Characteristics of glycometabolism in individuals without diabetes and a model to assess their glucometabolic category

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Introduction

Backgrounds:

Early detection of prediabetes and improvement of lifestyle are essential for diabetes prevention. The oral glucose tolerance test (OGTT) is a standard method to evaluate the state of glucose metabolism. However, it is rarely performed in non-diabetics. The models also have been developed to detect prediabetes using medical checkup values. However, there is no easy tool to assess the glycometabolic profiles of non-diabetics.

Aims:

- To classify glycometabolic profiles of non-diabetics into different categories based on the OGTT results.
- To develop a model that predict the glycometabolic category using a lifestyle questionnaire.

Methods

Data collection:

- Participants: 977 Japanese adults aged 20-64 without diabetes
- OGTT: Blood glucose and insulin levels at 0, 30, 60, 90, and 120 minutes
- Lifestyle questionnaire (309 questions): Topics are exercise and sleep habits, diet, family history, constitution, and physical condition.

Classification of the glycometabolic category:

	120 mPG < 126 mg/dL and Mi > 4.97	120 mPG ≥ 126 mg/dL or Mi ≤ 4.97
30 mPG < 157 mg/dL	Category 1	Category 2
30 mPG ≥ 157 mg/dL	Category 3	Category 4

Figure 1. the classification conditions for the glycometabolic categories.
Abbreviations: x mPG, x-min post-load plasma glucose level; Mi, Matsuda index

Development of the models:

Explanatory variables: questionnaire answers
Objective variables: glycometabolic categories
Considered models: decision tree, support vector machine, random forest, and XGBoost

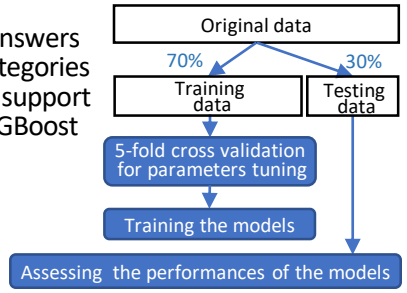

Figure 2. Flow chart of the models development

Results

Characteristics of the glycometabolic categories:

Compared with category 1 (the best glucose metabolism group, **46% of the participants**),

Category 2: low insulin sensitivity and high 120-min blood glucose levels (21%)
Category 3: low insulin-secreting capacity and rapid rise in blood glucose levels (13%)
Category 4: combination of categories 2 and 3 (20%)

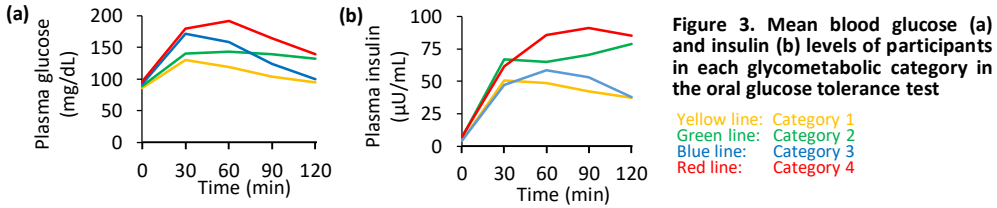

Figure 3. Mean blood glucose (a) and insulin (b) levels of participants in each glycometabolic category in the oral glucose tolerance test

Performances of the models:

- **Random forest provided the best performance among the models.**
- Another random forest model was developed using top 10 important variables in the previous random forest model. **Its area under the receiver operating characteristic curves (AUCs) for classifying [category 1, 2, 3, 4] and the others were [0.68, 0.66, 0.61, 0.70].**

Table 1. Performance of the random forest model using ten variables (95% confidence interval)

AUC for classifying category 1 and the others	Sensitivity to detect categories 2, 3, and 4	Specificity to detect category 1	AUC for classifying category 2 and the others	AUC for classifying category 3 and the others	AUC for classifying category 4 and the others
0.68 (0.62-0.75)	0.70	0.41	0.66 (0.58-0.73)	0.61 (0.51-0.70)	0.70 (0.62-0.77)

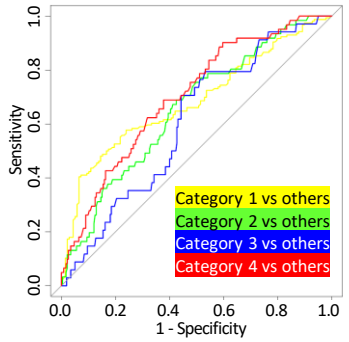

Figure 4. The ROC curves of the model

Table 2. The variables and these importances of the model

Variable	The mean decrease in Gini coefficient
Body mass index	10.3
Age	8.1
Height	3.3
Wake up in the middle of the night	3.1
Which do you usually eat, rice or bread?	2.5
Frequency of tea intake at lunch	2.1
Wake up late on non-working day	1.9
Frequency of mobile phone and tablet computer use at bedtime	1.4
Frequency of soup intake	1.4
Frequency of toothbrush replacement	0.8

Conclusion

- **Japanese adults without diabetes are classified into four categories with each different insulin sensitivity and insulin secretion.**
- **The random forest model was developed for assessing the glycometabolic category in non-diabetics. It needed only 10 lifestyle questions.**
- Some of the selected factors were not reported clear association with glucose metabolism. Future studies may clarify the association with diabetes risk.

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Conflict of interests:
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