Food recommender systems for diabetic patients: a Narrative review

Abstract

WHO estimates that the number of people with diabetes will grow 114% by 2030.It declares that, patients have to play a major role to control and therapy of diabetes by being provided with updated knowledge about the disease and different aspects of available treatments, diet therapy in particular. In this regard, diets recommender Systems would be helpful. They are techniques and tools which suggest the best diets according to patient's health situation and preferences. Accordingly this narrative reviewed studies on the topic of food recommender systems and their features by focusing on nutrition and diabetic issues. Literature searches whit Google scholar and Pubmed were conducted during June and October 2014 and February 2015. Results were limited to papers in English and no limits were applied for the published year. We recognize three common methods for food recommender system: collaborative filtering recommender system (CFRS), knowledge based recommender system (KBRS) and context-aware recommender system (CARS). Also wellness recommender systems are a subfield of food recommender systems which help users to find and adapt suitable personalized wellness treatments based on their individual needs. Food recommender systems often used artificial intelligence and semantic web techniques. Some used the combination of both techniques.

Keywords: Diabetes, Food recommender system, Diet therapy, Artificial intelligence, Semantic web

Introduction

Diabetes mellitus (DM) is a group of metabolic disorders, in which there are chronic hyperglycemia with disturbances of carbohydrate, protein and fat metabolism due to defects in insulin secretion, insulin action, or both(1).

World Health Organization (WHO) estimates that the number of people with diabetes will grow 114% by 2030(2). Prevalence of type2 diabetes quickly raised in native and immigrant Asian people too. Therefore the morbidity and mortality related with the disease and its complications are also common in Asian population. During recent decades, type2 diabetes has been rapidly epidemic in Asia(3).

Prevalence of type 2 diabetes at an early age has been affected on Asian countries economy. So, national preventive strategies must be taken to increase public awareness about the disease and improve standards of care and health in this respect(4).

Diet therapy is essential for the effective management of diabetes, type 2 in particular to reduce the risk of long term damage of tissues. All suggestions should be offer based on scientific evidences. They have to fit for the individual, taking into account cultural and personal preferences, beliefs and lifestyle(5). Because of significant effects of diet therapy combined with improving diseases, nutritionist and practitioners pay more attentions to developing food recommender systems.

Recommendation systems are sort of information systems help people make decisions in intricate area by suggesting evidence-based pieces of advices. Simply they compare user interest obtained from his/her profile with some reference characteristics come from the item information (content-based approach), knowledge (knowledge based recommender system), the user's profile (collaborative filtering approach) and the combination of all(6).

Computerized food recommender applications developed with the objective to assist the patients in daily diet selection, are installed on a variety of portable apparatuses such as cell phones, PDAs, and etc. (7) and suggest the best diets according patient's health situation and preferences every where every time(8).

The present study reviewed literatures to investigate various types of food recommender systems, their methods and features.

Literature review

We wrote this narrative review according to guideline of Zurich-Basel Plant Science Center. It reported items preferred for writing a review article but considering a more narrative approach. We defined the research questions and explored Medical Subject Heading (MeSH) terms to determine our search keys. Then we conducted literature searches whit Google scholar from June 2014 to February 2015 with the terms: recommender system, knowledge-based, context-aware, collaborative-filtering food, snack or nutrition or diabetes. We screened the titles and abstracts of the resulted papers. Finally papers in English in relation to food and diet recommender systems were selected without any limitation for the published year.

We identified three major food recommender types including: knowledge –based recommender system (KBRS), Context-aware recommender system (CARS) and Collaborative-filtering recommender system (CFRS). We also found three related studies which were not categorized into major types but their subjects remained in the area of recommender systems including: two papers about wellness recommender system and one about the challenges for Nutrition Recommender Systems. The results are shown in table 1.

Table 1. Types of food recommender systems

Type	**KBRS**	**CARS**	**CFRS**	**other**
Number	4	1	1	3

A KBRS type recommends items and their features which meet user's needs and preferences based on specific domain of knowledge. It also determines how the items are useful for the user(6). KBRS is divided into two categories: 1.Case-based recommender system and 2. Constraint-based recommender system. Case-based recommenders used similarity metrics to offer recommendations whereas constraint-based recommenders often used predefined explicit rules which have acquired from a knowledge base. The studies done by Khan Et.al, Suksom et.al, lee et.al and Chen et.al used KBRS technique and they all are in constraint-based category (7, 9-11).

Traditionally, recommender systems, which deal with applications, have two entities: users and items. They do not take into account the context when providing recommendations, while CARS focuses on context, e.g. time and place(6).

Out of the selected papers, Oh et.al proposed a CARS which for well-being care applications, Lim et.al and Farrell et.al in two separated studies, discussed the development of a wellness recommender system. The wellness recommender system helps users to find and adapt suitable personalized wellness treatments based on their individual needs (12-14).

Runo et.al developed a menu recommendation system according to CFRS technique(15). A CFRS is the simplest and original technique of recommender systems, suggests those items to the active user that other users with similar preferences liked in the past(6).

Mika et.al in their studies focused on Challenges for Nutrition Recommender Systems (17).

From another point, food recommender systems can be considered as two following types: The systems which recommend recipes for healthier meals, the systems which suggest healthier food items. The first type itself, is divided into two categories. The first category, uses similarity measures to recommend recipes which are most similar to the meals that user likes. Similarity measures either calculate according to the ingredients or user ratings. For the second category, both user's likes and dislikes are important, this category focuses more on the user's nutritional needs. The second category does not recommend whole meals. Instead, it suggests some foods to be replaced with some other healthier options(16).

According to our results, four papers used food ontology,(7, 9, 10, 12) while four papers prefer to use artificial intelligent techniques (rule-based reasoning and knapsack algorithm) maybe due to the complexity of the ontology construction(11, 13-15). Also, all the selected papers considered cultural, religious and lifestyle factors significantly.

Conclusion

The review revealed that CFRS, KBRS and CARS methods are the most common systems. And Artificial intelligence such as knapsack algorithm or rule- based reasoning and semantic web such as food ontology and the combination of both were the most popular techniques applied to develop food recommender systems. Also, food recommender systems focused on cultural, religious and lifestyle criteria.

In future, we are planning to design a food recommender system to recommend daily snacks for type-2 diabetic patients.

References

1. Consultation W. Definition, diagnosis and classification of diabetes mellitus and its complications: Part; 1999.
2. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes estimates for the year 2000 and projections for 2030. Diabetes care. 2004;27(5):1047-53.
3. Ramachandran A, Wan Ma RC, Snehalatha C. Diabetes in Asia. The Lancet. 2010;375(9712):408-18.
4. Yoon K-H, Lee J-H, Kim J-W, Cho JH, Choi Y-H, Ko S-H, et al. Epidemic obesity and type 2 diabetes in Asia. The Lancet. 2006;368(9548):1681-8.
5. Dyson P, Kelly T, Deakin T, Duncan A, Frost G, Harrison Z, et al. Diabetes UK evidence-based nutrition guidelines for the prevention and management of diabetes. Diabetic Medicine. 2011;28(11):1282-8.
6. Ricci F, Rokach L, Shapira B, Kantor PB. Recommender systems handbook: Springer; 2011.
7. Chen R-C, Lin Y-D, Tsai C-M, Jiang H. Constructing a diet recommendation system based on fuzzy rules and knapsack method. Recent Trends in Applied Artificial Intelligence: Springer; 2013. p. 490-500.
8. Kim J, Lee D, Chung K-Y. Item recommendation based on context-aware model for personalized u-healthcare service. Multimedia Tools and Applications. 2013:1-18.

9. Lee CS, Wang MH, Acampora G, Hsu CY, Hagras H. Diet assessment based on type-2 fuzzy ontology and fuzzy markup language. International Journal of Intelligent Systems. 2010;25(12):1187-216.
10. Suksom N, Buranarach M, Thein YM, Supnithi T, Netisopakul P, editors. A knowledge–based framework for development of personalized food recommender system. The Fifth International Conference on Knowledge, Information and Creativity Support Systems; 2010.
11. Khan AS, Hoffmann A. Building a case-based diet recommendation system without a knowledge engineer. Artificial Intelligence in Medicine. 2003;27(2):155-79.
12. Oh Y, Choi A, Woo W. u-BabSang: a context-aware food recommendation system. The Journal of Supercomputing. 2010;54(1):61-81.
13. Farrell RG, Danis CM, Ramakrishnan S, Kellogg WA, editors. Intrapersonal retrospective recommendation: lifestyle change recommendations using stable patterns of personal behavior. Proceedings of the First International Workshop on Recommendation Technologies for Lifestyle Change (LIFESTYLE 2012), Dublin, Ireland; 2012: Citeseer.
14. Lim TP, Husain W, Zakaria N. Recommender System for Personalised Wellness Therapy. International Journal of Advanced Computer Science and Applications (IJACSA). 2013;4(9).
15. Runo M. FooDroid: A Food Recommendation App for University Canteens. Unpublished semester thesis, Swiss Federal Institute of Theology, Zurich. 2011.
16. Mika S, editor Challenges for Nutrition Recommender Systems. Proceedings of the 2nd Workshop on Context Aware Intel Assistance, Berlin, Germany; 2011: Citeseer.