Toward the Construction of a Knowledge Graph from Japanese Food Ontology for the Prevention of Frailty

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Abstract

The Osaka Prefectural Government has formulated an inspection method for the four elements of frailty: nutrition, body function, oral cavity, and social activity decline. Since nutrition is primarily influenced by food intake, developing and utilizing a food ontology is essential for scientific research on frailty. Recent studies have also elucidated the relationship between food, gut bacteria, and disease. Foods are transformed into nutrients through metabolism, and in the process, there are changes in various genes and proteins, which are also associated with diseases in relation to gut bacteria. We aim to contribute to better prevention of frailty by constructing a knowledge graph consisting of these elements.

Keywords

Knowledge graph, Ontology, Food ontology, Frailty, Sarcopenia

1. Introduction

Nutrition is a key component of good health. However, many individuals may face challenges in obtaining sufficient nutrition due to factors that affect their health, such as allergies. To conduct nutritional research that yields reliable and comparable results, it is necessary to use uniform terminology and appropriate food descriptions. Consequently, there is a demand for a computer-readable Japanese food ontology that can accurately represent the characteristics and relationships of various foods.

Frailty is a condition of vulnerability and decreased physiological reserve in older adults. Sarcopenia is a disorder characterized by the loss of muscle mass and strength[1]. A survey of middle-aged and older adults aged 40 and over living in Settsu City, Osaka Prefecture, revealed that a certain proportion of them had frailty or sarcopenia even in their 40s and 50s. Since

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frailty and sarcopenia may affect not only the elderly but also the working-age population, early prevention is necessary. To prevent frailty and sarcopenia, it is important to improve lifestyle habits such as diet and exercise. People who perceive themselves as heavier than they actually are may have low muscle mass, which should be taken into account.

A knowledge graph with guidelines derived from previous frailty prevention studies is expected to contribute to more accurate frailty prevention. Genome-wide association studies (GWAS) have identified single nucleotide polymorphisms (SNPs) associated with frailty. The presence of SNPs suggests that individual differences in frailty prevention may occur. It has also been reported that the gut microbiota environment, which is influenced by food intake, is involved in the expression of messenger RNAs (mRNAs) and microRNAs (miRNAs), and vice versa, the expression of mRNAs and miRNAs, which are influenced by food intake, affects the gut microbiota environment. This suggests that the possible knowledge graph for frailty prevention can be very complex with other factors.

2. Methods

Weakness is said to be caused by the decline of four functions: nutrition, body function, oral cavity, and social activity. In Osaka Prefecture, the assessment includes whether individuals can form a loop with the thumb and index finger of both hands, and whether they can stand up from a chair on one leg. Whether or not the patient has a complete meal with staple food, main dishes, and side dishes. Whether or not the patient swallows when eating or drinking tea or soup. Whether or not the patient goes out once a week. The checklist consists of the following five items. The knowledge graph is created according to this list.

The above mentioned indicators of frailty diagnosis include food, necessitating a Japanese food ontology that cabe processed mechanically. FoodOn[2] is available for food ontology, but it lacks coverage of a common foods in Japan. We employed the Web Ontology Language (OWL) to describe the NHNS data, utilizing its hierarchical classification scheme and appropriate Uniform Resource Identifiers (URIs). This ontology is published as an alpha version of FGNHNS[3] on BioPortal (https://bioportal.bioontology.org/ontologies/FGNHNS). We use food names in this ontology to link foods to nutrients.

Associations between food, gut bacteria and disease were extracted from the databases listed below.

- Disease name and DOID from Disease ontology
  (https://disease-ontology.org/)
- Gut bacteria name and NCBI ID from NCBI taxonomy
  (https://www.ncbi.nlm.nih.gov/taxonomy)
- Gut bacteria disease interaction type from gutMDisorder database
  (http://bio-annotation.cn/gutMDisorder/)
- Gut bacteria edge type and weight from MIND database
  (http://www.microbialnet.org/mind_home.html)

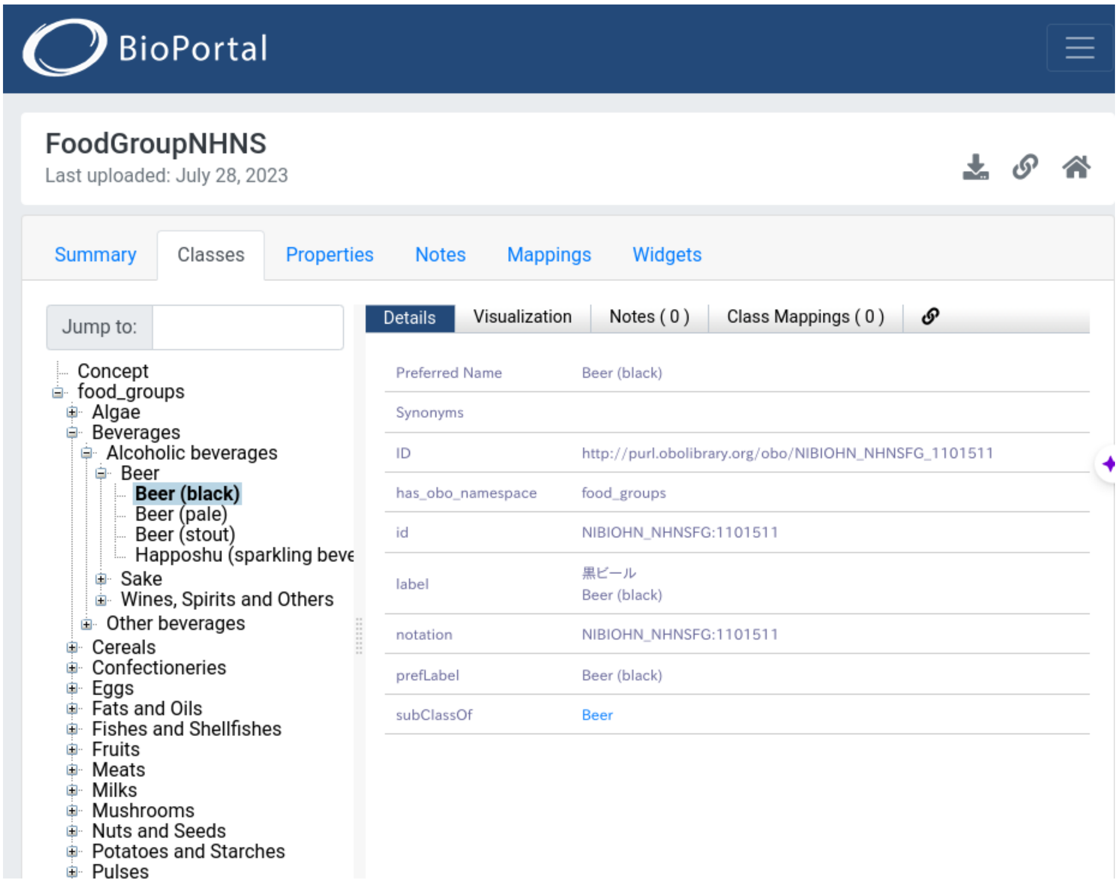

Figure 1: Classes view of FGNHNS registered on BioPortal. (https://bioportal.bioontology.org/ontologies/FGNHNS).

3. Result

We are building a knowledge graph using the constructed food ontology and various other factors related to frailty, but since there is some cohort data dependence, we have not yet reached a concrete inference. The constructed knowledge graph schema is Figure 2. We proposed that individual differences in genes that vary with food metabolism may influence frailty.

4. Discussion and conclusion

The four factors that traditionally define frailty are body function, social activity, oral cavity, and nutrients. A food component was added because nutrients are obtained through food metabolism, but food intake also causes variation in genes and gut bacteria, which affect frailty in terms of disease improvement. Individual differences due to genetic variants must also be taken into account. In addition, the factor of sleep should also play a role in frailty, although cohort data may not be sufficient. Therefore, the knowledge graph on frailty could be further

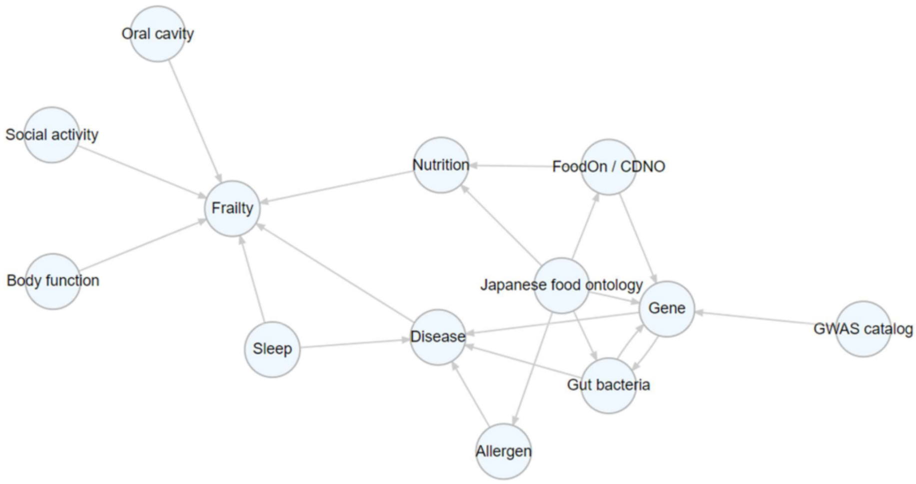

Figure 2: A knowledge graph schema to describe frailty

complicated, as shown in Figure 2, and could contribute to precise frailty prevention efforts. It is difficult to predict frailty using the knowledge graph with only a database of known reports, and additional data is needed. These are still in the process of being built and the various processes listed in future work need to be implemented. As this system matures, it is expected to elucidate the various associations and mechanisms between food and disease.

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