

# Dietary Minimum Days Estimation

Bachelor Project

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**Objective :** Identify the minimum number of days needed to achieve a reliable estimate of weekly nutritional intake

- **Weekly** = days from Monday to Sunday consecutive in time
- **Why weekly estimation ?**
  - Best compromise losing data / to short period
  - For data standardization, facilitate comparison between subject
  - Better understanding type of days impact (working-day/weekend)
  - Avoid bias related to type of days variation
  - Consecutive in time = more accurate reflection of usual dietary habits
- ➔ **Only keep subject with full and consecutive in time week**  
(if multiple full week ➔ average = representation of single week)

# The data used for the analysis

- 453 different subjects
- 37 nutritional features
- Intake in gram for each day and feature

How many days needed to reliably estimate weekly consumption for each feature/ food category

← 37 Nutritional features [g] →

	Week_day	Nutritional_feature_1 [gram]	....	Nutritional_feature_37 [gram]
7 day / subject ↑	Subject_1	Monday	Qty feature 1 in grams eaten on Monday	....
	Subject_1	Tuesday	....	....
	Subject_1	Wednesday	....	....
	....	....	....	....
	Subject_453	Saturday	....	....
	Subject_453	Sunday	....	....

## Nutritional features (n = 37)

- Quantity in grams
- Energy kcal
- Energy kJ
- Salt
- Sugar

- Carbs
- Fat
- Protein
- Fiber
- Alcohol

Macronutrients (n = 5)

- Beta carotene
- Calcium
- Cholesterol
- Fatty acids monounsaturated
- Fatty acids polyunsaturated
- Fatty acids saturated
- Folate
- Iron
- Magnesium
- Niacin
- Pantothenic acid
- Phosphorus
- Potassium
- Sodium
- Vitamin B1
- Vitamin B12
- Vitamin B2
- Vitamin B6
- Vitamin C
- Vitamin D
- Zinc

Micronutrients (n = 21)

- Dairy products, meat, fish, eggs, tofu
- Vegetables, fruits
- Sweets, salty snacks, alcohol
- Non-alcoholic beverages
- Grains, potatoes, pulses
- Oils, fats, nuts

Food types (n = 6)

# How we assess the reliability of the estimation ?

Compare data over 1,2,3...6 days with data over the whole week (approach reference using minimum data) in terms of 2 metrics:

- Mean intake over days
- Within-subject standard deviation (W-std) in intake between days.

## **Statistic method to compare :** Intraclass Correlation Coefficient (ICC)

- Quantify estimation reliability
- Calculates the ratio of between-subject variance to total variance → Score between [0;1]
- Gives us idea of how representative combination of “n” days is to the whole week in terms of mean intake and W-std

# Exemple

X\_1 = mean (or W-std in) protein intake Monday-Tuesday for subject 1

Y\_1 = mean (or W-std in) protein intake whole week for subject 1

	Protein_eaten_Mon_Tue	Protein_eaten_week
Subject_1	X_1	Y_1
...	...	...
Subject_N	X_N	Y_N

$$ICC_{3A} = \frac{\sigma_{bs}^2}{\sigma_{bs}^2 + \theta_m^2 + \sigma_{ws}^2}$$

$\sigma_{bs}^2$  : variance between subjects.

$\theta_m^2$  : variance between measurements.

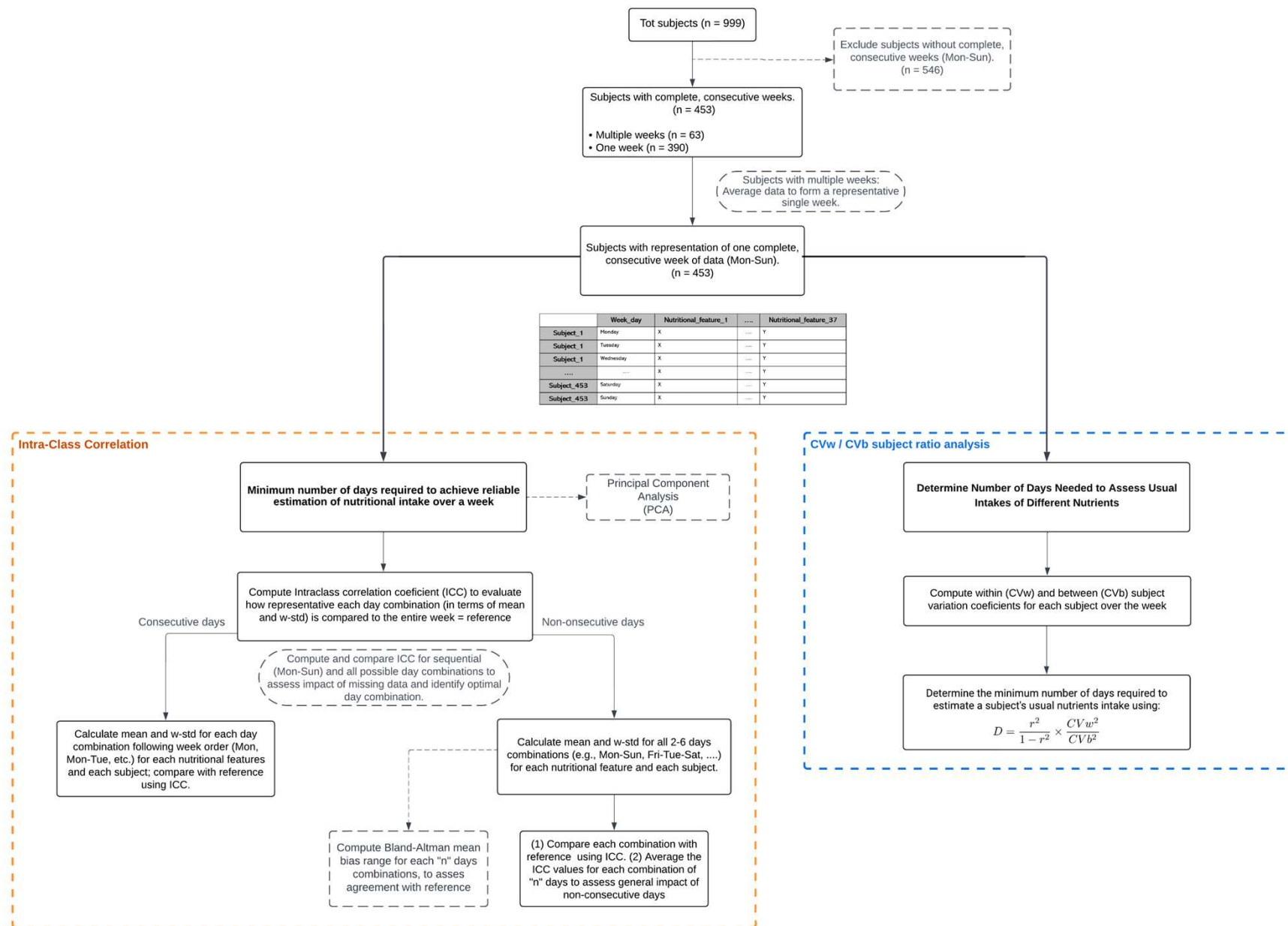
$\sigma_r^2$  : residual error variance.

**Is Mon-Tue globally a good representation of the whole week in terms of mean and W-std?**

- ICC > 0.6 : «good» reliability
- ICC > 0.8 : «very good» reliability

# Analysis

- ICC (in terms of mean and W-std) computed for **all feature, all possible day combinations**
  - Determine the minimum number of days, and specific combinations, required to reliably estimate weekly nutritional intake
  - What is the optimal combination of days strategy ?  
Sampling of consecutive days / non-consecutive days.... ?
- Additional analysis
  - Linear Mixed Model (LMM) : general trends in consumption and daily intake variations
  - PCA : which days of the week contribute the most to within subject variance
  - analysis, based on the ratio between intra-subject and inter-subject variance



# Linear Mixed Model

**Random effect :**

- Subject

**Categorical fixed effect :**

- Age group, Gender ,BMI, Week days

**Intercept :** Monday avg intake

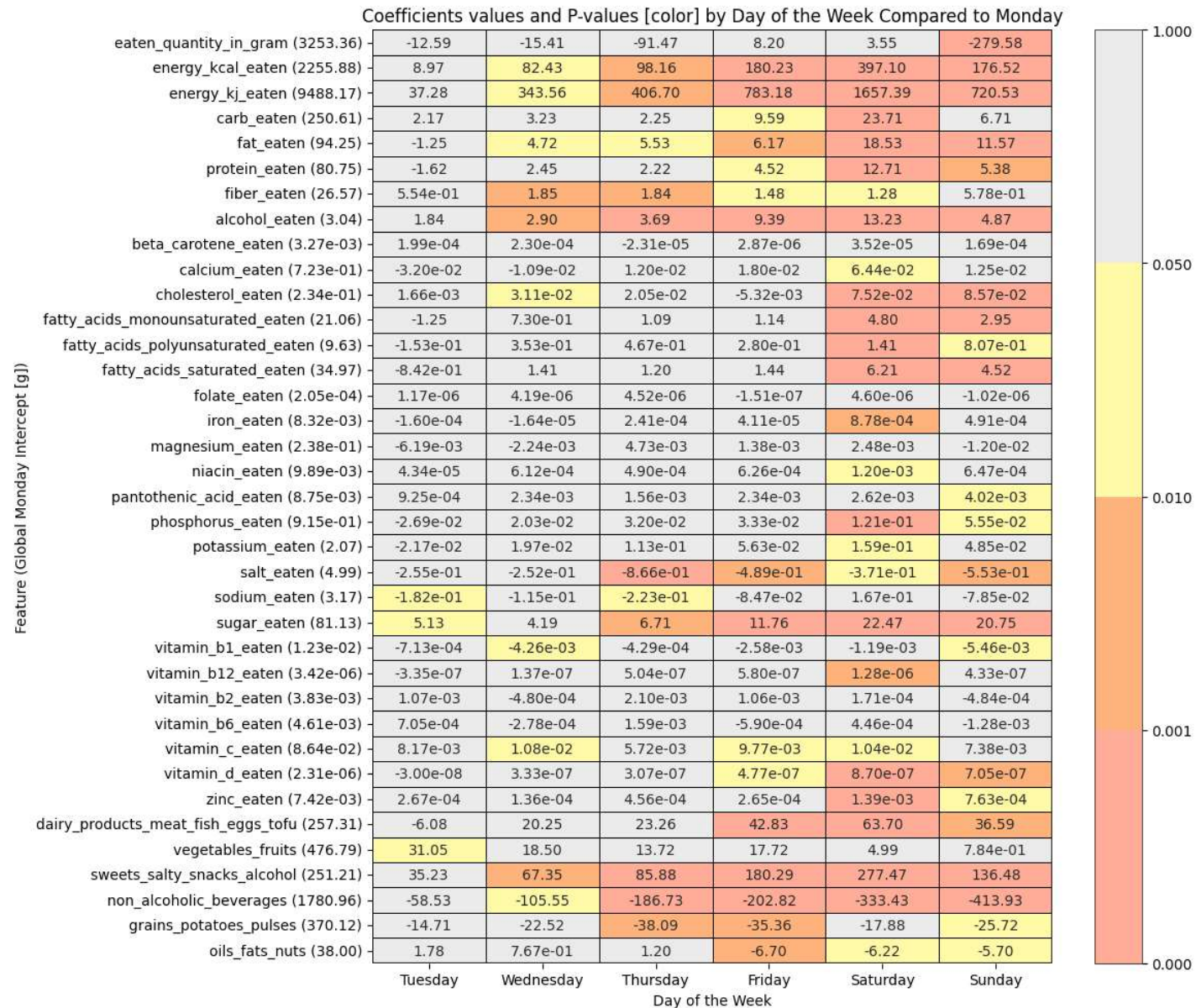
**Values :** coefficient of each days

**P-value test :** Null hypothesis coef = 0

Monday to Thursday : similar trends

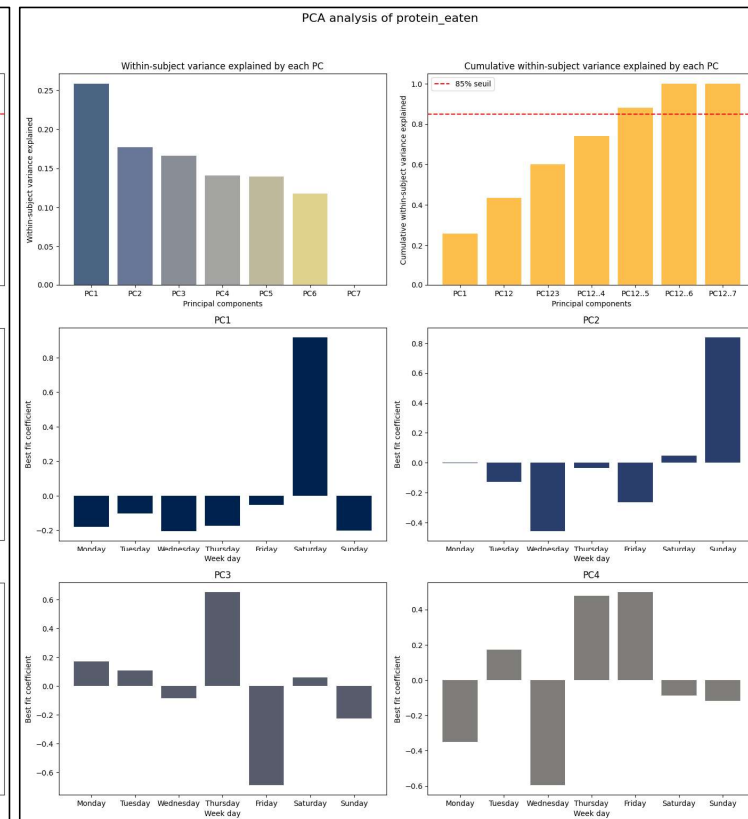
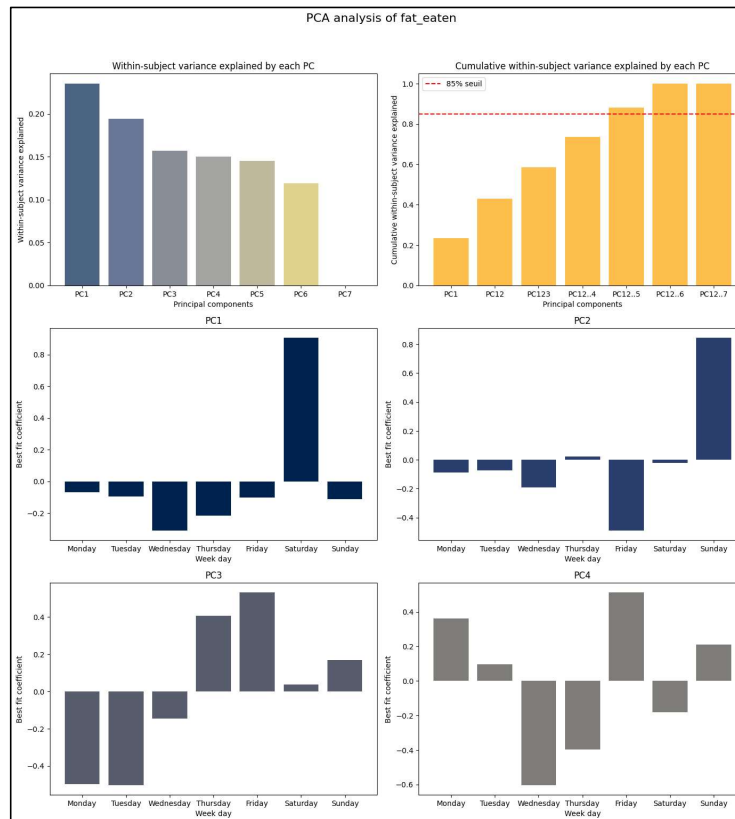
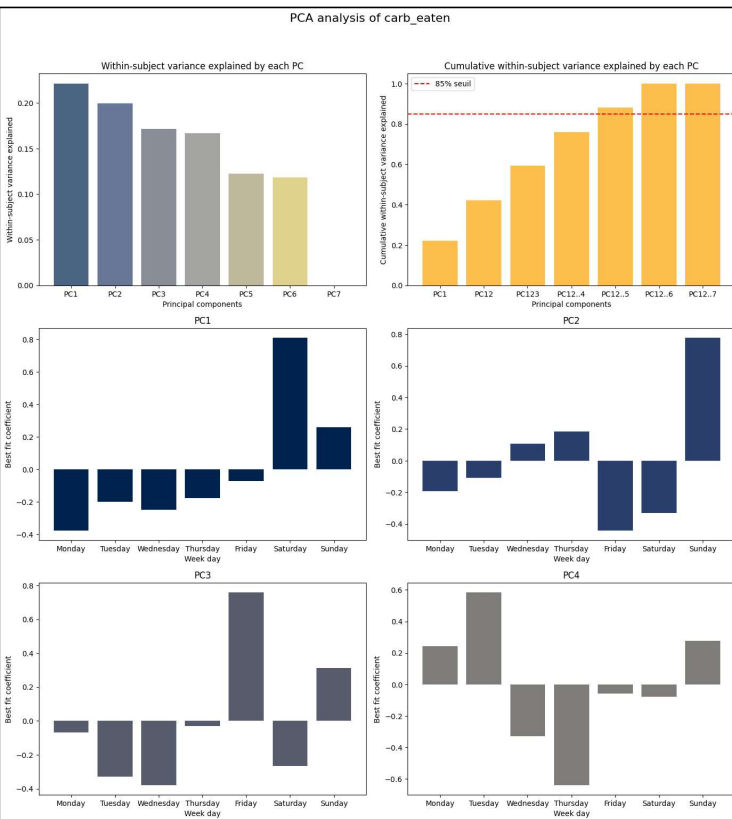
Weekend : more singular

→ Festive/leisure beahviour





# Principal Component Analysis

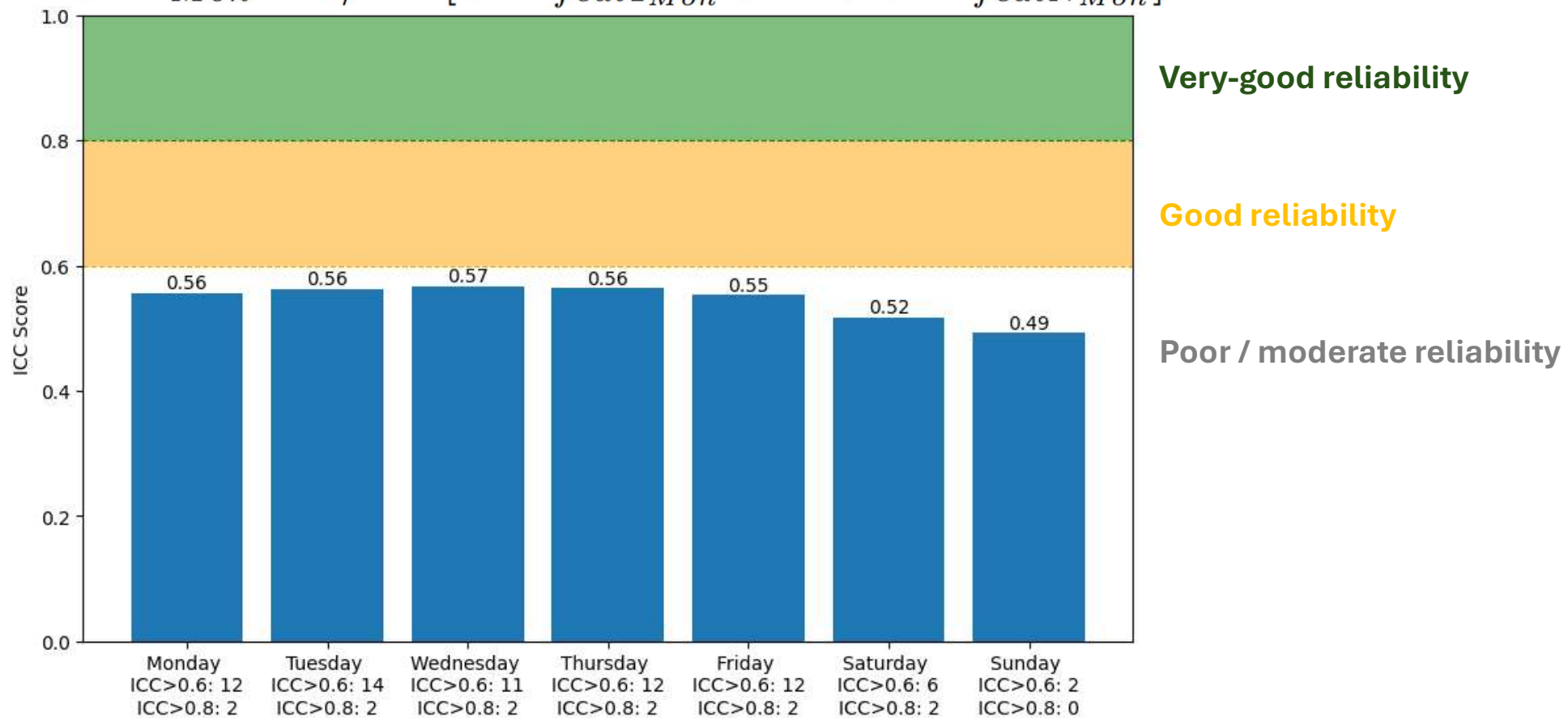


- PC1 = Linear combination of the week day, explaining most of the variance
- Within subject variance mainly comes from weekend
- Saturday is the main source of within-subject variance

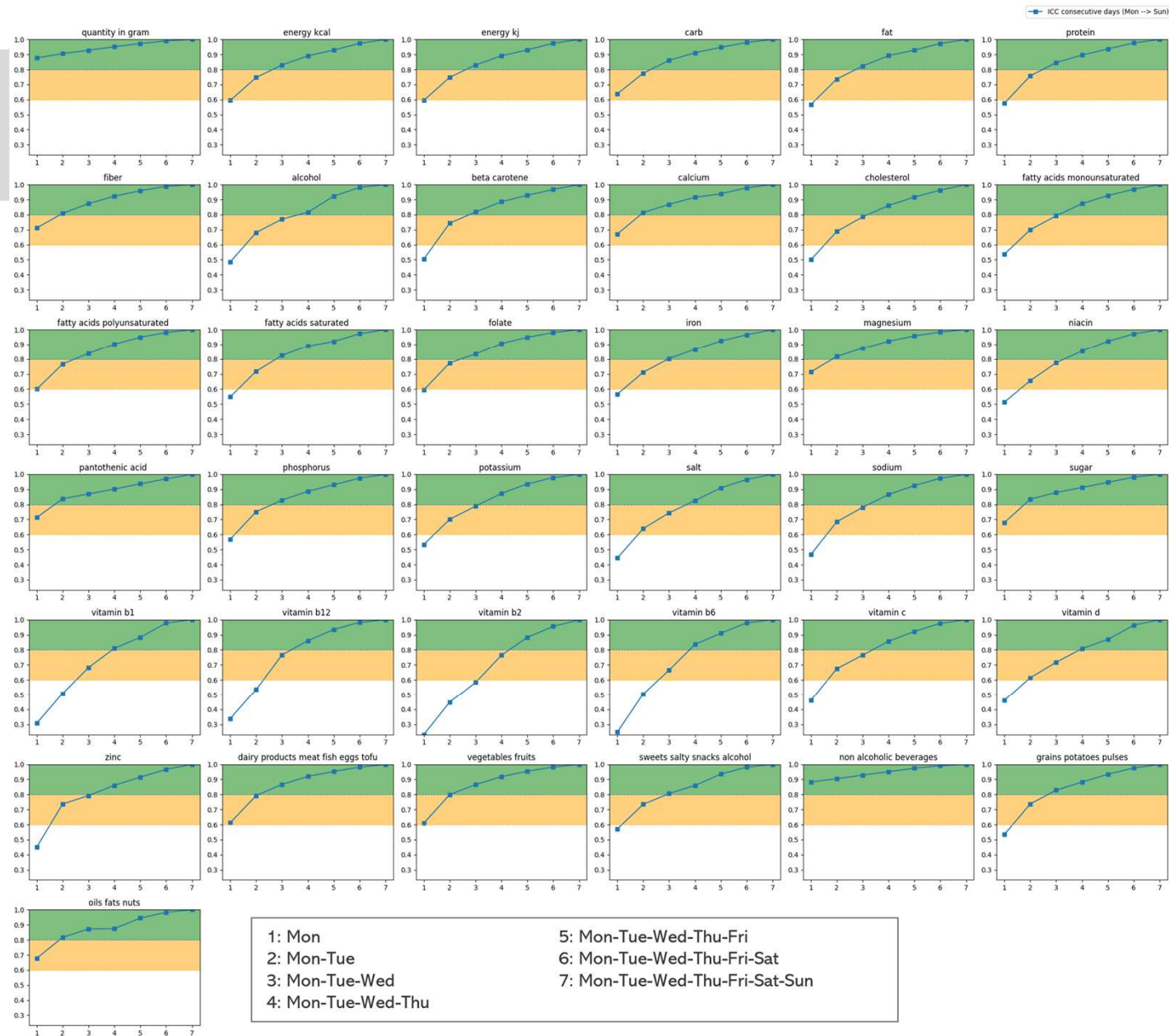
# ICC (mean) Single Day

- Mon to Thu days (alone) more representative of the whole week in terms of average intake than weekends

$$ICC_{Mon} = 1/n \times [ICC_{feat1_{Mon}} + \dots + ICC_{featN_{Mon}}]$$

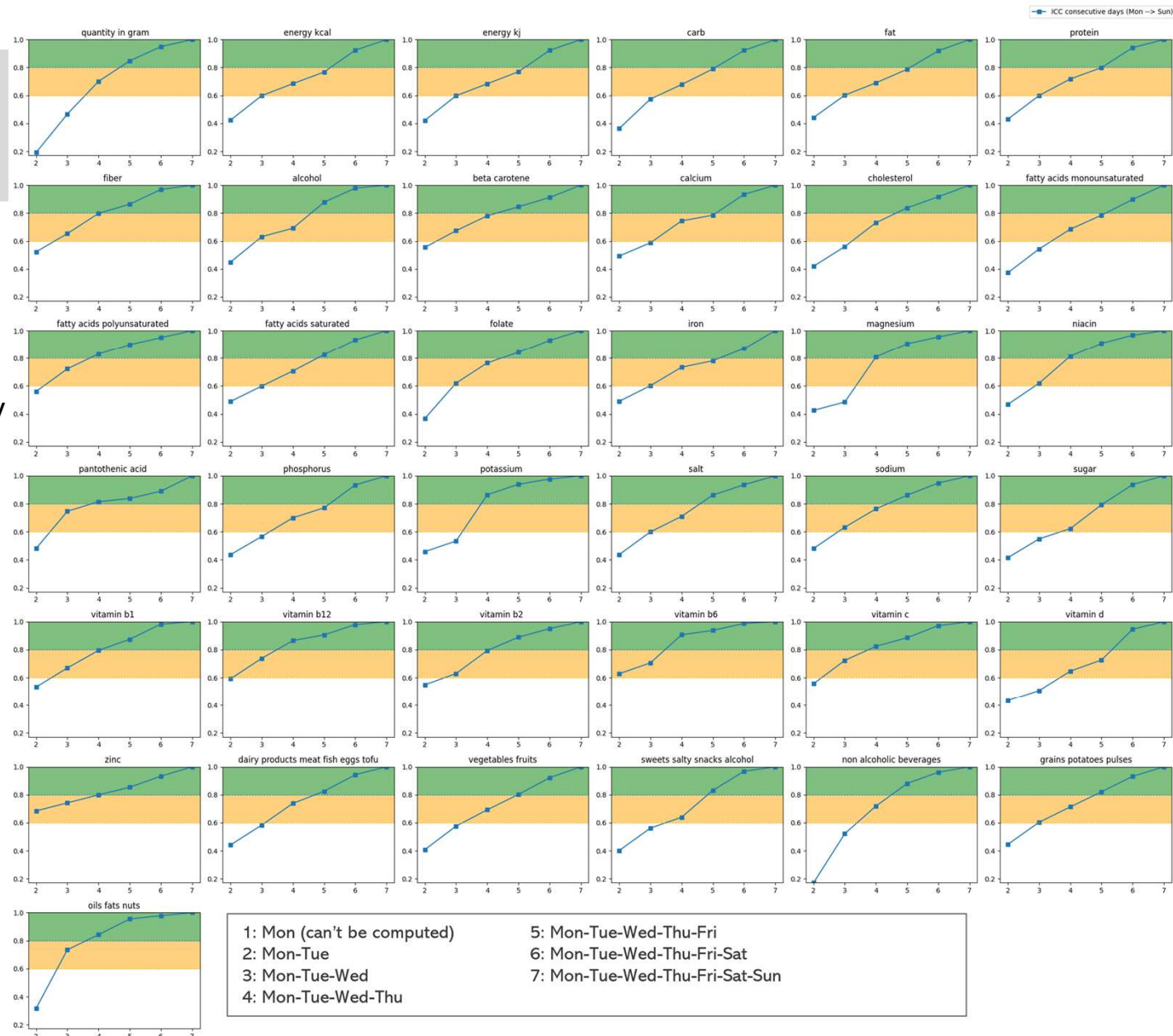


# ICC (mean) Consecutive combination



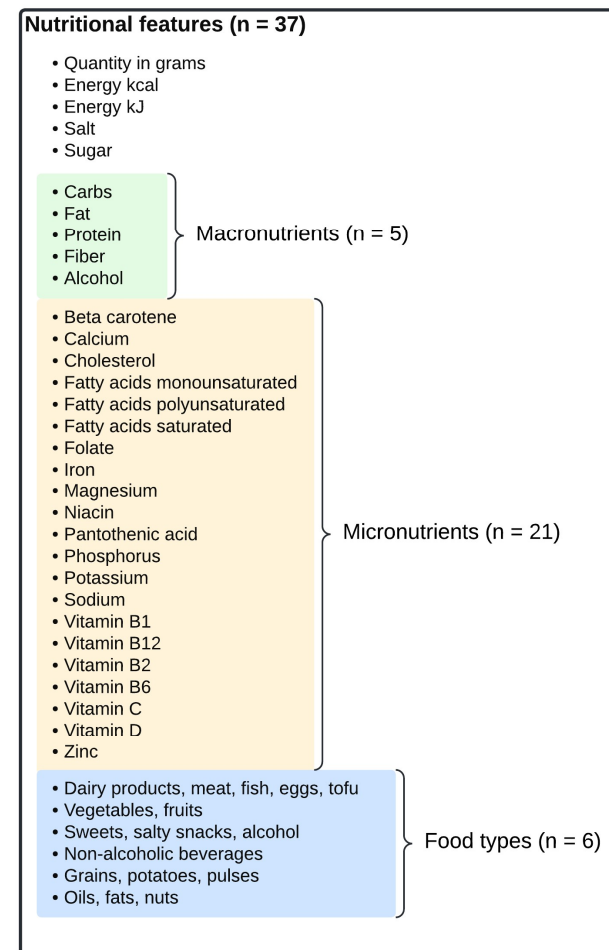
# ICC (W-std) Consecutive combination

- Peek in curve once weekend are added
- Weekend crucial to capture the full spectrum of an individual's dietary variability



# ICC consecutive combination Results

- **Macronutrients :**
  - In terms of mean need for very good reliability : **4 days**
  - In terms of W-std : **6 days**
- **Micronutrients :**
  - In terms of mean need for very good reliability : **5 days**
  - In terms of W-std : **6 days**
- **Food type :**
  - In terms of mean need for very good reliability : **3 days**
  - In terms of W-std : **4 days**





Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0,8	Count Feature ICC > 0,6
2	Wed_Sat	0,7524	2	Wed_Fri	11	34
2	Wed_Fri	0,7507	2	Mon_Fri	10	33
2	Thu_Sat	0,7497	2	Tue_Thu	10	34
2	Fri_Sun	0,7119	2	Wed_Thu	6	34
2	Fri_Sat	0,7096	2	Fri_Sun	5	32
2	Sat_Sun	0,6778	2	Sat_Sun	1	31
3	Tue_Thu_Sat	0,8559	3	Tue_Wed_Sat	32	36
3	Wed_Thu_Sat	0,8518	3	Wed_Fri_Sun	32	35
3	Mon_Thu_Sat	0,8514	3	Mon_Wed_Fri	32	36
3	Tue_Wed_Thu	0,8223	3	Mon_Fri_Sat	27	37
3	Mon_Sat_Sun	0,8176	3	Tue_Wed_Thu	26	37
3	Fri_Sat_Sun	0,7936	3	Fri_Sat_Sun	24	34
4	Mon_Tue_Thu_Sat	0,9108	4	Mon_Tue_Thu_Fri	37	37
4	Tue_Thu_Fri_Sat	0,9102	4	Mon_Thu_Fri_Sat	36	37
4	Mon_Wed_Thu_Sat	0,9097	4	Mon_Tue_Thu_Sat	36	37
4	Thu_Fri_Sat_Sun	0,8869	4	Thu_Fri_Sat_Sun	34	37
4	Mon_Tue_Wed_Fri	0,8864	4	Mon_Fri_Sat_Sun	33	37
4	Mon_Fri_Sat_Sun	0,8808	4	Mon_Tue_Wed_Sun	33	37
5	Mon_Tue_Thu_Fri_Sat	0,95	5	Mon_Tue_Wed_Thu_Sat	37	37
5	Mon_Tue_Thu_Sat_Sun	0,949	5	Mon_Wed_Thu_Fri_Sat	37	37
5	Mon_Wed_Thu_Fri_Sat	0,9488	5	Tue_Thu_Fri_Sat_Sun	37	37
5	Mon_Tue_Wed_Thu_Sun	0,9366	5	Wed_Thu_Fri_Sat_Sun	37	37
5	Mon_Tue_Fri_Sat_Sun	0,9365	5	Mon_Wed_Fri_Sat_Sun	35	37
5	Mon_Tue_Wed_Thu_Sun	0,9333	5	Tue_Wed_Fri_Sat_Sun	35	37
6	Mon_Tue_Thu_Fri_Sat_Sun	0,9781	6	Mon_Tue_Wed_Thu_Fri_Sun	37	37
6	Mon_Wed_Thu_Fri_Sat_Sun	0,9765	6	Mon_Tue_Wed_Thu_Sat_Sun	37	37
6	Mon_Tue_Wed_Thu_Sat_Sun	0,9763	6	Mon_Tue_Wed_Fri_Sat_Sun	37	37
6	Tue_Wed_Thu_Fri_Sat_Sun	0,9759	6	Mon_Tue_Thu_Fri_Sat_Sun	37	37
6	Mon_Tue_Wed_Fri_Sat_Sun	0,9707	6	Mon_Wed_Thu_Fri_Sat_Sun	37	37
6	Mon_Tue_Wed_Thu_Fri_Sun	0,9698	6	Tue_Wed_Thu_Fri_Sat_Sun	37	37

Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0,8	Count Feature ICC > 0,6
2	Wed_Fri	0,8349	2	Wed_Sun	4	6
2	Wed_Sat	0,8281	2	Mon_Wed	3	6
2	Thu_Fri	0,8256	2	Wed_Fri	3	6
2	Fri_Sun	0,7386	2	Mon_Sat	1	6
2	Fri_Sat	0,72	2	Fri_Sun	1	5
2	Sat_Sun	0,6919	2	Sat_Sun	0	5
3	Mon_Thu_Sat	0,9011	3	Mon_Tue_Thu	6	6
3	Tue_Thu_Sat	0,9001	3	Tue_Wed_Sat	6	6
3	Tue_Thu_Fri	0,8992	3	Thu_Sat_Sun	6	6
3	Mon_Fri_Sat	0,8585	3	Mon_Fri_Sun	5	6
3	Mon_Sat_Sun	0,8573	3	Mon_Sat_Sun	5	6
3	Fri_Sat_Sun	0,7881	3	Fri_Sat_Sun	4	5
4	Tue_Wed_Fri_Sun	0,9404	4	Mon_Tue_Wed_Fri	6	6
4	Tue_Thu_Fri_Sun	0,94	4	Mon_Thu_Fri_Sun	6	6
4	Wed_Thu_Fri_Sat	0,9383	4	Wed_Fri_Sat_Sun	6	6
4	Thu_Fri_Sat_Sun	0,9073	4	Thu_Fri_Sat_Sun	6	6
4	Tue_Fri_Sat_Sun	0,8975	4	Mon_Fri_Sat_Sun	5	6
4	Mon_Fri_Sat_Sun	0,8938	4	Tue_Fri_Sat_Sun	5	6
5	Mon_Wed_Thu_Fri_Sat	0,9671	5	Mon_Tue_Wed_Thu_Sat	6	6
5	Mon_Tue_Thu_Sat_Sun	0,9667	5	Mon_Tue_Wed_Thu_Sun	6	6
5	Mon_Tue_Thu_Fri_Sun	0,9662	5	Tue_Thu_Fri_Sat_Sun	6	6
5	Mon_Tue_Wed_Thu_Sat	0,9568	5	Mon_Tue_Wed_Fri_Sun	6	6
5	Mon_Tue_Wed_Thu_Sun	0,9499	5	Mon_Tue_Wed_Fri_Sat	6	6
5	Mon_Tue_Fri_Sat_Sun	0,9463	5	Wed_Thu_Fri_Sat_Sun	6	6
6	Mon_Wed_Thu_Fri_Sat_Sun	0,9856	6	Mon_Tue_Wed_Thu_Fri_Sun	6	6
6	Tue_Wed_Thu_Fri_Sat_Sun	0,9847	6	Mon_Tue_Wed_Thu_Sat_Sun	6	6
6	Mon_Tue_Thu_Fri_Sat_Sun	0,9833	6	Mon_Tue_Wed_Fri_Sat_Sun	6	6
6	Mon_Tue_Wed_Thu_Sat_Sun	0,9832	6	Mon_Tue_Thu_Fri_Sat_Sun	6	6
6	Mon_Tue_Wed_Thu_Fri_Sat_Sun	0,9827	6	Mon_Wed_Thu_Fri_Sat_Sun	6	6
6	Mon_Tue_Wed_Thu_Fri_Sun	0,9801	6	Tue_Wed_Thu_Fri_Sat_Sun	6	6

Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0,8	Count Feature ICC > 0,6
2	Thu_Sat	0,7869	2	Mon_Sat	2	5
2	Thu_Fri	0,7854	2	Mon_Sun	2	5
2	Wed_Sat	0,78	2	Tue_Thu	2	5
2	Tue_Wed	0,7575	2	Tue_Wed	1	5
2	Sat_Sun	0,7463	2	Mon_Fri	1	5
2	Fri_Sat	0,7426	2	Sat_Sun	1	5
3	Mon_Thu_Sat	0,879	3	Tue_Wed_Sun	5	5
3	Tue_Thu_Sat	0,8784	3	Wed_Thu_Sat	5	5
3	Wed_Thu_Sat	0,8768	3	Tue_Thu_Sat	5	5
3	Mon_Tue_Thu	0,8454	3	Mon_Thu_Sun	4	5
3	Tue_Wed_Thu	0,8435	3	Mon_Wed_Thu	4	5
3	Mon_Wed_Thu	0,8423	3	Mon_Tue_Thu	4	5
4	Tue_Thu_Fri_Sat	0,9261	4	Mon_Tue_Wed_Fri	5	5
4	Tue_Wed_Thu_Sat	0,9264	4	Tue_Thu_Fri_Sat	5	5
4	Mon_Wed_Thu_Sat	0,9259	4	Tue_Wed_Thu_Fri	5	5
4	Mon_Tue_Wed_Sun	0,9024	4	Mon_Tue_Thu_Fri	5	5
4	Mon_Wed_Thu_Sun	0,9009	4	Mon_Tue_Wed_Sun	5	5
4	Mon_Tue_Thu_Sun	0,9	4	Thu_Fri_Sat_Sun	5	5
5	Tue_Wed_Fri_Sat_Sun	0,9592	5	Mon_Tue_Wed_Thu_Sat	5	5
5	Tue_Wed_Thu_Fri_Sat	0,959	5	Mon_Tue_Wed_Thu_Sun	5	5
5	Mon_Tue_Thu_Fri_Sat	0,9587	5	Tue_Thu_Fri_Sat_Sun	5	5
5	Mon_Tue_Wed_Fri_Sun	0,9493	5	Mon_Tue_Wed_Fri_Sun	5	5
5	Mon_Wed_Thu_Fri_Sun	0,9487	5	Mon_Tue_Wed_Fri_Sat	5	5
5	Mon_Tue_Wed_Thu_Sun	0,9315	5	Wed_Thu_Fri_Sat_Sun	5	5
6	Tue_Wed_Thu_Fri_Sat_Sun	0,9845	6	Mon_Tue_Wed_Thu_Fri_Sun	5	5
6	Mon_Wed_Thu_Fri_Sat_Sun	0,9831	6	Mon_Tue_Wed_Thu_Sat_Sun	5	5
6	Mon_Tue_Thu_Fri_Sat_Sun	0,9823	6	Mon_Tue_Wed_Fri_Sat_Sun	5	5
6	Mon_Tue_Wed_Fri_Sat_Sun	0,9817	6	Mon_Tue_Thu_Fri_Sat_Sun	5	5
6	Mon_Tue_Wed_Thu_Fri_Sun	0,9782	6	Mon_Wed_Thu_Fri_Sat_Sun	5	5
6	Mon_Tue_Wed_Thu_Fri_Sun	0,9698	6	Tue_Wed_Thu_Fri_Sat_Sun	5	5

Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0,8	Count Feature ICC > 0,6
2	Wed_Fri	0,7153	2	Tue_Fri	5	18
2	Wed_Sat	0,7131	2	Mon_Fri	5	17
2	Tue_Sat	0,7126	2	Wed_Fri	4	18
2	Tue_Wed	0,684	2	Wed_Thu	1	18
2	Fri_Sun	0,6826	2	Thu_Sun	1	18
2	Sat_Sun	0,6484	2	Sat_Sun	0	16
3	Tue_Thu_Sat	0,8324	3	Wed_Thu_Sat	17	21
3	Wed_Thu_Sat	0,8273	3	Wed_Thu_Fri	17	21
3	Mon_Thu_Sat	0,8233	3	Tue_Thu_Sat	17	21
3	Wed_Sat_Sun	0,7949	3	Tue_Wed_Sun	12	20
3	Mon_Sat_Sun	0,7865	3	Tue_Wed_Thu	12	21
3	Fri_Sat_Sun	0,7746	3	Fri_Sat_Sun	11	19
4	Mon_Tue_Thu_Sat	0,8969	4	Mon_Tue_Thu_Fri	21	21
4	Tue_Thu_Fri_Sat	0,8953	4	Mon_Thu_Fri_Sat	20	21
4	Mon_Wed_Thu_Sat	0,8945	4	Mon_Tue_Thu_Sat	20	21
4	Mon_Tue_Wed_Sun	0,8671	4	Mon_Tue_Fri_Sun	18	21
4	Mon_Tue_Wed_Fri	0,8659	4	Thu_Fri_Sat_Sun	18	21
4	Mon_Fri_Sat_Sun	0,8617	4	Mon_Tue_Wed_Sun	17	21
5	Mon_Tue_Thu_Fri_Sat	0,942	5	Mon_Tue_Wed_Thu_Sat	21	21
5	Mon_Tue_Thu_Sat_Sun	0,9409	5	Mon_Wed_Thu_Fri_Sat	21	21
5	Mon_Wed_Thu_Fri_Sat	0,9395	5	Tue_Thu_Fri_Sat_Sun	21	21
5	Tue_Wed_Fri_Sat_Sun	0,9238	5	Wed_Thu_Fri_Sat_Sun	21	21
5	Mon_Wed_Fri_Sat_Sun	0,9226	5	Mon_Wed_Fri_Sat_Sun	19	21
5	Mon_Tue_Wed_Fri_Sun	0,9222	5	Tue_Wed_Fri_Sat_Sun	19	21
6	Mon_Tue_Thu_Fri_Sat_Sun	0,9748	6	Mon_Tue_Wed_Thu_Fri_Sun	21	21
6	Mon_Tue_Wed_Thu_Sat_Sun	0,973	6	Mon_Tue_Wed_Thu_Sat_Sun	21	21
6	Mon_Wed_Thu_Fri_Sat_Sun	0,9709	6	Mon_Tue_Wed_Fri_Sat_Sun	21	21
6	Tue_Wed_Thu_Fri_Sat_Sun	0,9697	6	Mon_Tue_Thu_Fri_Sat_Sun	21	21
6	Mon_Tue_Wed_Thu_Fri_Sun	0,9659	6	Mon_Wed_Thu_Fri_Sat_Sun	21	21
6	Mon_Tue_Wed_Fri_Sat_Sun	0,9615	6	Tue_Wed_Thu_Fri_Sat_Sun	21	21

All nutritional features

Food group

Macronutrients

Micronutrients

#### Nutritional features (n = 37)

- Quantity in grams
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Macronutrients (n = 5)

- Beta carotene
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Micronutrients (n = 21)

- Dairy products, meat, fish, eggs, tofu
- Vegetables, fruits
- Sweets, salty snacks, alcohol
- Non-alcoholic beverages
- Grains, potatoes, pulses
- Oils, fats, nuts

Food types (n = 6)

Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0.8	Count Feature ICC > 0.6
2	Thu_Sat	0.5535	2	Wed_Sun	3	7
2	Tue_Sat	0.5439	2	Mon_Fri	2	7
2	Mon_Sat	0.5317	2	Mon_Sat	2	10
2	Fri_Sat	0.4793	2	Tue_Wed	0	2
2	Mon_Wed	0.4602	2	Mon_Sun	0	5
2	Tue_Wed	0.4574	2	Sat_Sun	0	5
3	Tue_Thu_Sat	0.7213	3	Mon_Thu_Sat	6	36
3	Mon_Thu_Sat	0.7156	3	Wed_Fri_Sat	5	31
3	Wed_Thu_Sat	0.7093	3	Tue_Thu_Sun	5	34
3	Mon_Wed_Fri	0.6488	3	Mon_Tue_Thu	2	26
3	Tue_Wed_Fri	0.6481	3	Tue_Wed_Thu	1	25
3	Tue_Wed_Thu	0.6474	3	Mon_Wed_Thu	1	24
4	Tue_Thu_Sat_Sun	0.8219	4	Tue_Thu_Sat_Sun	24	37
4	Tue_Thu_Fri_Sat	0.8215	4	Wed_Thu_Fri_Sat	23	37
4	Mon_Thu_Thu_Sat	0.8185	4	Mon_Thu_Sat_Sun	22	37
4	Mon_Tue_Wed_Sun	0.7671	4	Tue_Wed_Thu_Fri	12	37
4	Mon_Wed_Thu_Fri	0.7663	4	Mon_Tue_Wed_Sun	9	36
4	Mon_Tue_Wed_Fri	0.7495	4	Mon_Tue_Wed_Fri	8	37
5	Tue_Thu_Fri_Sat_Sun	0.9091	5	Mon_Tue_Wed_Thu_Sat	37	37
5	Mon_Tue_Thu_Sat_Sun	0.896	5	Mon_Tue_Thu_Fri_Sat	37	37
5	Mon_Tue_Thu_Fri_Sat	0.8934	5	Mon_Tue_Thu_Sat_Sun	37	37
5	Mon_Tue_Wed_Fri_Sat	0.8647	5	Mon_Wed_Fri_Sat_Sun	32	37
5	Mon_Tue_Wed_Thu_Sun	0.8603	5	Mon_Tue_Wed_Fri_Sun	32	37
5	Mon_Tue_Wed_Fri_Sun	0.8495	5	Tue_Wed_Fri_Sat_Sun	32	36
6	Mon_Tue_Thu_Fri_Sat_Sun	0.9584	6	Mon_Tue_Wed_Thu_Fri_Sun	37	37
6	Tue_Wed_Thu_Fri_Sat_Sun	0.9547	6	Mon_Tue_Wed_Thu_Sat_Sun	37	37
6	Mon_Wed_Thu_Fri_Sat_Sun	0.9515	6	Mon_Tue_Thu_Fri_Sat_Sun	37	37
6	Mon_Tue_Wed_Thu_Sat_Sun	0.9481	6	Mon_Wed_Thu_Fri_Sat_Sun	37	37
6	Mon_Tue_Wed_Thu_Fri_Sat_Sun	0.9317	6	Tue_Wed_Thu_Fri_Sat_Sun	37	37
6	Mon_Tue_Wed_Thu_Fri_Sun	0.927	6	Mon_Tue_Wed_Fri_Sat_Sun	35	37

Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0.8	Count Feature ICC > 0.6
2	Thu_Sat	0.604	2	Mon_Fri	1	3
2	Wed_Sat	0.602	2	Mon_Sat	1	3
2	Mon_Sat	0.5953	2	Fri_Sun	1	1
2	Tue_Wed	0.4608	2	Tue_Wed	0	1
2	Fri_Sat	0.4576	2	Mon_Sun	0	2
2	Wed_Thu	0.4104	2	Sat_Sun	0	1
3	Mon_Thu_Sat	0.7644	3	Tue_Wed_Sun	2	6
3	Wed_Sat_Sun	0.7564	3	Wed_Fri_Sun	2	6
3	Wed_Fri_Sat	0.7491	3	Tue_Thu_Sun	2	5
3	Mon_Tue_Thu	0.6548	3	Fri_Sat_Sun	1	5
3	Mon_Wed_Thu	0.6427	3	Tue_Wed_Thu	0	3
3	Tue_Wed_Thu	0.6185	3	Mon_Wed_Thu	0	4
4	Wed_Fri_Sat_Sun	0.8519	4	Wed_Fri_Sat_Sun	5	6
4	Mon_Thu_Sat_Sun	0.8489	4	Mon_Thu_Sat_Sun	4	6
4	Wed_Thu_Sat_Sun	0.8481	4	Tue_Thu_Sat_Sun	4	6
4	Mon_Wed_Thu_Fri	0.7939	4	Mon_Tue_Thu_Fri	2	6
4	Mon_Tue_Wed_Fri	0.7905	4	Mon_Tue_Wed_Sun	2	6
4	Tue_Wed_Thu_Fri	0.7759	4	Mon_Tue_Wed_Fri	2	6
5	Mon_Wed_Thu_Sat_Sun	0.917	5	Mon_Tue_Wed_Thu_Sat	6	6
5	Mon_Wed_Fri_Sat_Sun	0.9135	5	Mon_Wed_Thu_Sat_Sun	6	6
5	Mon_Thu_Fri_Sat_Sun	0.913	5	Tue_Thu_Fri_Sat_Sun	6	6
5	Mon_Tue_Wed_Fri_Sun	0.8927	5	Mon_Tue_Wed_Fri_Sat	6	6
5	Tue_Wed_Thu_Fri_Sun	0.8877	5	Wed_Thu_Fri_Sat_Sun	6	6
5	Mon_Tue_Wed_Thu_Sun	0.8694	5	Mon_Tue_Wed_Thu_Sun	5	6
6	Mon_Wed_Thu_Fri_Sat_Sun	0.9653	6	Mon_Tue_Wed_Thu_Fri_Sun	6	6
6	Mon_Tue_Thu_Fri_Sat_Sun	0.9627	6	Mon_Tue_Wed_Thu_Sat_Sun	6	6
6	Tue_Wed_Thu_Fri_Sat_Sun	0.9562	6	Mon_Tue_Wed_Fri_Sat_Sun	6	6
6	Mon_Tue_Wed_Thu_Sat_Sun	0.9571	6	Mon_Tue_Thu_Fri_Sat_Sun	6	6
6	Mon_Tue_Wed_Thu_Sat_Sun	0.9566	6	Mon_Wed_Thu_Fri_Sat_Sun	6	6
6	Mon_Tue_Wed_Thu_Fri_Sun	0.941	6	Tue_Wed_Thu_Fri_Sat_Sun	6	6

Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0.8	Count Feature ICC > 0.6
2	Tue_Sat	0.515	2	Mon_Wed	0	0
2	Wed_Sat	0.502	2	Mon_Thu	0	0
2	Mon_Sat	0.5009	2	Fri_Sun	0	1
2	Wed_Thu	0.4374	2	Mon_Sat	0	1
2	Mon_Thu	0.4023	2	Mon_Fri	0	1
2	Mon_Sun	0.3963	2	Sat_Sun	0	1
3	Tue_Fri_Sat	0.6929	3	Tue_Fri_Sat	1	5
3	Thu_Thu_Sat	0.6901	3	Thu_Fri_Sat	1	5
3	Thu_Fri_Sat	0.6896	3	Wed_Fri_Sat	1	4
3	Mon_Tue_Thu	0.5996	3	Mon_Tue_Sun	0	4
3	Mon_Wed_Thu	0.5927	3	Mon_Tue_Sat	0	5
3	Mon_Thu_Sun	0.5835	3	Fri_Sat_Sun	0	5
4	Tue_Thu_Fri_Sat	0.8165	4	Wed_Thu_Fri_Sat	3	5
4	Tue_Fri_Sat_Sun	0.8052	4	Tue_Thu_Sat_Sun	3	5
4	Thu_Fri_Sat_Sun	0.8046	4	Tue_Thu_Fri_Sat	3	5
4	Mon_Tue_Wed_Sun	0.7249	4	Mon_Tue_Thu_Sun	0	5
4	Mon_Tue_Thu_Sun	0.7172	4	Mon_Wed_Thu_Sun	0	5
4	Mon_Wed_Thu_Sun	0.7155	4	Mon_Tue_Wed_Sun	0	5
5	Tue_Wed_Thu_Fri_Sat	0.8971	5	Mon_Tue_Wed_Thu_Sat	5	5
5	Tue_Thu_Fri_Sat_Sun	0.8963	5	Mon_Wed_Thu_Fri_Sat	5	5
5	Wed_Thu_Fri_Sat_Sun	0.8941	5	Tue_Thu_Fri_Sat_Sun	5	5
5	Mon_Tue_Wed_Fri_Sun	0.8274	5	Mon_Wed_Fri_Sat_Sun	4	5
5	Mon_Wed_Thu_Fri_Sun	0.8249	5	Mon_Tue_Wed_Fri_Sun	4	5
5	Mon_Tue_Wed_Thu_Sun	0.8059	5	Mon_Wed_Thu_Fri_Sun	3	5
6	Tue_Wed_Thu_Fri_Sat_Sun	0.9629	6	Mon_Tue_Wed_Thu_Fri_Sun	5	5
6	Mon_Wed_Thu_Fri_Sat_Sun	0.9476	6	Mon_Tue_Wed_Thu_Sat_Sun	5	5
6	Mon_Tue_Thu_Fri_Sat_Sun	0.9473	6	Mon_Tue_Wed_Fri_Sat_Sun	5	5
6	Mon_Tue_Wed_Fri_Sat_Sun	0.9443	6	Mon_Tue_Thu_Fri_Sat_Sun	5	5
6	Mon_Tue_Wed_Thu_Sat_Sun	0.9376	6	Mon_Wed_Thu_Fri_Sat_Sun	5	5
6	Mon_Tue_Wed_Thu_Fri_Sun	0.8952	6	Tue_Wed_Thu_Fri_Sat_Sun	5	5

Days	Combination	Average ICC All Features	Days	Combination	Count Feature ICC > 0.8	Count Feature ICC > 0.6
2	Thu_Sat	0.5614	2	Wed_Sun	1	4
2	Tue_Thu	0.5434	2	Mon_Wed	0	4
2	Thu_Sun	0.5413	2	Mon_Thu	0	6
2	Wed_Fri	0.4716	2	Mon_Sat	0	5
2	Fri_Sun	0.4706	2	Mon_Fri	0	2
2	Tue_Wed	0.458	2	Sat_Sun	0	2
3	Tue_Thu_Sat	0.7303	3	Mon_Thu_Sat	3	20
3	Mon_Thu_Sat	0.7177	3	Tue_Thu_Sat	2	20
3	Wed_Thu_Sat	0.7159	3	Tue_Thu_Sun	2	20
3	Fri_Sat_Sun	0.6375	3	Mon_Thu_Fri	0	17
3	Mon_Wed_Fri	0.636	3	Mon_Wed_Fri	0	14
3	Tue_Wed_Fri	0.6293	3	Thu_Fri_Sat	0	20
4	Tue_Thu_Sat_Sun	0.8273	4	Tue_Thu_Sat_Sun	16	21
4	Mon_Tue_Thu_Sat	0.8261	4	Mon_Thu_Sat_Sun	15	21
4	Tue_Thu_Fri_Sat	0.8199	4	Tue_Wed_Thu_Sat	15	21
4	Mon_Wed_Fri_Sun	0.759	4	Tue_Wed_Fri_Sun	6	19
4	Tue_Wed_Fri_Sun	0.7445	4	Mon_Tue_Wed_Sun	6	20
4	Mon_Tue_Wed_Fri	0.7374	4	Mon_Tue_Wed_Fri	4	21
5	Mon_Tue_Thu_Sat_Sun	0.9048	5	Mon_Tue_Wed_Thu_Sat	21	21
5	Tue_Thu_Fri_Sat_Sun	0.8981	5	Mon_Tue_Fri_Sat_Sun	21	21
5	Wed_Thu_Sat_Sun	0.895	5	Mon_Tue_Thu_Sat_Sun	21	21
5	Tue_Wed_Thu_Sat_Sun	0.8471	5	Mon_Tue_Wed_Fri_Sun	17	21
5	Mon_Tue_Wed_Fri_Sat	0.8454	5	Mon_Tue_Wed_Fri_Sat	17	21
5	Mon_Tue_Wed_Fri_Sun	0.8348	5	Tue_Wed_Fri_Sat_Sun	16	20
6	Mon_Tue_Thu_Fri_Sat_Sun	0.961	6	Mon_Tue_Wed_Thu_Fri_Sun	21	21
6	Mon_Tue_Thu_Wed_Sat_Sun	0.9526	6	Mon_Tue_Wed_Thu_Sat_Sun	21	21
6	Tue_Wed_Thu_Fri_Sat_Sun	0.9503	6	Mon_Tue_Thu_Fri_Sat_Sun	21	21
6	Mon_Wed_Thu_Fri_Sat_Sun	0.9476	6	Mon_Wed_Thu_Fri_Sat_Sun	21	21
6	Mon_Tue_Wed_Thu_Fri_Sun	0.9312	6	Tue_Wed_Thu_Fri_Sat_Sun	21	21
6	Mon_Tue_Wed_Fri_Sat_Sun	0.9146	6	Mon_Tue_Wed_Fri_Sat_Sun	19	21

All nutritional features

Food group

Macronutrients

Micronutrients

Nutritional features (n = 37)

- Quantity in grams
- Energy kcal
- Energy kJ
- Salt
- Sugar

- Carbs
- Fat
- Protein
- Fiber
- Alcohol

Macronutrients (n = 5)

- Beta carotene
- Calcium
- Cholesterol
- Fatty acids monounsaturated
- Fatty acids polyunsaturated
- Fatty acids saturated
- Folate
- Iron
- Magnesium
- Niacin
- Pantothenic acid
- Phosphorus
- Potassium
- Sodium
- Vitamin B1
- Vitamin B12
- Vitamin B2
- Vitamin B6
- Vitamin C
- Vitamin D
- Zinc

Micronutrients (n = 21)

- Dairy products, meat, fish, eggs, tofu
- Vegetables, fruits
- Sweets, salty snacks, alcohol
- Non-alcoholic beverages
- Grains, potatoes, pulses
- Oils, fats, nuts

Food types (n = 6)

# ICC non-consecutive combination Results

- Choosing optimal days combination can improve ICC performance (consecutive approach reflect worst combination)
- Optimal combination of 2 days almost systematically include 1 weekend day (mostly Saturday)  
→ Crucial to include weekend to capture full spectrum of dietary habits

- **Macronutrients :**

- In terms of mean : **3 days** enough for very good reliability
- In terms of W-std : **5 days** needed

Mon	Tue	Wed	Thu	Sat
Mon	Wed	Thu	Fri	Sat
Tue	Thu	Fri	Sat	Sun

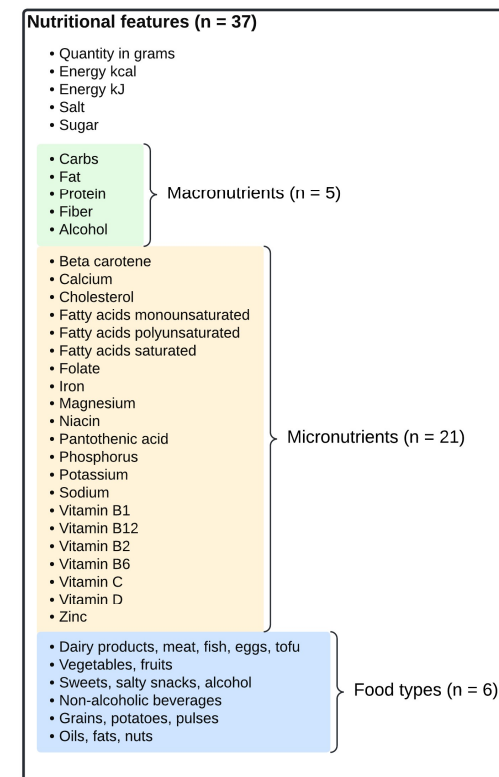
Tue	Wed	Sun
Wed	Thu	Sat
Tue	Thu	Sat

- **Micronutrients :**

- In terms of mean : **4 days** (after 3 day 17/21 nutrients reached treshold)
- In terms of W-std: **5 days**

- **Food type :**

- In terms of mean : **3 days**
- In terms of W-std : **4 days**



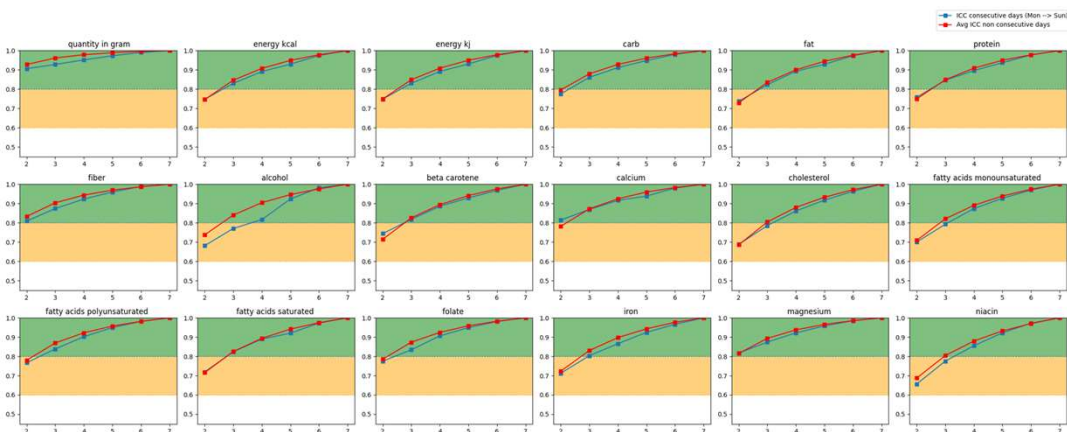


# Designing Optimal Protocol ?

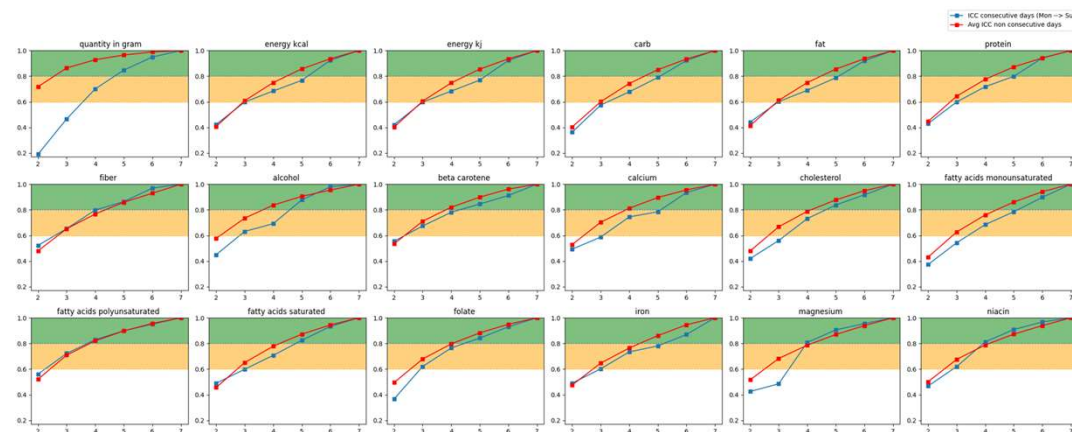
- Need to identify/anticipate days when consumption is stable and days when it varies
- Classify people according to their dietary profile (like students who like to party)
  - ➔ Design optimal protocol, how many days, which one to sample based on objective
- Optimal = less time, resource, effort..... to collect data

# Average ICC values for combinations of non-consecutive days

ICC using the mean



ICC using the w-std



- Red curve = general impact of non-consecutive days of dietary assessment
- Insight into general effect of missing data in a survey protocol intended to collect data over an entire week  
➔ **We wanted 7 days of data but miss 2, how would this impact representation of the week ?**

# Conclusion / Main Findings

- Crucial to identify days that deviate from the “stable” consumption to capture full spectrum of weekly dietary habits
- Dietary assessment protocol can be optimized to reduce number of days we need to sample (based on categorized profile)
- Idea of the general impact of missing data on a weekly food survey

# Variation Coefficient Ratio Analysis

Nutritional Feature	Mean ± Std	Median	CVw (%)	CVb (%)	Variance Ratio	Days (r=0.8)	Days (r=0.85)	Days (r=0.9)
eaten_quantity_in_gram	3225.63 ± 1491.44	3063	25,6035	38,5028	0,4422	1	2	2
energy_kcal_eaten	2544.42 ± 661.79	2425,025	21,72	11,6012	3,5052	7	10	15
energy_kj_eaten	10712.70 ± 2776.97	10249,6096	21,5851	11,6096	3,4568	7	10	15
salt_eaten	5.19 ± 3.06	4,655	53,8284	23,4325	5,277	10	14	23
sugar_eaten	91.14 ± 44.45	85,2937	37,4444	29,8928	1,5691	3	5	7
carb_eaten	263.34 ± 80.52	254,15	24,4739	16,5022	2,1995	4	6	10
fat_eaten	109.52 ± 38.93	103,468	30,3149	16,4893	3,3799	7	9	15
protein_eaten	93.47 ± 33.05	88,663	29,7196	16,5309	3,2322	6	9	14
fiber_eaten	28.32 ± 12.83	26,2505	34,2865	29,0175	1,3961	3	4	6
alcohol_eaten	10.06 ± 17.95	0	148,7938	86,4837	2,9601	6	8	13
beta_carotene_eaten	3.31e-03 ± 3.84e-03	0,0019	101,4457	55,0512	3,3957	7	9	15
calcium_eaten	8.03e-01 ± 5.13e-01	0,6963	51,9455	36,5667	2,018	4	6	9
cholesterol_eaten	2.97e-01 ± 2.33e-01	0,2339	69,4821	33,4483	4,3152	8	12	19
fatty_acids_monounsaturated_eaten	25.01 ± 13.06	22,924	45,4998	23,6145	3,7125	7	10	16
fatty_acids_polyunsaturated_eaten	10.97 ± 7.31	9,275	54,512	37,4079	2,1235	4	6	10
fatty_acids_saturated_eaten	40.83 ± 18.20	38,042	38,6834	19,9215	3,7706	7	10	17
folate_eaten	2.12e-04 ± 1.12e-04	0,0002	43,1487	29,7654	2,1014	4	6	9
iron_eaten	9.08e-03 ± 4.98e-03	0,0082	47,6244	26,6533	3,1927	6	9	14
magnesium_eaten	2.54e-01 ± 1.38e-01	0,2307	42,3156	33,5611	1,5898	3	5	7
niacin_eaten	1.19e-02 ± 8.02e-03	0,01	60,4616	28,6135	4,465	8	12	20
pantothenic_acid_eaten	1.08e-02 ± 3.56e-02	0,0038	250,743	211,6929	1,403	3	4	6
phosphorus_eaten	1.06 ± 4.72e-01	1,0012	38,0822	21,6481	3,0946	6	9	14
potassium_eaten	2.27 ± 1.10	2,137	42,6492	21,4975	3,9359	8	11	17
sodium_eaten	3.35 ± 1.48	3,1473	38,9297	18,5715	4,3941	8	12	19
vitamin_b1_eaten	1.07e-02 ± 3.36e-02	0,0009	299,0129	97,7763	9,3522	17	25	40
vitamin_b12_eaten	4.58e-06 ± 7.93e-06	0	152,5074	79,7377	3,6581	7	10	16
vitamin_b2_eaten	4.74e-03 ± 1.99e-02	0,001	415,9487	82,1951	25,6087	45	66	108
vitamin_b6_eaten	4.91e-03 ± 1.71e-02	0,0014	341,0752	65,3518	27,2386	49	72	117
vitamin_c_eaten	9.22e-02 ± 8.13e-02	0,0708	78,0623	40,1721	3,776	7	10	17
vitamin_d_eaten	3.05e-06 ± 3.47e-06	0	105,9042	39,841	7,0659	13	19	31
zinc_eaten	8.79e-03 ± 5.50e-03	0,0078	55,9173	26,6198	4,4125	8	12	19
dairy_products_meat_fish_eggs_tofu	336.70 ± 221.95	306	53,6116	35,0785	2,3358	5	7	10
vegetables_fruits	474.21 ± 288.59	439	47,7073	36,5684	1,702	4	5	8
sweets_salty_snacks_alcohol	372.40 ± 387.52	259	84,9345	51,4234	2,728	5	8	12
non_alcoholic_beverages	1547.18 ± 1375.89	1400	46,7922	75,1993	0,3872	1	2	2
grains_potatoes_pulses	366.45 ± 210.95	340	48,7895	29,1138	2,8084	6	8	12
oils_fats_nuts	37.06 ± 45.29	30	101,5772	66,8229	2,3107	5	7	10

$$D = \frac{r^2}{1 - r^2} \times \frac{CVw^2}{CVb^2}$$

r = hypothetical correlation coefficient

Reliability of this method depends on the precision with which the intra and inter-subject dietary variances can be estimated. Is a week enough ?