

# Knowledge graph for TCM health preservation: Design, construction, and applications



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## ABSTRACT

Traditional Chinese Medicine (TCM) is one of the important non-material cultural heritages of the Chinese nation. It is an important development strategy of Chinese medicine to collect, analyzes, and manages the knowledge assets of TCM health care. As a novel and massive knowledge management technology, knowledge graph provides an ideal technical means to solve the problem of “Knowledge Island” in the field of traditional Chinese medicine. In this study, we construct a large-scale knowledge graph, which integrates terms, documents, databases and other knowledge resources. This knowledge graph can facilitate various knowledge services such as knowledge visualization, knowledge retrieval, and knowledge recommendation, and helps the sharing, interpretation, and utilization of TCM health care knowledge.

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## 1. Introduction

Traditional Chinese Medicine (TCM) is an important part of the Chinese nation's outstanding culture, and it has a long history of development. Ancient physicians attach great importance to health and longevity. They have accumulated rich experience in health care throughout clinical activities and daily-life practices, and also created a system of theory and methods of health care. It is an important strategy for TCM practitioners to systematically sort out and preserve TCM health care knowledge. With the people's living standards are increasing, Chinese people began to pay more attention to quality of life, so the health knowledge has become an increasingly strong demand.

In recent years, the application of information technology in the field of TCM has made great progress. TCM practitioners constructed a large number of terminology systems, document libraries and databases, leading to the formation of a relatively complete system of Chinese medicine scientific data [1]. These digital resources contain a wealth of knowledge, which can support the development of knowledge systems in health care. However, the related knowledge resources are scattered and disconnected, like a set of “knowledge islands”. The lack of data integration led to low

utilization of resources and hinders the capacity of services. There are still gaps between the people's needs for health knowledge and the quality of services.

*Knowledge Graph* is an emerging technology for massive knowledge management and intelligent services in the big data era [2,3]. A “knowledge graph” is a huge knowledge system built on the “Semantic Network”. It can capture and present the intricate relationships among the domain concepts, and connect the fragmented pieces of knowledge in various information systems. Knowledge graphs are very useful in knowledge retrieval, question-answering, knowledge recommendation, knowledge visualization and other applications. Knowledge graph provides an ideal technical means to solve the problem of “knowledge island” in the field of traditional Chinese medicine, and it is helpful to realize the integration of knowledge resources and enhance the knowledge service ability.

As shown in Fig. 1, knowledge graph is a graph-based knowledge representation and organization method. It uses a set of “subject-predicate-object” triples to represent the various entities and their relationships in a domain. Knowledge graph can also be seen as a huge network, in which nodes represent domain entities and arcs represents semantic relationships between entities. The core component of knowledge graph is “semantic network”. The knowledge graph adds more knowledge content into the framework of semantic network, such as the information of the domain entity and the link of related literature resources. These knowledge resources come from digital resources such as databases, document library, and data files, which may be dispersed in different information sys-

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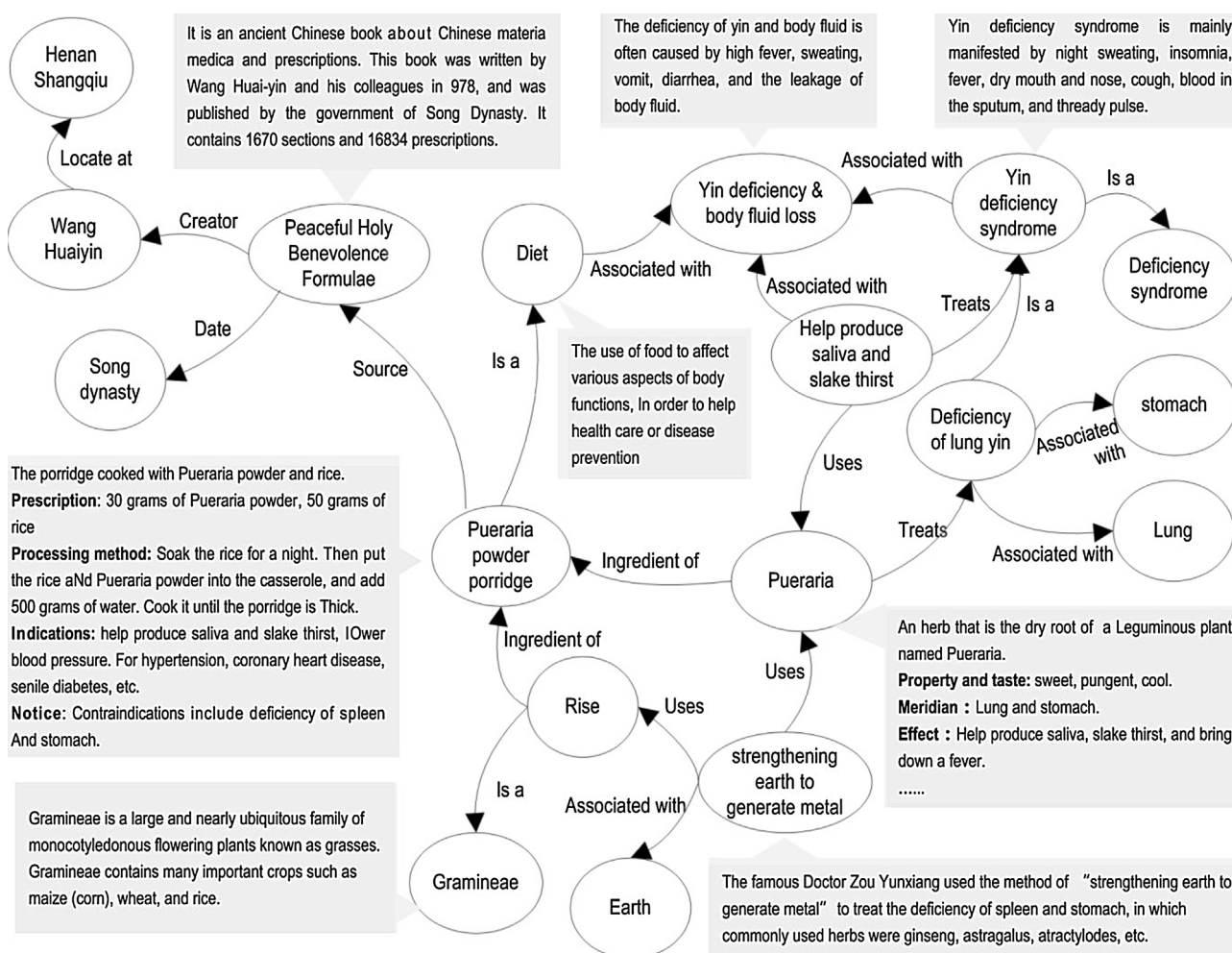


Fig. 1. An illustrative example of knowledge graph for TCM health care.

tems and organizations. The knowledge graph uses the semantic network as the skeleton to collect and systematically organize the scattered domain knowledge and realize the functions of knowledge retrieval, knowledge query, knowledge browsing, knowledge display and knowledge visualization.

The content of the TCM knowledge graph is explained with an example as shown in Fig. 1. This graph contains TCM concepts of various types, such as principles, human organs, diseases, herbs, methods, techniques, famous doctors, and classics. For example, the concept "Earth" comes from the "five phase theory", which is one of the philosophical theories of medical practice in ancient China, concerning the five phases: wood, fire, earth, metal and water, and their movements and changes [7]. The concept "Strengthening Earth to Generate Metal" is a therapeutic principle according to the "five phase theory", which uses herbal therapies (e.g., Pueraria) that reinforce the spleen (belongs to earth) in order to benefit the lung (belongs to metal). Accordingly, the graph connects the concept "Pueraria" and the concept "Deficiency of lung yin" with an edge labeled "Treats", which means Pueraria can be used to treat the deficiency of lung yin (which means the yin fluid that moistens the lung). Also, the graph establishes an "Ingredient of" relation between "Pueraria" and "Pueraria Powder Porridge", which is the porridge cooked with Pueraria and rice. In addition, the graph connects the porridge with its source as an ancient Chinese book "Peaceful Holy Benevolence Formulae", connects the book with its creator Wang Huaiyin who was a famous doctor, and so on. In

summary, the TCM knowledge graph is an intuitive and scalable knowledge model that can encapsulate essential TCM knowledge through concepts, relations, and annotations.

In recent years, knowledge graph has become a hot topic in knowledge management, knowledge service and other fields. Internet companies have introduced knowledge graphs to improve the quality of services, such as Google Knowledge Graph, Baidu Knowledge Graph, and Sogou Knowledge Cube. TCM health care has its own characteristics and needs, and it is necessary to study the construction method of TCM knowledge graph and solve the key technical problems, in order to realize the rapid growth of knowledge graph and fully realize its application value. In view of this, this project takes the conceptual system of traditional Chinese medicine as the focus of study, and integrates related structural knowledge resources into a large-scale knowledge graph. This knowledge graph can be embedded in the literature search, knowledge retrieval and other systems to provide knowledge services such as knowledge navigation, integration, and visualization. It promotes knowledge sharing, dissemination and utilization of TCM health care, and has the value of reference and service for TCM practitioners as well as ordinary people.

## 2. Construction of knowledge graph

The purpose of this study is to construct the TCM health care knowledge graph by using the data resources accumulated in the

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