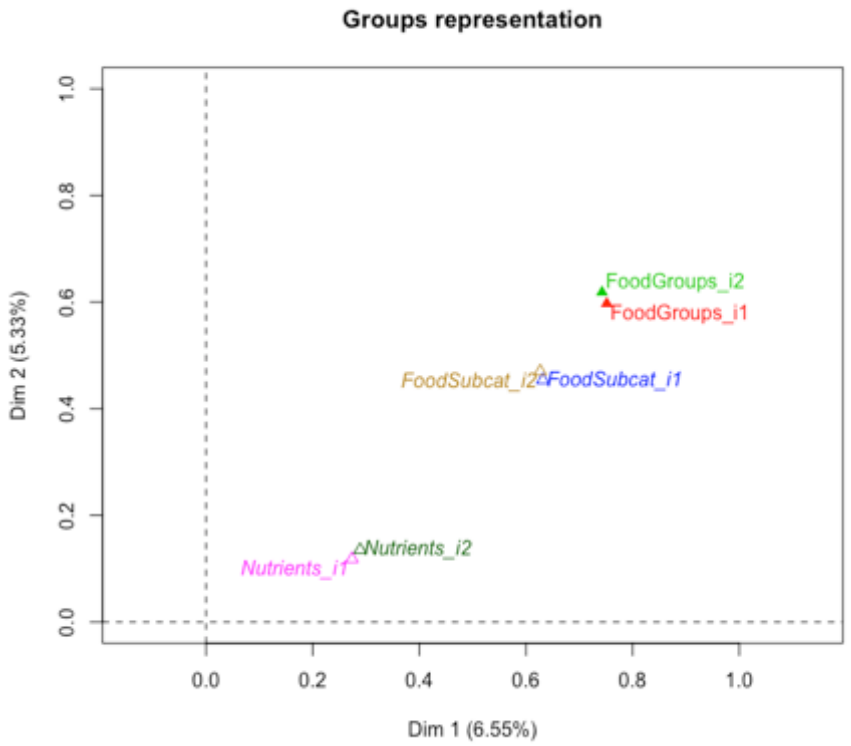
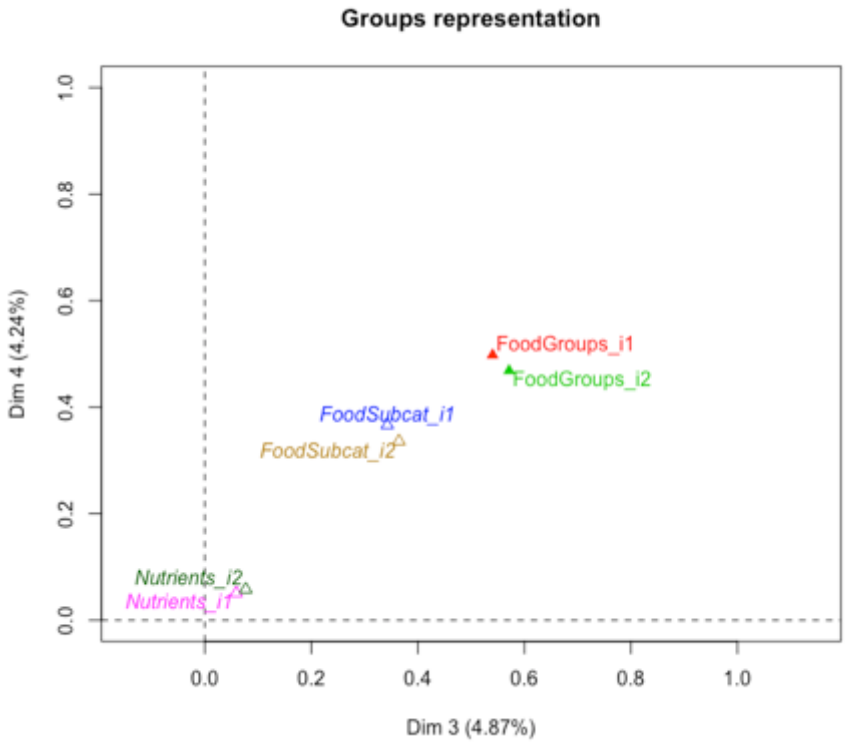




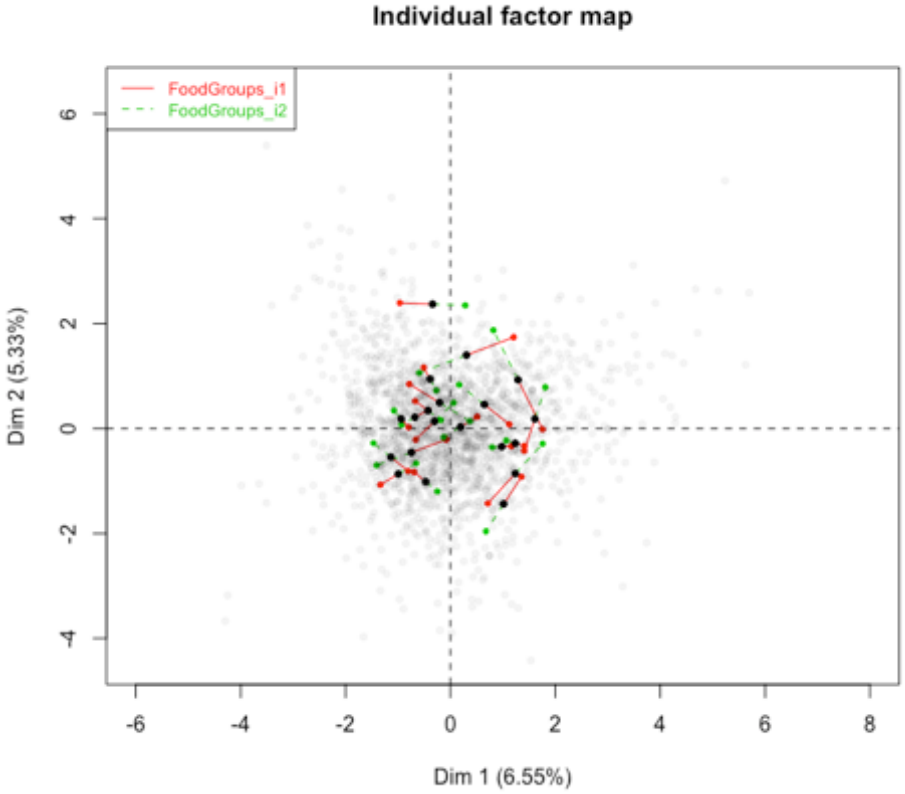
Data from interviews 1 and 2 show a high degree of agreement

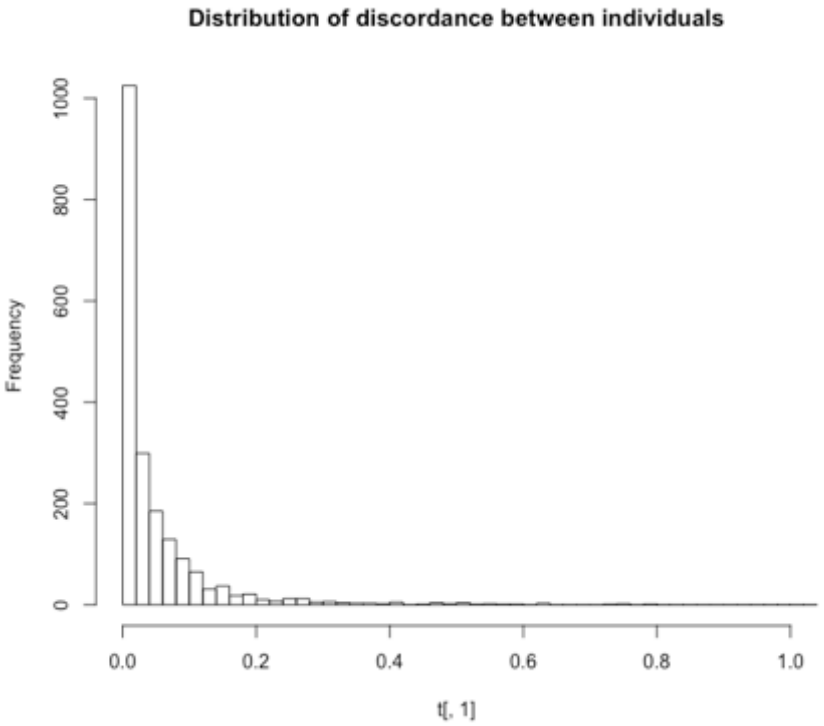




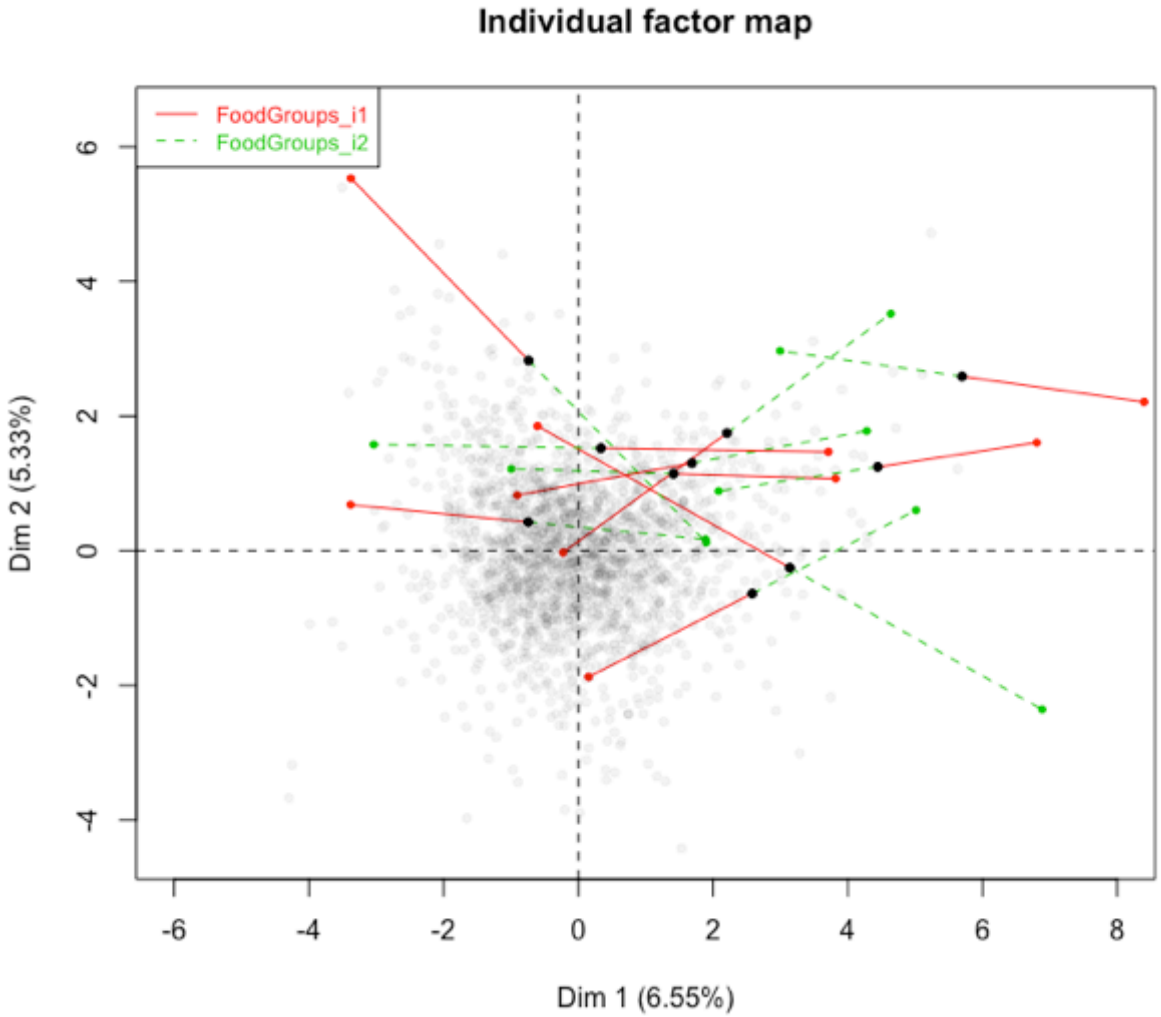
Q2: Individually, do people eat similarly between the 2 interviews?

Most of the individuals have a moderate discordance between the 2 recalls...



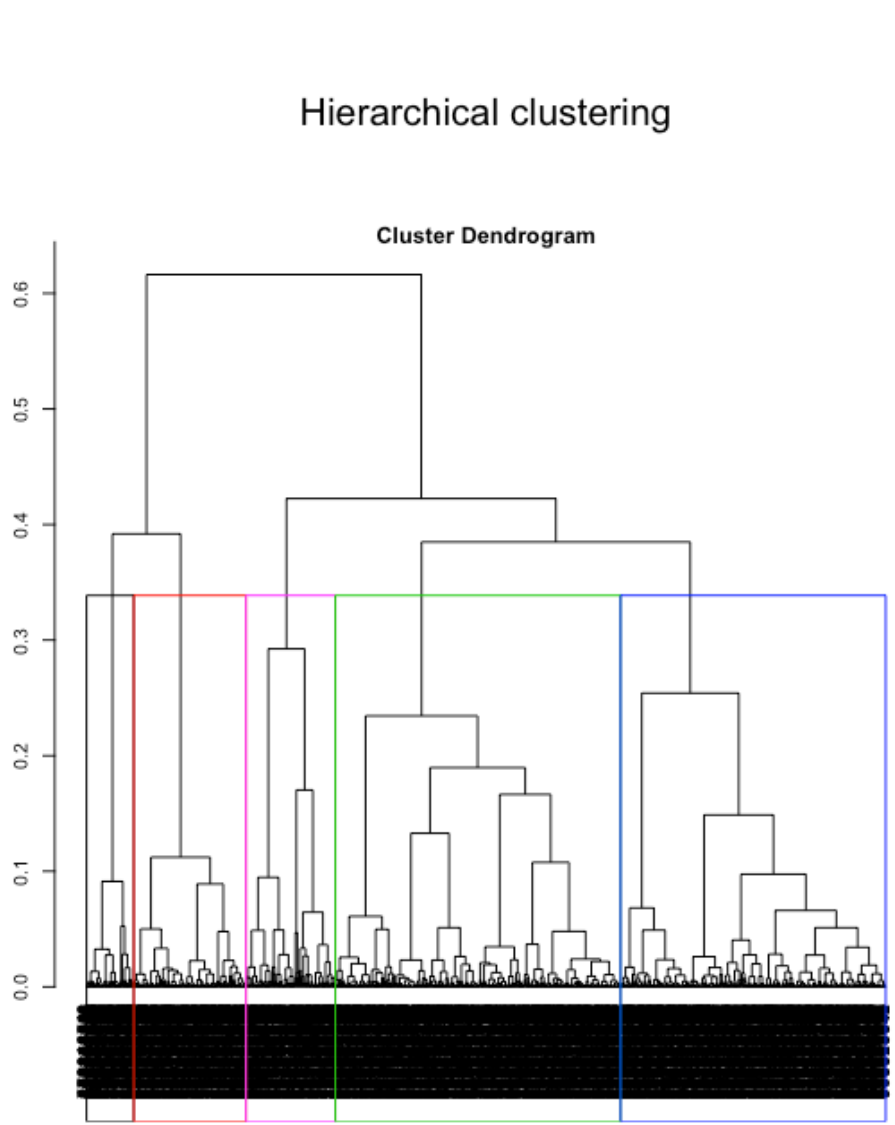


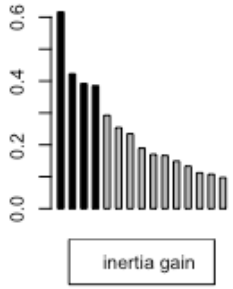
... But certain individuals have a high discordance between the 2 recalls



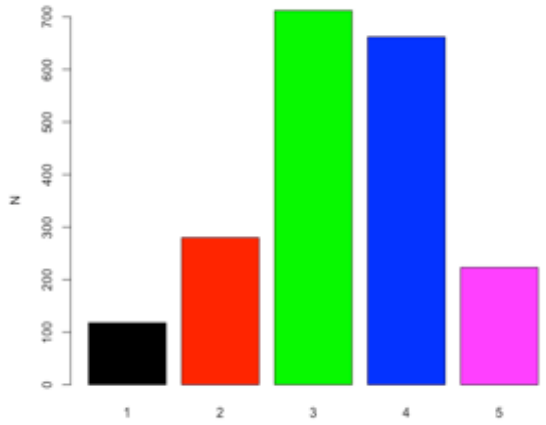
Q3: How many and which dietary patterns can we see?

Clustering results

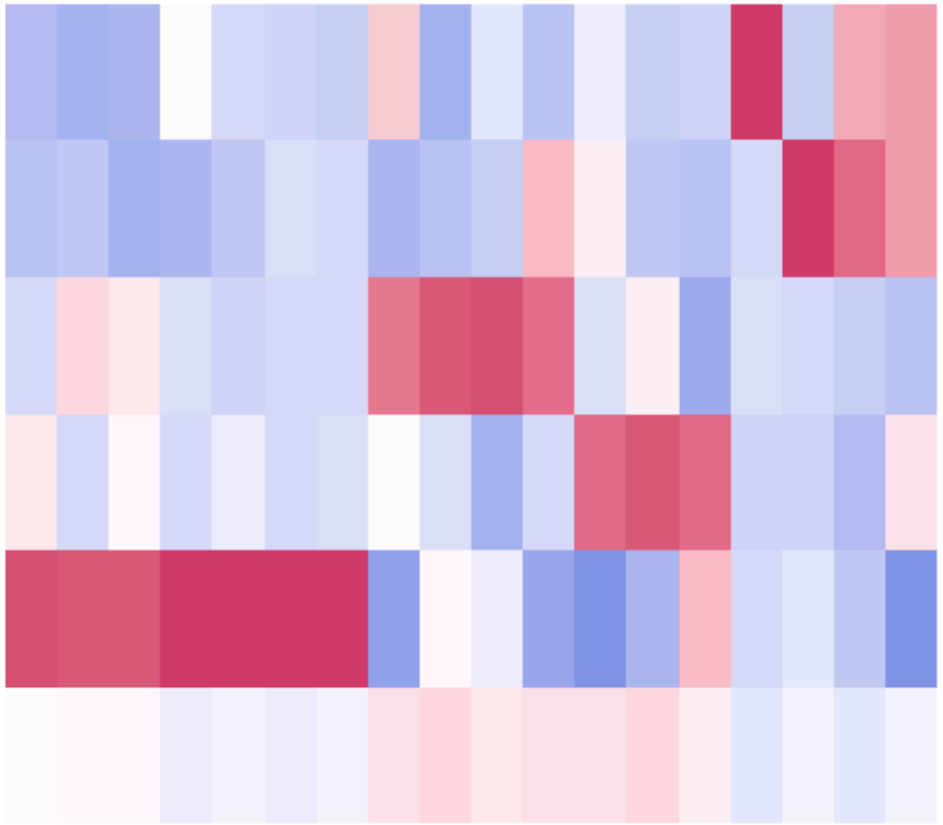




Number of participants / cluster



Cluster characterization



1 Monotonous, soft drinks, cakes, red-processed meat, low fiber

2 Monotonous, alcohol, red-processed meat, low fiber, some convenience food

3 High milk and dairy, convenience food and snacks

4 High energy-dense foods (starchy, chocolate, added fats)

5 Fruits and vegetables, eggs, low energy-energy foods, some added fats (cooking?)

ALL

Vegetables_i2
Soups_i2
Fruits_Nuts_i2
Meat_white_i2
Fish_i2
Miscellaneous_i2
Eggs_i2
Cakes_i2
Milk_i2
Savoury_snacks_i2
Receipe_i2
Cereals_Starchy_i2
Chocolate_i2
Fats_i2
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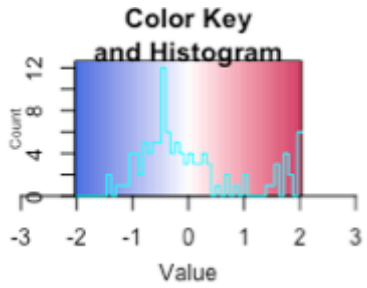
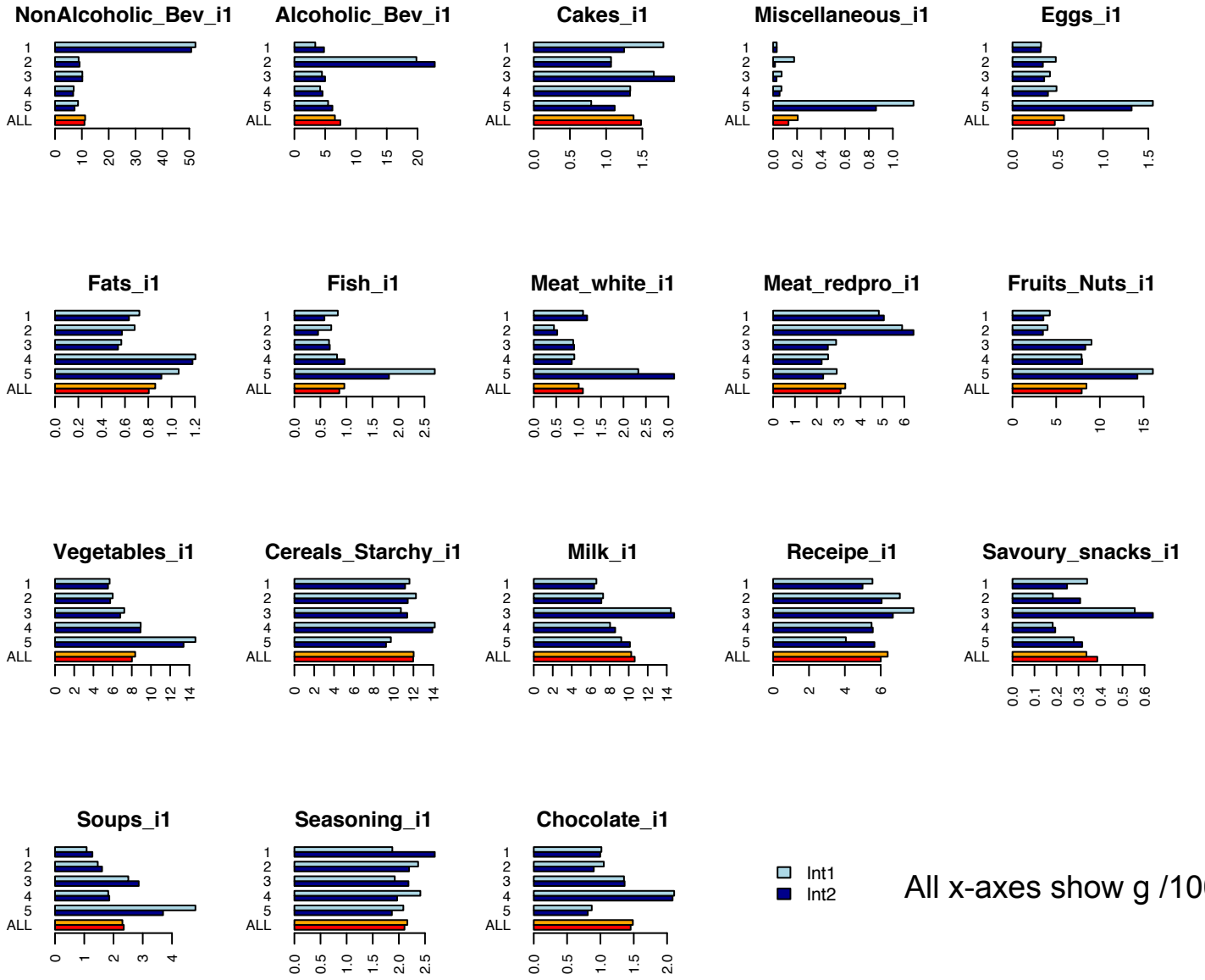
Meat_redpro_i2
Seasoning_i2

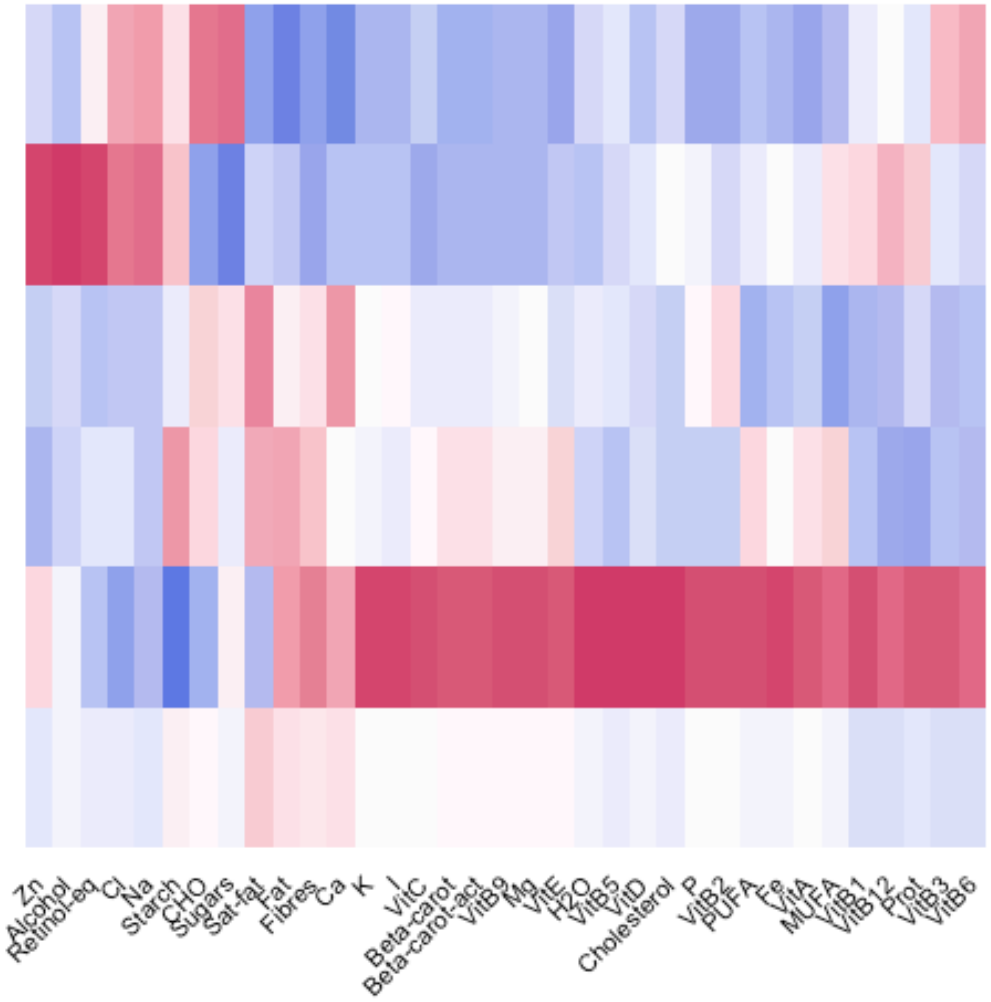


Cluster characterization



All x-axes show g /100 kcal

Cluster characterization > NUTRIENTS



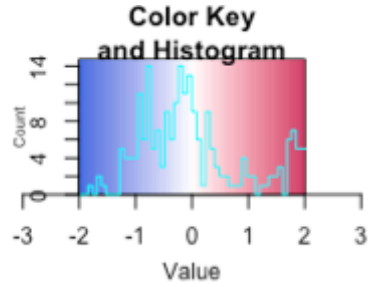
Monotonous, soft drinks, cakes, red-processed meat, low fiber

Monotonous, alcohol, red-processed meat, low fiber, some convenience food

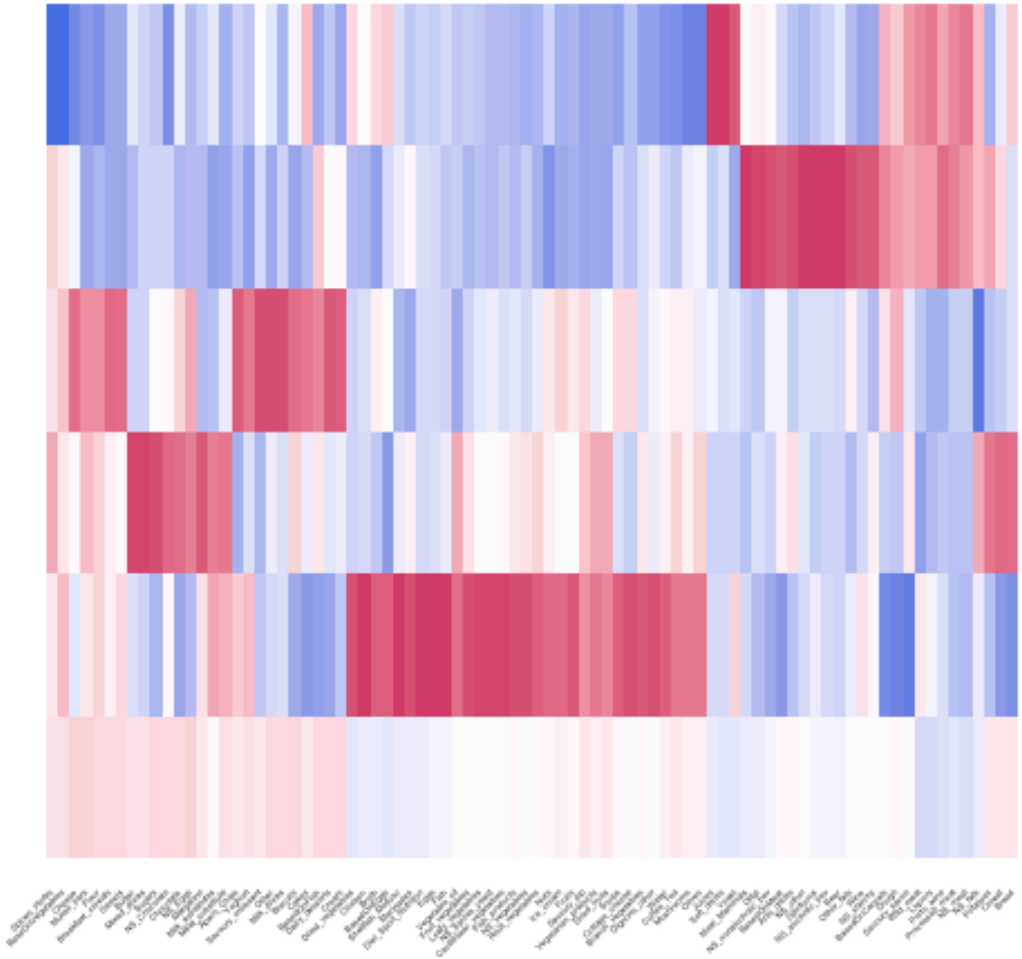
Average with high milk and dairy, and some convenience food

Average with high energy foods (starchy, chocolate, added fats)

Fruits and vegetables, eggs, low high-energy foods, some added fats (cooking?)



Cluster characterization > SUBCATEGORIES



1 Monotonous, soft drinks, cakes, red-processed meat, low fiber

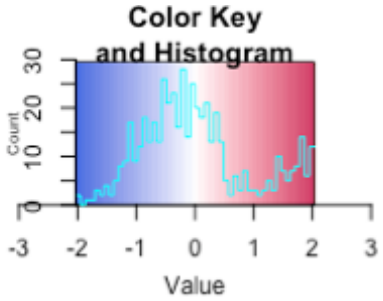
2 Monotonous, alcohol, red-processed meat, low fiber, some convenience food

3 Average with high milk and dairy, and some convenience food

4 Average with high energy foods (starchy, chocolate, added fats)

5 Fruits and vegetables, eggs, low high-energy foods, some added fats (cooking?)

ALL



Summary

- To analyze the MenuCH nutrition data, we need to go beyond PCA.

- For this, we used Multiple Factorial Analysis, followed by clusterization.

- We identified 5 dietary patterns (2 monotonous, 2 average, 1 healthy).

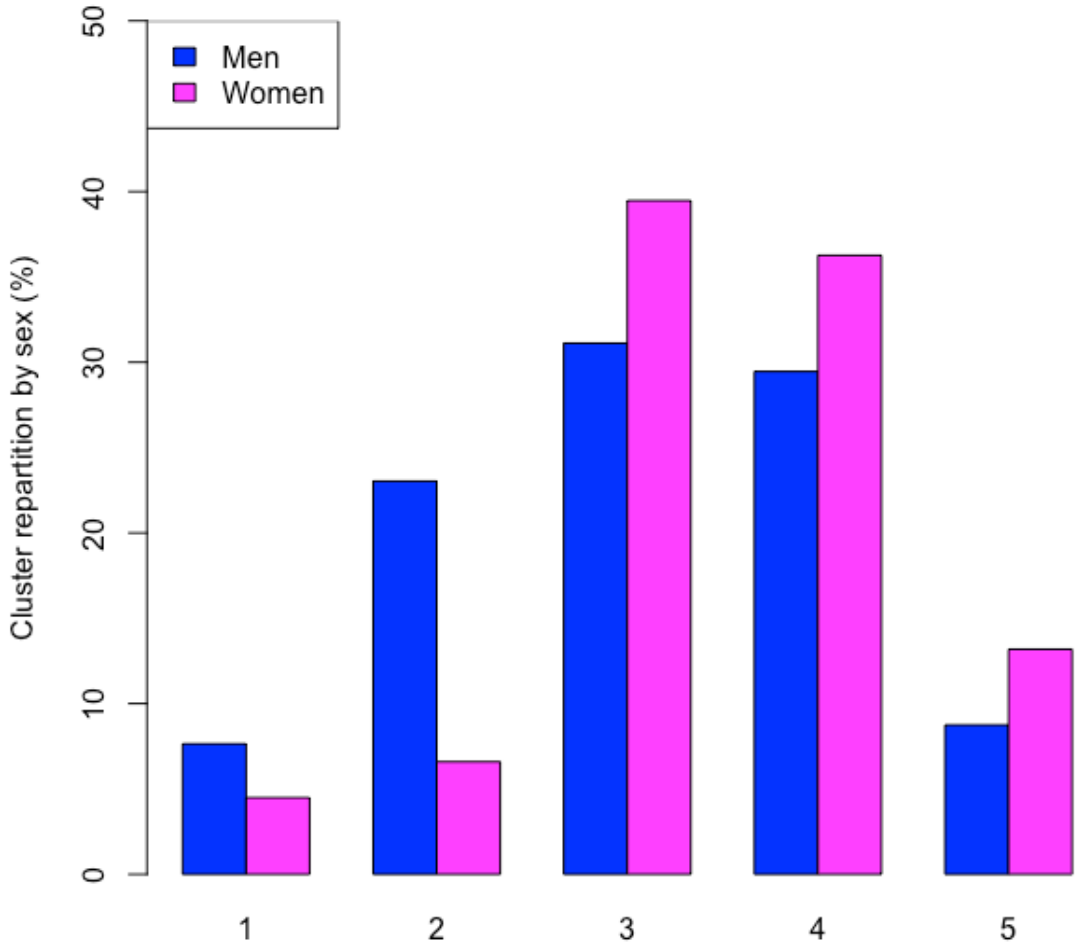
- These dietary patterns also strongly cluster with nutrient intakes.

To go further

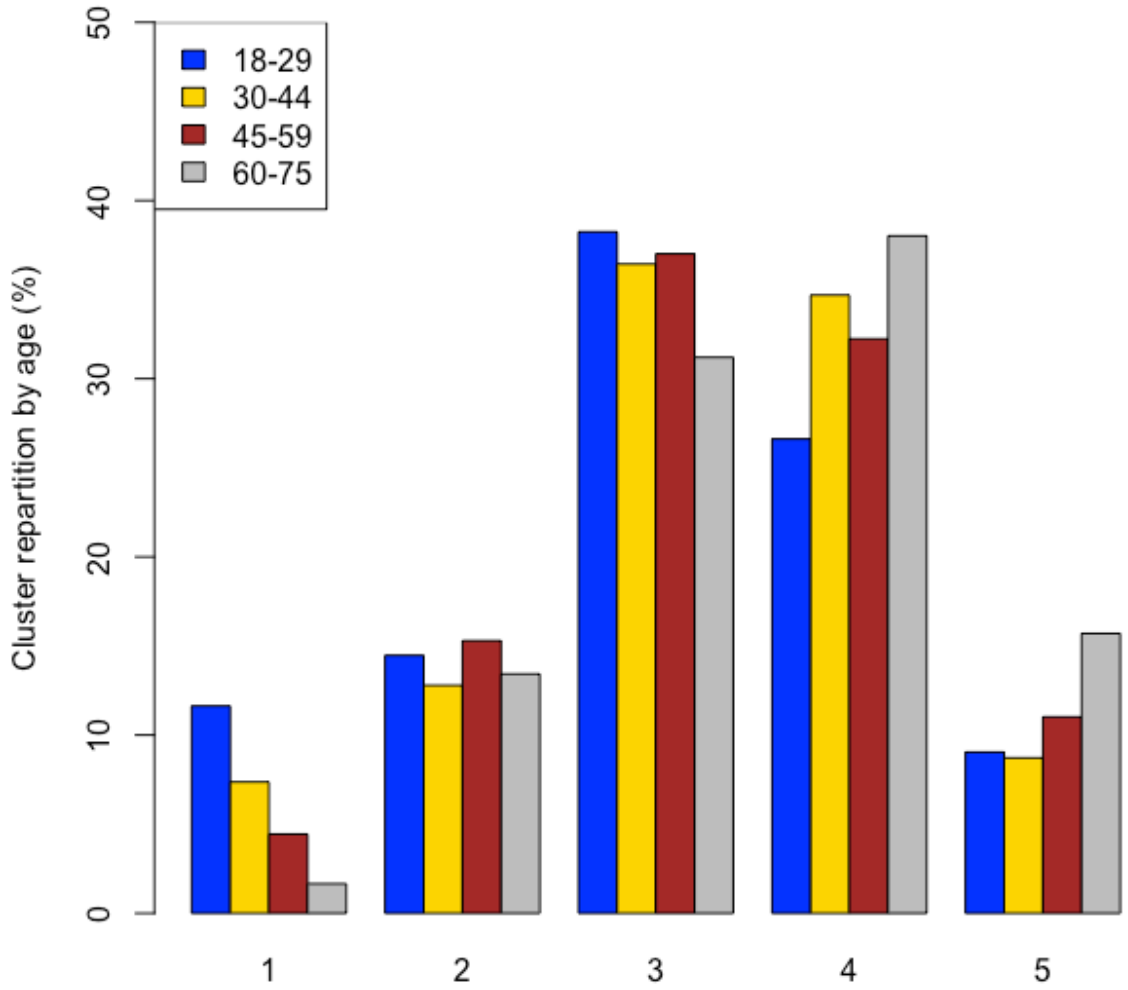
- Characterize the participants (demographics, lifestyle, ...) by dietary patterns

- Geographic repartition of the dietary patterns

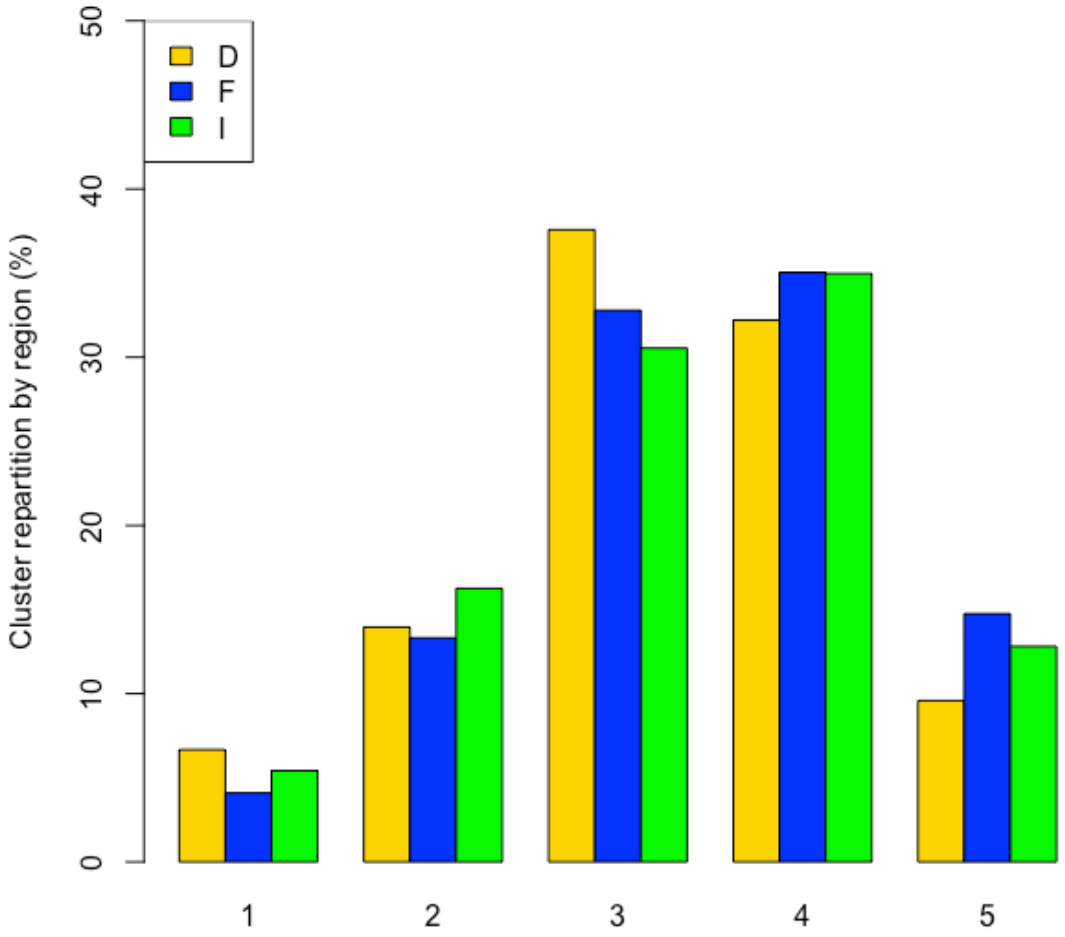
The 5 dietary patterns by sex



The 5 dietary patterns by age group



The 5 dietary patterns by language region



The 5 dietary patterns by canton