DISCOVERING ASSOCIATION BETWEEN METABOLIC SYNDROME AND ITS RELATED CHRONIC DISEASES REPRESENTED BY ICD-10 CODE

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ABSTRACT

This paper applies the association rules method to discover the relationship between metabolic syndrome and its chronic diseases. The sample data used in this research is the medical records specifying the metabolic syndrome patients in a large government hospital. The Apriori and FP-Growth algorithms are chosen to be compared in the performance and applicable results of extracting the relationship of the metabolic syndrome patient records represented by ICD-10 code. The results show that the Apriori can extract 6 rules and 724 rules from FP-Growth. The comparative results between Apriori and FP-Growth found that 6 rules are common. The overall results show that the metabolic syndrome patients mostly have strong relationships with hypertension, obesity and diabetes. Interestingly, these diseases often occur with the patients diagnosed to have metabolic syndrome. Additionally, the results would bring the suggestion of metabolic syndrome to the patients in order to know about the relationship of these chronic diseases. Moreover, the physicians could use this guide for the treatment strategy in the future.

KEY WORDS: ASSOCIATION RULES / METABOLIC SYNDROME / CHRONIC DISEASES / ICD-10

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การหาความสัมพันธ์ระหว่างโรคอ้วนลงพุงและโรคเรื้อรังที่เกี่ยวข้อง แสดงโดยรหัส ICD-10
DISCOVERING ASSOCIATION BETWEEN METABOLIC SYNDROME AND ITS RELATED CHRONIC DISEASES REPRESENTED BY ICD-10 CODE

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บทคัดย่อ

งานวิจัยนี้ประยุกต์ใช้วิธีกฎความสัมพันธ์เพื่อหาความสัมพันธ์ระหว่างโรคอ้วนลงพุงและโรคเรื้อรังที่เกี่ยวข้อง ข้อมูลกลุ่มตัวอย่างที่ใช้ในการวิจัยนี้เป็นระเบียนทางการแพทย์ที่ระบุเกี่ยวกับผู้ป่วยโรคอ้วนลงพุงในโรงพยาบาลของรัฐที่มีขนาดใหญ่แห่งหนึ่ง อัลกอริทึม Apriori และอัลกอริทึม FP-Growth ถูกเลือกใช้เพื่อเปรียบเทียบในประสิทธิภาพการทำงานและผลลัพธ์ที่ใช้ในการสกัดความสัมพันธ์ของระเบียนผู้ป่วยโรคอ้วนลงพุง แสดงโดยรหัส ICD-10 ผลลัพธ์แสดงให้เห็นว่า Apriori สามารถสกัดความสัมพันธ์ได้ 6 กฎและ FP-Growth สกัดความสัมพันธ์ได้ 724 กฎ การเปรียบเทียบผลลัพธ์ระหว่าง Apriori และ FP-Growth พบว่ามี 6 กฎที่เหมือนกันและมีร่วมกัน ผลลัพธ์โดยรวมแสดงให้เห็นว่าส่วนใหญ่ผู้ป่วยโรคอ้วนลงพุงมีความสัมพันธ์อย่างมากและมีอิทธิพลกับโรคความดันโลหิตสูง โรคอ้วนและโรคเบาหวาน ที่น่าสนใจคือโรคเหล่านี้มักเกิดขึ้นบ่อยกับผู้ป่วยที่ได้รับวินิจฉัยว่าเป็นโรคอ้วนลงพุง นอกจากนี้ผลลัพธ์ที่ได้จะนำมาเพื่อให้ข้อเสนอแนะในผู้ป่วยโรคอ้วนลงพุง เพื่อให้รู้เกี่ยวกับความสัมพันธ์ของโรคเรื้อรังเหล่านี้ นอกจากนั้นแพทย์สามารถใช้คำแนะนำนี้สำหรับเป็นกลยุทธ์ในการรักษาในอนาคตได้อีกด้วย

85 หน้า

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CHAPTER I
INTRODUCTION

1.1 Background and significance of the problems

In present, there are an increasing number of metabolic syndrome's patients. Moreover, those patients also have any other diseases making their life in difficulties. The patients must be careful about food, health, and so on. Metabolic syndrome [1] is obesity condition especially for the waist. It makes adversely affect various organ systems in body. This condition refers to a group disease caused by metabolic disorders, affecting the hyperlipidemia, hypertension, insulin resistance, heart disease, and high artery pressure. Two major causes of metabolic syndrome given as: the obesity and the insulin resistance. The obesity is imbalance of food intake and energy consumption of the body which makes the fat accumulation, especially for the abdominal surface and the waistline. Additionally, the insulin resistance is caused by genetic causes and external causes such as the obesity, aging process, and so on. Usually, the metabolic syndrome's patients would have opportunity of insulin resistance rather than patient's abdominal obesity. Moreover, the metabolic syndrome also causes the Hypertension, high blood triglycerides, low blood cholesterol, low blood sugar, heart disease, and artery pressure, subsequently. Besides, lag of relaxation, sleep deprivation, stress, and working style with part-time job would generate the metabolic syndrome.

The person, who is metabolic syndrome, could cause chronic diseases, subsequently. The word of "Chronic diseases" means a disease that when the onset may without symptoms, but the symptoms will gradually intensified as when it is not treated. It often needs to be continuedly treaded and completely cured for a long life. It causes the acute redundant symptoms such as diabetes, hypertension, heart disease, hypercholesterolemia, and cancer.

Currently, there are a classification of various diseases and symptoms of diseases by using classification codes of various diseases such as myocardial disease,

renal disease, aborticide, multiple pregnancies, and metabolic syndrome. The disease classification code, namely the International Classification of Diseases and Related Health Problem 10th Revision (ICD-10), is the code of disease and symptoms prepared by the World Health Organization (WHO) [3]. It aims to classify the illness according to the logs files' collection as the statistics data of international health planning. The system of ICD-10 has two major elements as follows:

1. Classification system of the diseases and various health problems found in humans.
2. System codes of both diseases and health problem.

In medicine, the metabolic syndrome, the chronic diseases, and other diseases are provided for the disease classification codes with the use of ICD-10 code including E88.9 of Metabolic disorder unspecified, E66.9 of Obesity unspecified, E51.9 of Heart disease unspecified, etc.

For the problems and diseases with the patients diagnosed to be metabolic syndrome, the researcher has the concept of the metabolic syndrome study by using the data of patients based on ICD-10 code. By using the association rules techniques, we find the relationships of two data sets between the metabolic syndrome and the related chronic disease with the large data group in order to raise awareness in care, protection, attitude suggestion, and treatment policy of metabolic syndrome.

1.2 Research Objectives

The objectives of research are given as: To apply the association rules with the relationships between the metabolic syndrome and the related chronic diseases.

- To discover the chronic diseases that usually occur with metabolic syndrome patients.
- To create the campaign obtain from research for the guideline of behavior in daily life with the suggestions of the metabolic syndrome prevention.

1.3 Research Scopes

This research uses the data of metabolic syndrome's patients taken from the government hospital during the period of 2007 - 2014. With the use of association rules techniques, we have two methods including: Apriori and FP-Growth for finding the relationships of the data represented by ICD-10 code.

1.4 Expected Results

1. To discover the relationships between metabolic syndrome and chronic diseases caused by metabolic syndrome with the use of data ICD-10 code.
2. To discover chronic disease that usually occurs with metabolic syndrome patients.
3. To conduct the suggestions, attitudes, and prevention of the metabolic syndrome.

1.5 Outline Summary

Chapter II is the background knowledge of metabolic syndrome, chronic syndrome, ICD-10, data mining, and related research. Chapter III presents the methodology. The results are given in Chapter IV. Lastly, discussion and conclusion are provided in Chapter V.

CHAPTER II
LITERATURE REVIEW

In this research, we start from the gathering data of patients with metabolic syndrome, and study the method for finding the relationships between metabolic syndrome and chronic disease caused by metabolic syndrome as our model. This chapter discusses the concepts of research study as follows:

2.1 Metabolic Syndrome,

2.2 Chronic Syndrome,

2.3 International Classification of Diseases and Related Health Problem 10^{th} Revision (ICD-10),

2.4 Data Mining,

2.5 Checking on the confidence values of the association rules,

2.6 Related Research.

2.1 Metabolic Syndrome

Metabolic syndrome [4] is obesity condition especially for the waist. It makes adversely affect various organ systems in body. The word "Metabolic syndrome" is widely used in medical terminology. This condition refers to a group of diseases caused by metabolic disorders, affecting the hyperlipidemia, hypertension, insulin resistance, heart disease, and high artery pressure. Hence, this disease group is called the syndrome X and insulin resistance syndrome.

The metabolic syndrome must satisfy the criteria at least 3 of 5 of the NCEP ATP III diagnostic criterion as follows:

1. The metabolic syndrome patient normally has the waist circumference $\geq$ 102 cm. for men and women with 88 cm. greater.

2. Levels of triglycerides in blood $\geq$ 150 mg. / Dl.

3. Levels of HDL cholesterol <40 mg. / Dl. for men and women with < 50 mg. / Dl.

4. Blood pressure ≥ 130/85 mm Hg., or having the medication to reduce the blood pressure at the time.

5. Levels of glucose while fasting ≥ 110 mg. / Dl.

Two major causes of metabolic syndrome are given as: the obesity and the insulin resistance. The obesity is imbalance of food intake and energy consumption of the body which makes the fat accumulation, especially for the abdominal surface and the waistline. It the body has the increasing number of fat cells, the intensity level of various latent hormones of fat cells will be increased in the bloodstream. Additionally, the genetic and external causes are the sources of insulin resistance including the obesity, aging process, and so on. Usually, the metabolic syndrome's patients would have the opportunity of insulin resistance rather than patient's abdominal obesity. Moreover, the metabolic syndrome also causes the Hypertension, high blood triglycerides, low blood cholesterol, low blood sugar, heart disease, and artery pressure, subsequently. Besides, lag of relaxation, sleep deprivation, stress, and working style with part-time job would generate the metabolic syndrome [5].

2.2 Chronic Syndrome

The word of "Chronic diseases" means a disease that the onset may without symptoms. However, the symptoms will be gradually intensified when it is not treated. It often needs to be continuely treated for lifelong, although it is not completely cured due to the acute redundancy symptoms. This disease is a major public health problem, lack of efficiency in the functioning of the patient, lack of the life quality, and wasteful spending for medical treatment. It also includes the diabetes, hypertension, heart disease, hypercholesterolemia, and cancer. For the causes of chronic diseases, there are several causes as follows [6]:

1. The immune system disorders: Given as: Allergies, Systemic Lupus Erythematosus, etc.

2. Genetic disorders: These are also included the psoriasis and diabetes type 1.

3. Lach of the life quality: Living with invalid prolonged life would be accreted the health disorders with various diseases.

4. The deterioration of various health mechanisms by aging: These symptoms often occur with the elderly as a naturally health mechanism occurring to everyone.

2.3 International Classification of Diseases and Related Health Problem 10th Revision (ICD-10)

International Classification of Diseases and Related Health Problem 10th Revision (ICD-10) is the code of the diseases/symptoms presented by the World Health Organization (WHO) [7]. There are aims to classify the diseases/symptoms according to the logs and the collection of statistics data in the international health planning.

ICD started in 1893 is to indicate the causes of death with the universal codes. In 1948, WHO had a responsibility to improve the ICD with edition of sixth edition. After that ICD-10 codes has been developed steadily and continuously updated the information. The latest edition of ICD10: 2010 was an update version in 2010.

By the Ministry of Health's declaration, ICD-10 system has two major sections as follows:

1. System of classification of the diseases and various health problems found in humans.

2. The diseases codes and health problem code.

ICD-10 codes are the alphanumeric codes. For each code, starting with English characters from A to Z following two to four digits of decimal numbers is merged with diseases code for each patient. The code providers must realize that a patient has any disease. In general, the ICD-10 codes will provide the disease code that the patient was just one disease. Providers the code wants to name the clear diagnosis

and looks great. The good characteristics name of disease consists of the three elements as follows:

1. The word which describes the disease of patient..
2. The word which describes the position and system of body causing the disease.
3. The word which describes the classification of disease.

2.3.1 The sorting of disease code

Disease code identification is necessary when the patients are admitted to the hospital. The staff will search the codes matching with the patient's symptoms and then sort those codes again to match the type of disease code. Similarly, providing the disease code to inpatient, the staff has to sort the disease code according to the various diseases as shown in the following principles:

2.3.1.1 Main condition code/ Principal diagnosis

2.3.1.2 Co-morbidity codes / Comorbidity

Comorbidity is the disease that appears together with the principal diagnosis. It is an acute disease causing the patient has the higher risk. In addition, the patient may use more resources during the treatment time.

2.3.1.3 Complication codes/ Complication

Complication is the disease that does not appear together with the principal diagnosis, but it appears after admission. The disease causes the patient has the higher risk. In addition, the patient may use more resources during the treatment time.

2.3.1.4 Other diagnosis codes / other diagnosis

Other diagnostic is the disease of the patient that is not related to the principal diagnosis, the comorbidity and the complication. This diagnosis does not have enough risk to harm patient's life. The resource is not required to use during treatment time. The disease may occur together with the primary diagnosis or found after admission.

2.3.1.5 External causes of injury/ External causes of injury and poisoning

The external causes of injury and poisoning is the data getting from the history. It consists of the cause of injury such as the accident, the suicide attack, etc. This information is used to prevent injuries that may be the cause of losing. The doctor has to identify the injury mechanism for all patients.

2.4 Data Mining

Data mining [8] is a process making with a hugh data to find the patterns and the hidden relationships in data set. Currently, data mining has been applied in task of numerous types to help in decision of executives in terms of science, medicine, economics, and social.

Data mining is the evolution of the storage and interpreting data easily. Firstly, original data storage was with the simple database. After then, database can be extracted the information. Data mining can discover the hidden knowledge in the data.

Data mining consisting of various a techniques is used in solutions. There are no any techniques that can solve every problem. Therefore, the variety of techniques must be investigated to find the best solution for data mining.

2.4.1 Data mining process

A standard process for data mining, called Cross-Industry Standard Process for Data Mining (CRISP-DM), consists of six major processes as follows [9]:

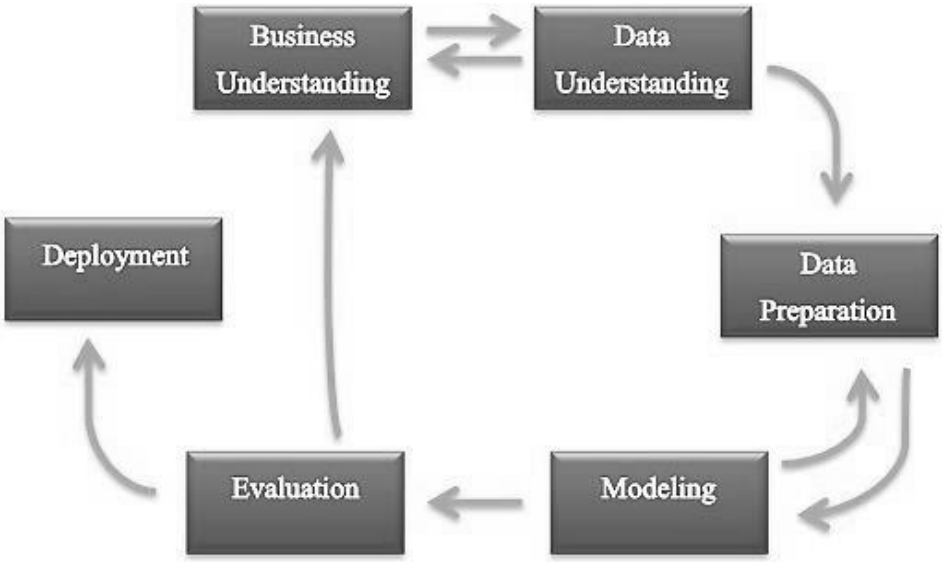


Figure 2.1 Data mining process.

2.4.1.1 Business understanding

The business understanding consists of assessing the current situation, developing the project plan, determining the objectives of business, and establishing data mining goals.

2.4.1.2 Data understanding

Once the project plan and business objectives are established, the data understanding considers the data requirement. This process includes the verification of the data quality, the data exploration, initial data collection, and the data description. The data exploration is given as, viewing the statistics summary occurred at the end of this process. For modeling, cluster analysis could also be applied during this process with the intention of identified pattern in the data.

2.4.1.3 Data preparation

The available data resources are identified to select, and built into the desirous, formatted, and cleaned form. Data transformation with cleaning in preparation of the data modeling needs to occur in this process. Data exploration at a greater depth could be applied during this process, and additional models utilized, again provided the opportunity to see patterns based on the business understanding. Data preparation can be divided into three steps, given as:

1) Data Selection: The target should be set before the data analysis.

2) Data Cleaning: In some cases, it may be found the invalid data, because of the problems in during data storage such as the incomplete data filling and redundancy of data filling. In this process, the data have to be filtered to eliminate the invalid, redundant, and missing data with a certain method such as considering from the average of data.

3) Data Transformation: It is the data preparation process providing the format ready to be analyzed with the algorithms of data mining.

2.4.1.4 Modeling

Data mining software tools including the cluster analysis and visualization are useful for the initial analysis. It is generalized induction rule that can develop the initial association rules. When the data is gained, the more details of model, that is suitable for the data type, can be applied. The training data section and the test sets are also need for modeling.

2.4.1.5 Evaluation

The results of model are evaluated in the context of the business objectives established in the first step. This phrase will identify the other needs, while the frequency is reverted to the steps of CRISP-DM. The gained understanding of business consists of the iterative procedure in data mining; artificial intelligence tools; the statistical results; and the various visualizations which show the new user relationship and provide the deep understanding of organization's operation.

2.4.1.6 Deployment

Data mining used both verification of the previous hypothesis and the discovered knowledge. The knowledge discovered in the earlier steps of the CRISP-DM sound models process is obtained, and applied to business operations for many purposes including prediction and identifying of key situation. These models are required to monitor the changes of conditions during the operating time, because it is not necessary to be always true. If there is any important change, the model should be redone. It is capable to record the results of data mining projects. Therefore, recognized documents will be available for the future study.

2.4.2 Association Rules

Association rule [8] is finding the relationship of data which is the same as the process in data mining, the most popular technique. For this part, the association rule is used to find the relation between two sets of data or more. Within the large data groups, it shows the relationship of events or objects occurred simultaneously. The example of using association rules consists of the analysis of product's data sold from the system storage at the point of sale (POS) or online shop. Then, considering the products that are often bought simultaneously by customers; for example, the people who buy the video will also buy the tape. The stores should arrange two products close together to increase the sale. The association rule consists of the processes of finding ways as following [10]:

2.4.2.1 Apriori algorithm

This is the most basic method to find all sets of items in the regulative database. The main concept of Apriori algorithm is to make multiple paths over the databases. It has the dependent characteristic which means "All non-empty item sets of frequent item set must be frequent" [10]. It is also used to explain the anti-monotonic characteristic, the system that cannot pass the minimum support test causing all supersets fail the test. Apriori algorithm has stages as follows: 1) Creation Stage, the candidate (k+1) – item set is created by using k-item set. After that, the C_k candidate set will be finally get; 2) The Trimming Stage, the candidate set is trimmed to create the large frequent item set using "minimum support" as the trimming parameter. This stage creates L_k large item set.

2.4.2.2 FP-Growth algorithm

In order to store database in the primary storage and calculate the support of all generated data sets, the FP-Growth algorithm uses the blend between the vertical and the horizontal model of a database. Instead of saving the scope of each element from the database, the transactions of the database are kept in terms of tree structures. Each data has a pointer for all contained transactions. FP-Growth [10] is another efficiently frequent mining pattern method. It creates frequent item sets without generation of candidate which is based on tree structure. The problem of Apriori algorithm is managed by the novel introduction and the compact data structure called the frequent pattern of tree, FP-tree. The FP-tree-based pattern segment growth

method is dependent structure developed to construct the conditional tree pattern and conditional pattern based on database, which satisfies the minimum support and FP-growth traces, the set of concomitant item. FP tree construction consists of: 1) Scanning data and counting support for each item; 2) Removing infrequent items; 3) Sorting frequent items in the descending order depended on their support; 4) Reading only one transaction at a time and mapping with the tree. For the order, it is fixed for sharing the path, while the pointer maintained between nodes contains the same items, and the frequent items are extracted from item.

2.5 Checking confidential association rules

Finding the confidence value of data's association rules is the results of selection process obtained by entering data to the process of association rules. The selected support and confidence value of association rules provide the reliability in acceptable level, which it can be explained according to the following principles [8]:

- Support value is used to represent the accuracy of association rules when the probability event occurred simultaneously. Which has the calculated formula as follows:

$$\text{Support} = P(A \cap B) = \frac{\text{Transaction number that A and B occurring simultaneously}}{\text{Transaction number that all occurring}}$$

- Confidence value is used to describe how much the actuality of acquired rules Which has the calculated formula as follows:

$$\text{Confidence} = P(A \mid B) = \frac{P(A \cap B)}{P(A)} = \frac{\text{Transaction number that A and B occurring simultaneously}}{\text{Transaction number that has A occurring}}$$

2.6 Related research

Garcia-Portilla et al. [11] proposed the predictive models of metabolic syndrome for patients by using schizophrenic or bipolar disorders. The research developed the prediction modeling of metabolic syndrome for the patients who have schizophrenic or bipolar disorders. This method was very helpful for both clinical practice and research. In generally, researchers spent one-year to follow-up this study conducted in Asturias of Spain. The 172 patients with schizophrenic or bipolar disorders symptom perform signing their name to consent to the study. Metabolic syndrome was defined according to the NCEP ATP-III criteria. MARS, GA, and SVM analysis were performed. The research developed the simple and easy prediction modeling to identify metabolic syndrome in schizophrenic or bipolar disorders patients. It was the same as studying of metabolic syndrome. The comparison result showed the research' advantages getting from one-year study were receiving data and the movement of data group. However, the number of patients in group was too low to represent for a large sample of data.

Osvaldo P. Almeida [12] proposed the obesity and metabolic syndrome that increased the risk of incident depression in older men. The research evaluated the relationships between various measures of the obesity and incident depression over 10 years in a large cohort of community-based older men. The 12,216 men aging between 65–84 years and living in Perth, Australia in 1996 and 1998 were selected. Those were measured their weight, blood pressure, height, and waist including hip circumference. Participants also fill the questionnaire containing information about the clinical diagnosis and treat for hypertension, diabetes, triglycerides, and high cholesterol together. After that, the Western Australian Linked Data System was used to extract the information about the ICD-10 diagnosis between 1 January, 1966 and 31 December, 2006; dysthymia; recurrent depressive disorder; and depressive episode. The results showed that the obesity and the metabolic syndrome were relationships of incident depression's increasing risk among older men. If this relationship was real, reducing prevalence of obesity and metabolic syndrome could be decreased in the prevalence and depression incidence. The related research used metabolic syndrome and ICD-10 in the study. The research will be advantaged, if big amounts of data were used. This is because it made the result has more effective. However, the data received

from questionnaire may is not totally true, because the patients may not fill actuality data.

Tai et al. [13] proposed the comorbidity study of ADHD applying the association rule mining (ARM) to National Health Insurance Database of Taiwan. This research applied association rule mining (ARM) to survey the labyrinthian network of ADHD comorbidity and examined the practicality of ARM in comorbidity study by using clinic databases. The clinic databases consisted of Taiwan National Health Insurance (NHI)'s enrollee records. The 18,321 youngsters had the age less than or equal to 18 years old. They had to be diagnosed the ADHD in the year 2001 and made all clinical diagnosis as the comorbidity. The information was divided according to "The International Classification of Disease, 9th Revision, Clinical Modification" (ICD-9-CM) diagnosis system. In comparison, the fourfold non-ADHD control were selected from 2001s NHI enrollee on a random database, but it had to paired the age and the gender of cases together. ARM was done by using Apriori algorithm for examination of association's strength among those diagnosed. The results of support value and confidence value of ARM were examined. Comorbidity rates and relative risk rate were compared to each other. The result showed the important role of DD between ADHD and other psychiatric comorbidity supported neurological finding in developmental delay of ADHD children's front cortex as well as the some epidemiology result. In addition, it also showed the practicality of ARM in comorbidity study by using hugely clinical databases like NHIRD. This related research was the same as the association rules research. The comparison result showed this research was very effective. However, the data of age is too low which is not efficient enough and it could not be used instead of the large diversity sample.

This chapter reviews the related information and the previous researches. Each part contains the important information that gives the good idea for development. The main topic consists of the various diseases such as metabolic syndrome, chronic diseases, ICD-10, and data mining. For the next chapter, the methodology of this research will be discussed.

CHAPTER III
METHODOLOGY

This chapter focuses the use of association rules techniques by Apriori and FP-Growth method for finding the relationship between metabolic syndrome and related chronic diseases. In this research, we use the data of the metabolic syndrome patients of government hospital in the modeling for finding the relationships of patient's data. The researchers will perform as follows:

3.1 Research Process

This research uses the association rules to find the relationship between metabolic syndrome and related chronic diseases. For the process for finding the relationships of patient's data, there are various processes, as shown in Figure 3.1.

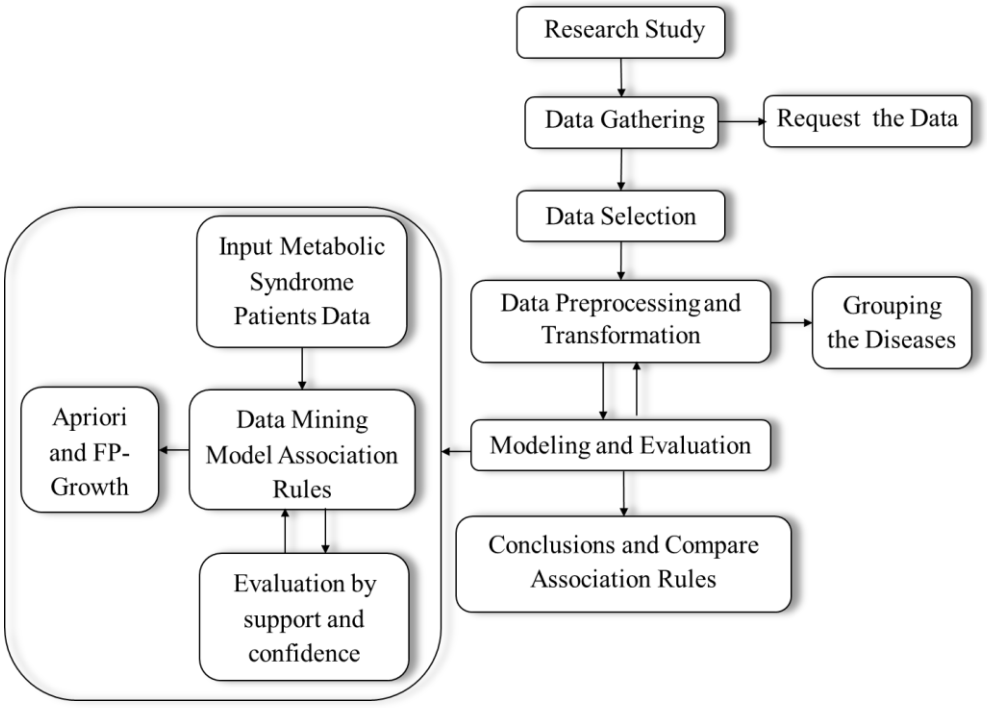


Figure 3.1 Research Process.

3.1.1 Research study

The research study is to search an interesting topic research. The concept is similar to the things that the researchers have to pay attention for the guideline in research.

1) Searching the interesting research

In the research study, it starts from searching an interesting topic research. For example, the researchers are interested about research with any aspect. Then, the research search for the selected topic of research. In addition, it would help to focus the scope of research study.

2) Conclusion of interesting research

After making the research study in the field of interesting study, the researchers summarize that research study including: the problem statements, method/solution for solving problem, and the obtained results of the researches.

3.1.2 Data gathering

For the patient's data, the researchers request the data of the metabolic syndrome patients during 2007-2014 from a government hospital. The data used in this study, it is a secondary data having been collected. With the data structure of 1,024 data sets, there are 13 attributes and 3,677 instances as demonstrated in Table 3.1 and Figure 3.2.

Table 3.1 The meaning of 13 attributes.

Attribute	Meaning
Idno	Auto number of SQL system.
sdate	Date that has eligible.
snc	The number of an OPD.
enc_type	Type the coming get service.
no_id	Number for service.
adate	Dates are IPD. (Date of hospital admission).
dx_date	Date of diagnosis.
dx_time	Time of diagnosis.
ward	The unit to admit.
dx_code	Diseases code.
dr_code	Physician code.
birthdate	Date of birth.
sex	Gender.

idno	sdate	snc	enc_type	no_id	adate	dx_date	dx_time	ward	dx_code	dr_code	birthdate	sex
7070688	27022014	4840122	AMB	10238431	NULL	27022014	17:11	VB0106	E889	NULL	01081996	1
7354629	22042014	4168053	AMB	10555235	NULL	22042014	15:18	OPD14	E889	NULL	15122007	2
7354630	22042014	4168053	AMB	10555235	NULL	22042014	15:18	OPD14	N183	NULL	15122007	2
7354631	22042014	4168053	AMB	10555235	NULL	22042014	15:18	OPD14	D509	NULL	15122007	2
8031175	19082014	4585278	AMB	11306668	NULL	19082014	14:42	OGY103	E039	NULL	25081989	2
8031176	19082014	4585278	AMB	11306668	NULL	19082014	14:42	OGY103	E889	NULL	25081989	2
8031177	19082014	4585278	AMB	11306668	NULL	19082014	14:42	OGY103	N970	NULL	25081989	2
8031178	19082014	4585278	AMB	11306668	NULL	19082014	14:42	OGY103	D352	NULL	25081989	2
1730286	13042011	4326978	EMER	157691	NULL	13042011	04:14	OER101	R230	NULL	02032009	1
1730287	13042011	4326978	EMER	157691	NULL	13042011	04:14	OER101	E889	NULL	02032009	1
1730288	13042011	4326978	EMER	157691	NULL	13042011	04:14	OER101	G409	NULL	02032009	1
50440	02092009	2854284	AMB	1606871	NULL	02092009	12:41	OMD01	E889	NULL	02031941	2

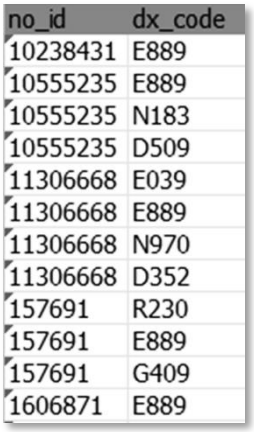
Figure 3.2 Data Structure of metabolic syndrome patients records.

3.1.3 Data Selection

In this process, the data gathering of the patients diagnosed with metabolic syndrome taken from a government hospital is used in the time selection. The data selection for finding the relationship between metabolic syndrome, and its related chronic diseases consists of 2 attribute, given as: no_id and dx_code, as shown in Table 3.2 and Figure 3.3.

Table 3.2 The meaning of 2 attributes.

Attribute	Meaning of Attribute
no_id	Number for service.
dx_code	Diseases code.



no_id	dx_code
10238431	E889
10555235	E889
10555235	N183
10555235	D509
11306668	E039
11306668	E889
11306668	N970
11306668	D352
157691	R230
157691	E889
157691	G409
1606871	E889

Figure 3.3 Data Selection of metabolic syndrome patients.

3.1.4 Data Preprocessing and Transformation

After processing the data selections, the data preprocessing and transformation will be performed. For the data transformation, we will classify the group of diseases with the data taken from previous process by using the attribute of "dx_code". Note: the attribute of "dx_code" is the diseases codes of patient treatment. From Table 3.3, we classify the similar symptoms into the same group, given as:

- Both disease codes of E119 (Non-insulin-dependent diabetes mellitus without complications) and E113 (Non-insulin-dependent diabetes mellitus with ophthalmic complication) are grouped into EX04 (diabetes);
- Both disease codes of E669 (Obesity, unspecified) and E668 (Other obesity) are grouped into EX03 (Obesity); and so on.

It would help to reduce the amount of attribute in the modeling. Then, we define the new code and new name for attribute data in each group, but it must be unique to the ICD-10 codes. After performing the data transformation, there are 85 attributes. In addition, the researchers will convert the attribute data of "no_id" from numeric data to nominal data. For example, a new generated patient ID of "no_id" is represented as ID1, ID2,…, ID1024, as shown in Figure 3.4. Where, "Y" means "with disease", and "N" means "No disease".

Table 3.3 ICD code with classified group merged with various diseases.

ICD code that group	Meaning	ICD-10 that merging
EX01	Metabolic syndrome.	E889, E789, E788, E880, E835
EX02	Hypertension.	I10, I129
EX03	Obesity.	E669, E668
EX04	Diabetes.	E119, E113, E149, H360, E112, N083, G590, E114, E142, E146, O240
EX05	Liver diseases.	K760, K758, B181, K759, Z225, B171, R945, B182, K746, Z944, B169, K716, K768, K859, K703, I820
EX06	Endocrine disease.	E282, E230, E278, E349, E274
EX07	Gout.	M1099, M1009, M1094, E790, M109

Table 3.3 ICD code with classified group merged with various diseases (cont.).

ICD code that group	Meaning	ICD-10 that merging
EX08	Kidney disease.	N189, N19, N180, N049, Q612, I701, N004, N009, Q605, Z940, Z992, N085
EX09	Psoriatic.	L409, L400, L405, L404, L408
EX10	Osteoarthritis of the knee.	M171, M179, M1999, M170
EX11	Asthma.	J459, J450
EX12	Heart disease.	I251, I259, I517, I422, I350, I351, I500, Q211, Q249, Q250, I330, I48
EX13	Disease involving the urinary system.	R80, N028, Q642, R398, R32, R31
EX14	Tumor.	C509, D352, D444, C189, C169, C349, C787, D34
EX15	Thyroid disease.	E039, E050, E031, E02, E030, E059, E890, R946
EX16	Anemia.	D638, D509, D529, D591, D649, D508, D551, D561, D560
EX17	Lung disease.	J449, A150, J691, J82, J91
EX18	Short stature disease.	Q871, E343
EX19	Disease about the menstruation.	N951, N911, N912, N920, N953
EX20	Diseases of the respiratory.	G473, R065, Z870, J069
EX21	Autoimmune disease.	M329, M321
EX22	Bone disease.	M4786, M8199, M8589, M4319, M4809, M4789, M8219, M8433, M925, Z478, S5210

Table 3.3 ICD code with classified group merged with various diseases (cont.).

ICD code that group	Meaning	ICD-10 that merging
EX23	Alcohol, Dependence syndrome.	F1025, F1020
EX24	Disease about the stomach.	K259, K279, K219, K30, K297
EX25	Brain and nervous system.	G560, G111, G20, G902, G911, H46, H470, I675, I693, R413, Z866, I610, I639, Q909
EX26	Paralysis.	I64, I694, G819
EX27	Stones disease.	K802, N200, K805
EX28	Disease about the headaches.	G442, R51
EX29	Mental disorder.	F319, F900, F2098, F799, F840, F819, F909, Z865, F2058
EX30	Arthritis.	M0730, M0908, M0739, M0230, M2557
EX31	Endometrial.	N850, N851, N800
EX32	Disease about the eye.	H101, H209, H405, Q120
EX33	Tonsil.	J350, A182, C833, J351
EX34	Disease about the ear.	H905, H919
EX35	Skin disorder.	L309, B07, L811, L219, R230
EX36	Diseases about the pharynx.	J00, J029
EX37	Back pain.	M5499, M5496
EX38	Muscle disease.	M6269, M7919
EX39	Pure hypercholesterolaemia.	E781, E785, E780
EX40	Vertigo.	H811, R42
EX41	Vascular disease.	I739, I776

Table 3.3 ICD code with classified group merged with various diseases (cont.).

ICD code that group	Meaning	ICD-10 that merging
EX42	Hypokalemia and hyperkalemia.	E876, E875
EX43	Disease about the Breast.	N63, N62
EX44	NULL	N184, N183, N185
EX45	N/A	M5456, M5459, 9146
EX46	Female infertility.	N970, N979
EX47	Follow-up examination after treatment.	Z099, Z098
R730	Abnormal glucose tolerance test.	R730
J304	Allergic rhinitis, unspecified.	J304
Z135	Special screening examination for eye and ear disorders.	Z135
B24	AIDS, unspecified human immunodeficiency virus [HIV] disease.	B24
E559	Vitamin D Deficiency, unspecified.	E559
N40	Hyperplasia of prostate.	N40
G409	Epilepsy, unspecified.	G409
Z002	Examination for period of rapid growth in childhood.	Z002

Table 3.3 ICD code with classified group merged with various diseases (cont.).

ICD code that group	Meaning	ICD-10 that merging
E041	Thyroid nodule, nontoxic single.	E041
K590	Constipation.	K590
O926	Galactorrhoea.	O926
E46	Unspecified protein-energy malnutrition.	E46
G250	Essential tremor.	G250
G470	Disorders of initiating and maintaining sleep [insomnias].	G470
R471	Dysarthria and anarthria.	R471
Z014	Gynaecological examination (general)(routine).	Z014
Z088	Follow-up examination after other treatment for malignant neoplasm.	Z088
Z877	Personal history of congenital malformations, deformations and chromosomal.	Z877
B029	Zoster without complication.	B029
B699	Cysticercosis, unspecified.	B699

Table 3.3 ICD code with classified group merged with various diseases (cont.).

ICD code that group	Meaning	ICD-10 that merging
B909	Sequelae of respiratory and unspecified tuberculosis.	B909
B968	Other specified bacterial agents as the cause of diseases classified to other.	B968
D688	Other specified coagulation defects.	D688
E86	Hypovolemia, volume depletion.	E86
J209	Bronchitis, acute unspecified.	J209
N433	Hydrocele, unspecified.	N433
N938	Other specified abnormal uterine and vaginal bleeding.	N938
P920	Vomiting in newborn	P920
R101	Pain localized to upper abdomen.	R101
R11	Nausea and Vomiting.	R11
R55	Syncope and collapse.	R55
R635	Abnormal weight gain.	R635
T618	Toxic effect of other seafood.	T618

Table 3.3 ICD code with classified group merged with various diseases (cont.).

ICD code that group	Meaning	ICD-10 that merging
Z000	General medical examination.	Z000
Z038	Observation for other suspected diseases and conditions.	Z038
Z713	Dietary counselling and surveillance.	Z713
Z768	Persons encountering health services in other specified circumstances.	Z768
Z861	Personal history of infectious and parasitic diseases.	Z861

no_id	B029	B24	B699	B909	B968	D688	E041	E46	E559	E86	EX01	EX02	EX03	EX04	EX05
ID1	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	N	N
ID2	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	N	N
ID3	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y
ID4	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y
ID5	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	N
ID6	N	N	N	N	N	N	N	N	N	N	Y	N	Y	Y	Y
ID7	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	N
ID8	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y	N
ID9	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y	N
ID10	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y	N
ID11	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y	N
ID12	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y	N
ID13	N	N	N	N	N	N	N	N	N	N	Y	N	Y	Y	Y
ID14	N	N	N	N	N	N	N	N	N	N	Y	Y	N	Y	N
ID15	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y
ID16	N	N	N	N	N	N	N	N	N	N	Y	N	N	Y	N

Figure 3.4 Data Preprocess of metabolic syndrome patients.

3.1.5 Modeling and evaluation using data mining

The data of patient with metabolic syndrome feed to the model as an input data with the selective algorithm of either Apriori or FP-Growth. Then, the algorithm model would process to obtain both support values and confident values. Then, we have compared both of methods for the results of matched association rules.

3.1.6 Conclusions on the research, suggestions, and attitudes

We bring the results of models with the comparison between Apriori and FP-Growth in order to conclude the results of the relationships between metabolic syndrome and chronic diseases. Furthermore, by the results, we would represent the attribute suggestions and prevention of metabolic syndrome for our lifestyle.

3.2 Research Schedule

The steps and operating methods of research cloud explain as Table 3.4.

Table 3.4 Scheduling of Research.

No	Steps and operating methods	Month, 2014																			
		August				September				October				November				December			
		W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
1	Research Interests study																				
2	Data Gathering																				
3	Data Selection																				
4	Data Preprocessing and Transformation																				
5	Modeling and evaluation using data mining																				
6	Conclusions the research and offer the suggestions, attitudes																				

This chapter are discusses methodology of this research. Next chapter are discussed experimental results received from processes of data.

CHAPTER IV
EXPERIMENTAL RESULTS

This research focuses the use of data of patients diagnosed to be metabolic syndrome for finding the relationships between metabolic syndrome and its related chronic diseases. The researcher uses the techniques of association rules by using Apriori and FP-Growth method. In this chapter, from the modeling for finding the association rules of patient's data, the analysis results can be explained as follows:

4.1 Results of Apriori

With the modeling of the association rules for finding the relationships between metabolic syndrome and its related chronic diseases for the 1,024 metabolic syndrome patients, by using Apriori method, it has the minimum support value of 0.1 and minimum confidence value of 0.1, there are given six rules, as shown in Table 4.1.

Table 4.1 Association rules results of Apriori.

No.	Association Rules	Support (%)	Confidence (%)
1	EX04 ==> EX02	10	67
2	EX03 ==> EX02	10	52
3	EX02 ==> EX04	10	51
4	EX04 ==> EX03	10	45
5	EX02 ==> EX03	10	43
6	EX03 ==> EX04	10	42

From Table 4.1, it can be interpreted the discovery rules, given as:

Rule 1 : If patients are metabolic syndrome (EX01) and diabetes (EX04), the patients would be hypertension (EX02).

Rule 2 : If patients are metabolic syndrome (EX01) and obesity (EX03), the patients would be hypertension (EX02).

Rule 3 : If patients are metabolic syndrome (EX01) and hypertension (EX02), the patients would be diabetes (EX04).

Rule 4 : If patients are metabolic syndrome (EX01) and diabetes (EX04), the patients would be obesity (EX03).

Rule 5 : If patients are metabolic syndrome (EX01) and hypertension (EX02), the patients would be obesity (EX03).

Rule 6 : If patients are metabolic syndrome (EX01) and obesity (EX03), the patients would be diabetes (EX04).

The rule with the best and high confidence is given as: if patients are metabolic syndrome and diabetes, the patients would be hypertension with given association rules' confidence value of 67%, which both of diseases are the most frequently occuring in metabolic syndrome patients by Apriori method.

4.2 Results of FP-Growth

With the modeling of association rules for finding the relationships between metabolic syndrome and its related chronic diseases for the 1,024 metabolic syndrome patients, by using FP-Growth method, it has the minimum support value of 0.1 and minimum confidence value of 0.1. There are given 724 rules. Total 10 rules are discovered as shown in Table 4.2.

Table 4.2 Association rules results of FP-Growth.

No.	Association Rules	Support (%)	Confidence (%)
1	EX13 ==> Z877	98.1	100
2	EX20 ==> Z877	88.1	100
3	EX03 ==> Z877	69.4	100
4	EX02 ==> Z877	62.8	100
5	EX04 ==> Z877	28.3	100
6	EX05 ==> Z877	16.4	100
7	EX05 ==> EX13	16.4	100
8	R730 ==> EX13	9.8	100
9	R730 ==> Z877	9.8	100
10	EX07 ==> Z877	6.2	100

From Table 4.2, it can be interpreted the discovery rules, given as:

Rule 1 : If patients are metabolic syndrome (EX01) and disease involving the urinary system (EX13), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 2 : If patients are metabolic syndrome (EX01) and diseases of the respiratory (EX20), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 3 : If patients are metabolic syndrome (EX01) and obesity (EX03), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 4 : If patients are metabolic syndrome (EX01) and hypertension (EX02), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 5 : If patients are metabolic syndrome (EX01) and diabetes (EX04), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 6 : If patients are metabolic syndrome (EX01) and liver diseases (EX05), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 7 : If patients are metabolic syndrome (EX01) and liver diseases (EX05), the patients would be disease involving the urinary system (EX13).

Rule 8 : If patients are metabolic syndrome (EX01) and abnormal glucose tolerance test (R730), the patients would be disease involving the urinary system (EX13).

Rule 9 : If patients are metabolic syndrome (EX01) and abnormal glucose tolerance test (R730), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 10 : If patients are metabolic syndrome (EX01) and gout (EX07), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

The rule with the best and high confidence is given as: if patients are metabolic syndrome and disease involving the urinary system, the patients would be personal history of congenital malformations, deformations, and chromosomal with given association rules' confidence value of 100%. Both of diseases are the most frequently occuring in metabolic syndrome patients by FP-Growth method.

4.3 Comparison between Apriori and FP-Growth on the experimental results

According to the results of Apriori and FP-Growth, the comparative results are shown that there are six common association rules to extract by both of methods, as shown in Table 4.3.

Table 4.3 The comparison between Apriori and FP-Growth on that same association rules.

No.	Association Rules	Apriori		FP-Growth	
		Support (%)	Confidence (%)	Support (%)	Confidence (%)
1	EX03 ==> EX02	10	52	48	69.2
2	EX02 ==> EX03	10	43	48	76.5
3	EX04 ==> EX02	10	67	9.5	33.4
4	EX04 ==> EX03	10	45	15.6	55.2
5	EX02 ==> EX04	10	51	9.5	15.1
6	EX03 ==> EX04	10	42	15.6	22.5

From Table 4.3, it can be interpreted the discovery rules, given as:

Rule 1 : If patients are metabolic syndrome (EX01) and obesity (EX03), the patients would be hypertension (EX02).

Rule 2 : If patients are metabolic syndrome (EX01) and hypertension (EX02), the patients would be obesity (EX03).

Rule 3 : If patients are metabolic syndrome (EX01) and diabetes (EX04), the patients would be Hypertension (EX02).

Rule 4 : If patients are metabolic syndrome (EX01) and diabetes (EX04), the patients would be obesity (EX03).

Rule 5 : If patients are metabolic syndrome (EX01) and hypertension (EX02), the patients would be diabetes (EX04).

Rule 6 : If patients are metabolic syndrome (EX01) and obesity (EX03), the patients would be diabetes (EX04).

The comparisons between Apriori and FP-Growth are shown that the metabolic syndrome patients mostly have the relationship with obesity, hypertension, and diabetes. These diseases are the most frequently occurred diseases in metabolic syndrome patients.

There are the association rules that are not common with the several rules taken from the comparison between Apriori and FP-Growth, which those rules are extracted by FP-Growth only, as the example in Table 4.4.

Table 4.4 The comparison between Apriori and FP-Growth on the unmatched association rules.

No.	Association Rules	Support (%)	Confidence (%)
1	EX13 ==> Z877	98.1	100
2	EX20 ==> Z877	88.1	100
3	EX03 ==> Z877	69.4	100
4	EX02 ==> Z877	62.8	100
5	EX04 ==> Z877	28.3	100

From Table 4.4, it can be interpreted the discovery rules, given as:

Rule 1 : If patients are metabolic syndrome (EX01) and disease involving the urinary system (EX13), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 2 : If patients are metabolic syndrome (EX01) and diseases of the respiratory (EX20), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 3 : If patients are metabolic syndrome (EX01) and obesity (EX03), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 4 : If patients are metabolic syndrome (EX01) and hypertension (EX02), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

Rule 5 : If patients are metabolic syndrome (EX01) and diabetes (EX04), the patients would be personal history of congenital malformations, deformations, and chromosomal (Z877).

The association rules are not common with the comparison between Apriori and FP-Growth because of the differences in methods, which Apriori is based on frequency, FP-Growth is based on tree.

The research results of both methods are shown that Apriroi is the best method for finding the relationships between metabolic syndrome and its related chronic diseases.

4.4 The Campaign obtained from Research

From the experimental results, it is make the researchers can create campaign as follows:

- Patients with obesity are occurred from patients enjoying the foods with sugar, fat, Dietary starch, carouse, Lack of exercise, etc. Hence, if metabolic syndrome patients have these characters, the patients would enable to be obesity.
- Patients with hypertension are occurred by enjoying the salty food, drug, strain, etc. Hence, if metabolic syndrome patients have these characters, those would enable to be hypertension.
- Patients with diabetes are occurred from the patients with hypertension, dyslipidemia, genetics with diabetes genes, and so on. Hence, if metabolic syndrome patients have these characters, those would enable to be diabetes.

This chapter are discusses experimental results receive from processes of this research. Next chapter are discussion, conclusions, and suggestions.

CHAPTER V
DISCUSSION AND CONCLUSION

This research focuses the use of data of patients diagnosed to be metabolic syndrome for finding the relationship between metabolic syndrome and chronic diseases with the association rules techniques by Apriori and FP-Growth method. By the experimental results, the discussion is also given, conclusion and suggestion are also described as follows.

5.1 Research Discussion

From research results, the discussion is also given as follows:

This research is to apply the association rules with Apriori and FP-Growth methods in order to discover the relationship between metabolic syndrome and its chronic diseases represented by ICD-10. The results are shown that Apriori can extract 6 rules and 724 rules from FP-Growth. With the comparisons between Apriori and FP-Growth method, it is found that there are the 6 rules which are the same for finding the relationship. Moreover, the metabolic syndrome patients mostly have the relationships with diabetes, hypertension, and obesity. From the results, the researchers can create the campaign of research for the guidelines of behavior in daily life. For example, the patients with obesity are occurred by enjoying the foods with sugar, fat, dietary starch, carouse, lack of exercise, etc. Hence, if metabolic syndrome patients have these characters, those would enable to be obesity.

The experimental results are shown that Apriroi is the best method for finding the relationships between metabolic syndrome and its related chronic diseases.

This research have the advantages for finding the relationship between chronic diseases and other diseases on the large data. It make the comprehensive relationship of the various diseases that the metabolic syndrome patients are likely to

be these diseases. However, the number of factors and data of patients diagnosed with metabolic syndrome are not sufficient to represent as a large sample of data.

However, with the association rules techniques on the data, the results of the metabolic syndrome patients is not mean that the patient diagnosed with metabolic syndrome will a chronic disease for 100%. In fact, it depends on the patient's life style. The analysis results as above are the data for studying the relationships of the diseases to make the decision of the medical treatment.

5.2 Research Conclusion

From the results for finding the relationships between metabolic syndrome and chronic diseases, the conclusion can be given as follows:

1) The results of Apriori method are found with the association rules of 6 interesting rules, for example:

- If patients diagnosed with metabolic syndromes are the diabetes along, the patients have the chance to be hypertension.
- If patients diagnosed with metabolic syndromes are the obesity along, the patients have the chance to be hypertension.

For Apriori method, it is shown that the metabolic syndrome patients mostly have the relationship with diabetes, obesity, and hypertension. But, the rule that has the best and high confidence as: if patients are the metabolic syndromes and diabetes, the patients would be the hypertension with given association rules' confidence value of 67%, which both diseases are the most appearances in metabolic syndrome patients by Apriori method.

2) The results of FP-Growth method are found with the association rules of 10 interesting rules, for example:

- If patients diagnosed with metabolic syndrome are the disease involving the urinary system along, the patients have the chance to be personal history of congenital malformations, deformations, and chromosomal.
- If patients diagnosed with metabolic syndrome are the diseases of the respiratory along, the patients have the chance to be personal history of congenital malformations, deformations, and chromosomal.

For FP-Growth method, it shows that the metabolic syndrome patients mostly have the relationship with Disease involving the urinary system, Diseases of respiratory, Personal history of congenital malformations, deformations and chromosomal, Obesity, Hypertension, Diabetes, Liver diseases, Abnormal glucose tolerance test, and Gout. However, the rule that has the best and high confidence as: if patients are metabolic syndrome and disease involving the urinary system, the patients would be personal history of congenital malformations, deformations, and chromosomal with given association rules' confidence value of 100%. Both diseases are the most appearances in metabolic syndrome patients by using FP-Growth method.

3) The comparison of the association rules results between Apriori and FP-Growth method are found the same of 6 interesting rules, for example:

- If patients diagnosed with metabolic syndromes are the obesity along, the patients have the chance to be hypertension.
- If patients diagnosed with metabolic syndromes are the hypertension along, the patients have the chance to be obesity.

The results from comparison between Apriori and FP-Growth are shown that the metabolic syndrome patients mostly have the relationship with obesity, hypertension, and diabetes, these diseases are the most appearances in metabolic syndrome patients.

4) The comparison results of association rules between Apriori and FP-Growth method are found that the association rules with unmatched rules are given as 718 rules, for example:

- If patients diagnosed with metabolic syndromes are the diseases involving the urinary system along, the patients have the chance to be personal history of congenital malformations, deformations, and chromosomal.
- If patients diagnosed with metabolic syndromes are the diseases of the respiratory along, the patiens have the chance to be personal history of congenital malformations, deformations, and chromosomal.

The association rules are not common with comparison of Apriori and FP-Growth, because of differences in methods. It is that Apriori is the frequency method, whereas FP-Growth is the tree method.

5.3 Suggestions for Future Works

5.3.1 The suggestions of the research results for the applications.

1) The physician is able to use the results taken from the research to apply the treatment of metabolic syndrome patients and other patients in future.

2) The general people could use the results taken from the research to guide the lifestyle of human in future.

5.3.2 The suggestions for the research in next time.

1) In the future, we should increase the number of patients diagnosed with metabolic syndrome for analyzing the relationships in order to provide more effective.

2) In the future, we should gather the more detail of metabolic syndrome patients on the other side of data such as age, gender, weight, etc. Then, the data should be used for more efficiency in analysis of relationship.

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APPENDICES

APPENDIX A
ASSOCIATION RULES RESULTS OF APRIORI

Table A Association rules results of Apriori.

No.	Association Rules	Support	Confidence
1	EX04 ==> EX02	0.1	0.67
2	EX03 ==> EX02	0.1	0.52
3	EX02 ==> EX04	0.1	0.51
4	EX04 ==> EX03	0.1	0.45
5	EX02 ==> EX03	0.1	0.43
6	EX03 ==> EX04	0.1	0.42

APPENDIX B

ASSOCIATION RULES RESULTS OF FP-GROWTH

Table B Association rules results of FP-Growth.

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
1	EX13	Z877	0.981	1.0
2	EX20	Z877	0.881	1.0
3	EX03	Z877	0.694	1.0
4	EX02	Z877	0.628	1.0
5	EX04	Z877	0.283	1.0
6	EX05	Z877	0.164	1.0
7	R730	Z877	0.098	1.0
8	EX07	Z877	0.063	1.0
9	EX05	EX13	0.164	1.0
10	R730	EX13	0.098	1.0
11	EX13 , EX20	Z877	0.864	1.0
12	EX13 , EX03	Z877	0.686	1.0
13	EX13 , EX02	Z877	0.618	1.0
14	EX13 , EX04	Z877	0.273	1.0
15	EX05	Z877 , EX13	0.164	1.0
16	Z877 , EX05	EX13	0.164	1.0
17	EX13 , EX05	Z877	0.164	1.0
18	R730	Z877 , EX13	0.098	1.0
19	Z877 , R730	EX13	0.098	1.0

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
20	EX13 , R730	Z877	0.098	1.0
21	EX13 , EX07	Z877	0.098	1.0
22	EX20 , EX03	Z877	0.062	1.0
23	EX20 , EX02	Z877	0.649	1.0
24	EX20 , EX04	Z877	0.564	1.0
25	EX20 , EX05	Z877	0.254	1.0
26	EX20 , R730	Z877	0.144	1.0
27	EX03 , EX02	Z877	0.075	1.0
28	EX03 , EX04	Z877	0.481	1.0
29	EX03 , EX05	Z877	0.156	1.0
30	EX02 , EX04	Z877	0.107	1.0
31	EX02 , EX05	Z877	0.095	1.0
32	EX04 , EX05	Z877	0.074	1.0
33	EX20 , EX05	EX13	0.065	1.0
34	EX20 , R730	EX13	0.144	1.0
35	EX03 , EX05	EX13	0.075	1.0
36	EX02 , EX05	EX13	0.107	1.0
37	EX04 , EX05	EX13	0.074	1.0
38	EX13 , EX20 , EX03	Z877	0.064	1.0
39	EX13 , EX20 , EX02	Z877	0.641	1.0
40	EX13 , EX20 , EX04	Z877	0.554	1.0
41	EX20 , EX05	Z877 , EX13	0.244	1.0
42	Z877 , EX20 , EX05	EX13	0.144	1.0
43	EX13 , EX20 , EX05	Z877	0.144	1.0

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
44	EX20 , R730	Z877 , EX13	0.075	1.0
45	Z877 , EX20 , R730	EX13	0.075	1.0
46	EX13 , EX20 , R730	Z877	0.075	1.0
47	EX13 , EX03 , EX02	Z877	0.478	1.0
48	EX13 , EX03 , EX04	Z877	0.151	1.0
49	EX03 , EX05	Z877 , EX13	0.106	1.0
50	Z877 , EX03 , EX05	EX13	0.106	1.0
51	EX13 , EX03 , EX05	Z877	0.106	1.0
52	EX13 , EX02 , EX04	Z877	0.09	1.0
53	EX02 , EX05	Z877 , EX13	0.074	1.0
54	Z877 , EX02 , EX05	EX13	0.074	1.0
55	EX13 , EX02 , EX05	Z877	0.074	1.0
56	EX04 , EX05	Z877 , EX13	0.064	1.0
57	Z877 , EX04 , EX05	EX13	0.064	1.0
58	EX13 , EX04 , EX05	Z877	0.064	1.0
59	EX20 , EX03 , EX02	Z877	0.456	1.0
60	EX20 , EX03 , EX04	Z877	0.148	1.0
61	EX20 , EX03 , EX05	Z877	0.102	1.0
62	EX20 , EX02 , EX04	Z877	0.087	1.0
63	EX20 , EX02 , EX05	Z877	0.07	1.0
64	EX20 , EX04 , EX05	Z877	0.06	1.0
65	EX03 , EX02 , EX05	Z877	0.061	1.0
66	EX20 , EX03 , EX05	EX13	0.102	1.0
67	EX20 , EX02 , EX05	EX13	0.07	1.0

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
68	EX20 , EX04 , EX05	EX13	0.06	1.0
69	EX03 , EX02 , EX05	EX13	0.061	1.0
70	EX13 , EX20 , EX03 , EX02	Z877	0.453	1.0
71	EX13 , EX20 , EX03 , EX04	Z877	0.144	1.0
72	EX20 , EX03 , EX05	Z877 , EX13	0.102	1.0
73	Z877 , EX20 , EX03 , EX05	EX13	0.102	1.0
74	EX13 , EX20 , EX03 , EX05	Z877	0.102	1.0
75	EX13 , EX20 , EX02 , EX04	Z877	0.082	1.0
76	EX20 , EX02 , EX05	Z877 , EX13	0.07	1.0
77	Z877 , EX20 , EX02 , EX05	EX13	0.07	1.0
78	EX13 , EX20 , EX02 , EX05	Z877	0.07	1.0
79	EX20 , EX04 , EX05	Z877 , EX13	0.06	1.0
80	Z877 , EX20 , EX04 , EX05	EX13	0.06	1.0
81	EX13 , EX20 , EX04 , EX05	Z877	0.06	1.0
82	EX03 , EX02 , EX05	Z877 , EX13	0.061	1.0
83	Z877 , EX03 , EX02 , EX05	EX13	0.061	1.0
84	EX13 , EX03 , EX02 , EX05	Z877	0.061	1.0

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
85	EX03 , EX02	EX13	0.478	0.994
86	EX03 , EX02	Z877 , EX13	0.478	0.994
87	Z877 , EX03 , EX02	EX13	0.478	0.994
88	EX20 , EX03 , EX02	EX13	0.453	0.994
89	EX20 , EX03 , EX02	Z877 , EX13	0.453	0.994
90	Z877 , EX20 , EX03 , EX02	EX13	0.453	0.994
91	EX03	EX13	0.686	0.987
92	EX03	Z877 , EX13	0.686	0.987
93	Z877 , EX03	EX13	0.686	0.987
94	EX20 , EX03	EX13	0.641	0.986
95	EX20 , EX03	Z877 , EX13	0.641	0.986
96	Z877 , EX20 , EX03	EX13	0.641	0.986
97	EX02	EX13	0.618	0.984
98	EX02	Z877 , EX13	0.618	0.984
99	Z877 , EX02	EX13	0.618	0.984
100	EX07	EX13	0.062	0.984
101	EX07	Z877 , EX13	0.062	0.984
102	Z877 , EX07	EX13	0.062	0.984
103	Z877	EX13	0.981	0.983
104	EX20 , EX02	EX13	0.554	0.983
105	EX20 , EX02	Z877 , EX13	0.554	0.983
106	Z877 , EX20 , EX02	EX13	0.554	0.983
107	EX20	EX13	0.864	0.981

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
108	EX20	Z877 , EX13	0.864	0.981
109	Z877 , EX20	EX13	0.864	0.981
110	EX03 , EX04	EX13	0.151	0.969
111	EX03 , EX04	Z877 , EX13	0.151	0.969
112	Z877 , EX03 , EX04	EX13	0.151	0.969
113	EX20 , EX03 , EX04	EX13	0.144	0.967
114	EX20 , EX03 , EX04	Z877 , EX13	0.144	0.967
115	Z877 , EX20 , EX03 , EX04	EX13	0.144	0.967
116	EX04	EX13	0.273	0.966
117	EX04	Z877 , EX13	0.273	0.966
118	Z877 , EX04	EX13	0.273	0.966
119	EX20 , EX04	EX13	0.244	0.962
120	EX20 , EX04	Z877 , EX13	0.244	0.962
121	Z877 , EX20 , EX04	EX13	0.244	0.962
122	EX03 , EX05	EX20	0.102	0.954
123	EX03 , EX05	Z877 , EX20	0.102	0.954
124	Z877 , EX03 , EX05	EX20	0.102	0.954
125	EX03 , EX05	EX13 , EX20	0.102	0.954
126	EX13 , EX03 , EX05	EX20	0.102	0.954
127	EX03 , EX05	Z877 , EX13 , EX20	0.102	0.954
128	Z877 , EX03 , EX05	EX13 , EX20	0.102	0.954
129	EX13 , EX03 , EX05	Z877 , EX20	0.102	0.954

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
130	Z877 , EX13 , EX03 , EX05	EX20	0.102	0.954
131	EX03 , EX04	EX20	0.148	0.95
132	EX03 , EX04	Z877 , EX20	0.148	0.95
133	Z877 , EX03 , EX04	EX20	0.148	0.95
134	EX03 , EX02	EX20	0.456	0.949
135	EX03 , EX02	Z877 , EX20	0.456	0.949
136	Z877 , EX03 , EX02	EX20	0.456	0.949
137	EX13 , EX03 , EX02	EX20	0.453	0.949
138	EX13 , EX03 , EX02	Z877 , EX20	0.453	0.949
139	Z877 , EX13 , EX03 , EX02	EX20	0.453	0.949
140	EX02 , EX04	EX13	0.09	0.948
141	EX02 , EX04	Z877 , EX13	0.09	0.948
142	Z877 , EX02 , EX04	EX13	0.09	0.948
143	EX13 , EX03 , EX04	EX20	0.144	0.948
144	EX13 , EX03 , EX04	Z877 , EX20	0.144	0.948
145	Z877 , EX13 , EX03 , EX04	EX20	0.144	0.948
146	EX02 , EX05	EX20	0.07	0.947
147	EX02 , EX05	Z877 , EX20	0.07	0.947
148	Z877 , EX02 , EX05	EX20	0.07	0.947
149	EX02 , EX05	EX13 , EX20	0.07	0.947
150	EX13 , EX02 , EX05	EX20	0.07	0.947

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
151	EX02 , EX05	Z877 , EX13 , EX20	0.07	0.947
152	Z877 , EX02 , EX05	EX13 , EX20	0.07	0.947
153	EX13 , EX02 , EX05	Z877 , EX20	0.07	0.947
154	Z877 , EX13 , EX02 , EX05	EX20	0.07	0.947
155	EX20 , EX02 , EX04	EX13	0.082	0.944
156	EX20 , EX02 , EX04	Z877 , EX13	0.082	0.944
157	Z877 , EX20 , EX02 , EX04	EX13	0.082	0.944
158	EX03 , EX02	EX13 , EX20	0.453	0.943
159	EX03 , EX02	Z877 , EX13 , EX20	0.453	0.943
160	Z877 , EX03 , EX02	EX13 , EX20	0.453	0.943
161	EX03	EX20	0.649	0.935
162	EX03	Z877 , EX20	0.649	0.935
163	Z877 , EX03	EX20	0.649	0.935
164	EX13 , EX03	EX20	0.641	0.934
165	EX13 , EX03	Z877 , EX20	0.641	0.934
166	Z877 , EX13 , EX03	EX20	0.641	0.934
167	EX04 , EX05	EX20	0.06	0.924
168	EX04 , EX05	Z877 , EX20	0.06	0.924
169	Z877 , EX04 , EX05	EX20	0.06	0.924
170	EX04 , EX05	EX13 , EX20	0.06	0.924
171	EX13 , EX04 , EX05	EX20	0.06	0.924
172	EX04 , EX05	Z877 , EX13 , EX20	0.06	0.924

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
173	Z877 , EX04 , EX05	EX13 , EX20	0.06	0.924
174	EX13 , EX04 , EX05	Z877 , EX20	0.06	0.924
175	Z877 , EX13 , EX04 , EX05	EX20	0.06	0.924
176	EX03	EX13 , EX20	0.641	0.923
177	EX03	Z877 , EX13 , EX20	0.641	0.923
178	Z877 , EX03	EX13 , EX20	0.641	0.923
179	EX03 , EX04	EX13 , EX20	0.144	0.919
180	EX03 , EX04	Z877 , EX13 , EX20	0.144	0.919
181	Z877 , EX03 , EX04	EX13 , EX20	0.144	0.919
182	EX02 , EX04	EX20	0.087	0.918
183	EX02 , EX04	Z877 , EX20	0.087	0.918
184	Z877 , EX02 , EX04	EX20	0.087	0.918
185	EX13 , EX02 , EX04	EX20	0.082	0.913
186	EX13 , EX02 , EX04	Z877 , EX20	0.082	0.913
187	Z877 , EX13 , EX02 , EX04	EX20	0.082	0.913
188	EX02	EX20	0.563	0.897
189	EX02	Z877 , EX20	0.563	0.897
190	Z877 , EX02	EX20	0.563	0.897
191	EX04	EX20	0.254	0.897
192	EX04	Z877 , EX20	0.254	0.897
193	Z877 , EX04	EX20	0.254	0.897
194	EX13 , EX02	EX20	0.554	0.896

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
195	EX13 , EX02	Z877 , EX20	0.554	0.896
196	Z877 , EX13 , EX02	EX20	0.554	0.896
197	EX13 , EX04	EX20	0.244	0.893
198	EX13 , EX04	Z877 , EX20	0.244	0.893
199	Z877 , EX13 , EX04	EX20	0.244	0.893
200	Z877	EX20	0.881	0.883
201	EX02	EX13 , EX20	0.554	0.882
202	EX02	Z877 , EX13 , EX20	0.554	0.882
203	Z877 , EX02	EX13 , EX20	0.554	0.882
204	EX13	EX20	0.864	0.881
205	EX13	Z877 , EX20	0.864	0.881
206	Z877 , EX13	EX20	0.864	0.881
207	EX05	EX20	0.144	0.875
208	EX05	Z877 , EX20	0.144	0.875
209	Z877 , EX05	EX20	0.144	0.875
210	EX05	EX13 , EX20	0.144	0.875
211	EX13 , EX05	EX20	0.144	0.875
212	EX05	Z877 , EX13 , EX20	0.144	0.875
213	Z877 , EX05	EX13 , EX20	0.144	0.875
214	EX13 , EX05	Z877 , EX20	0.144	0.875
215	Z877 , EX13 , EX05	EX20	0.144	0.875
216	EX02 , EX04	EX13 , EX20	0.082	0.866
217	EX02 , EX04	Z877 , EX13 , EX20	0.082	0.866

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
218	Z877 , EX02 , EX04	EX13 , EX20	0.082	0.866
219	Z877	EX13 , EX20	0.864	0.866
220	EX04	EX13 , EX20	0.244	0.862
221	EX04	Z877 , EX13 , EX20	0.244	0.862
222	Z877 , EX04	EX13 , EX20	0.244	0.862
223	EX13 , EX20 , EX02	EX03	0.453	0.818
224	EX13 , EX20 , EX02	Z877 , EX03	0.453	0.818
225	Z877 , EX13 , EX20 , EX02	EX03	0.453	0.818
226	EX02 , EX05	EX03	0.061	0.816
227	EX02 , EX05	Z877 , EX03	0.061	0.816
228	Z877 , EX02 , EX05	EX03	0.061	0.816
229	EX02 , EX05	EX13 , EX03	0.061	0.816
230	EX13 , EX02 , EX05	EX03	0.061	0.816
231	EX02 , EX05	Z877 , EX13 , EX03	0.061	0.816
232	Z877 , EX02 , EX05	EX13 , EX03	0.061	0.816
233	EX13 , EX02 , EX05	Z877 , EX03	0.061	0.816
234	Z877 , EX13 , EX02 , EX05	EX03	0.061	0.816
235	EX20 , EX02	EX03	0.456	0.809
236	EX20 , EX02	Z877 , EX03	0.456	0.809
237	Z877 , EX20 , EX02	EX03	0.456	0.809
238	EX20 , EX02	EX13 , EX03	0.453	0.804
239	EX20 , EX02	Z877 , EX13 , EX03	0.453	0.804

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
240	Z877 , EX20 , EX02	EX13 , EX03	0.453	0.804
241	EX13 , EX02	EX03	0.478	0.773
242	EX13 , EX02	Z877 , EX03	0.478	0.773
243	Z877 , EX13 , EX02	EX03	0.478	0.773
244	R730	EX20	0.075	0.77
245	R730	Z877 , EX20	0.075	0.77
246	Z877 , R730	EX20	0.075	0.77
247	R730	EX13 , EX20	0.075	0.77
248	EX13 , R730	EX20	0.075	0.77
249	R730	Z877 , EX13 , EX20	0.075	0.77
250	Z877 , R730	EX13 , EX20	0.075	0.77
251	EX13 , R730	Z877 , EX20	0.075	0.77
252	Z877 , EX13 , R730	EX20	0.075	0.77
253	EX02	EX03	0.48	0.765
254	EX02	Z877 , EX03	0.48	0.765
255	Z877 , EX02	EX03	0.48	0.765
256	EX02	EX13 , EX03	0.478	0.76
257	EX02	Z877 , EX13 , EX03	0.478	0.76
258	Z877 , EX02	EX13 , EX03	0.478	0.76
259	EX13 , EX20	EX03	0.641	0.741
260	EX13 , EX20	Z877 , EX03	0.641	0.741
261	Z877 , EX13 , EX20	EX03	0.641	0.741
262	EX20	EX03	0.649	0.737

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
263	EX20	Z877 , EX03	0.649	0.737
264	Z877 , EX20	EX03	0.649	0.737
265	EX13 , EX02	EX20 , EX03	0.453	0.733
266	EX13 , EX02	Z877 , EX20 , EX03	0.453	0.733
267	Z877 , EX13 , EX02	EX20 , EX03	0.453	0.733
268	EX20	EX13 , EX03	0.641	0.727
269	EX20	Z877 , EX13 , EX03	0.641	0.727
270	Z877 , EX20	EX13 , EX03	0.641	0.727
271	EX02	EX20 , EX03	0.456	0.726
272	EX02	Z877 , EX20 , EX03	0.456	0.726
273	Z877 , EX02	EX20 , EX03	0.456	0.726
274	EX02	EX13 , EX20 , EX03	0.453	0.722
275	EX02	Z877 , EX13 , EX20 , EX03	0.453	0.722
276	Z877 , EX02	EX13 , EX20 , EX03	0.453	0.722
277	EX20 , EX05	EX03	0.102	0.707
278	EX20 , EX05	Z877 , EX03	0.102	0.707
279	Z877 , EX20 , EX05	EX03	0.102	0.707
280	EX20 , EX05	EX13 , EX03	0.102	0.707
281	EX13 , EX20 , EX05	EX03	0.102	0.707
282	EX20 , EX05	Z877 , EX13 , EX03	0.102	0.707
283	Z877 , EX20 , EX05	EX13 , EX03	0.102	0.707
284	EX13 , EX20 , EX05	Z877 , EX03	0.102	0.707

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
285	Z877 , EX13 , EX20 , EX05	EX03	0.102	0.707
286	EX13 , EX20 , EX03	EX02	0.453	0.707
287	EX13 , EX20 , EX03	Z877 , EX02	0.453	0.707
288	Z877 , EX13 , EX20 , EX03	EX02	0.453	0.707
289	EX20 , EX03	EX02	0.456	0.702
290	EX20 , EX03	Z877 , EX02	0.456	0.702
291	Z877 , EX20 , EX03	EX02	0.456	0.702
292	EX13	EX03	0.686	0.699
293	EX13	Z877 , EX03	0.686	0.699
294	Z877 , EX13	EX03	0.686	0.699
295	EX20 , EX03	EX13 , EX02	0.453	0.698
296	EX20 , EX03	Z877 , EX13 , EX02	0.453	0.698
297	Z877 , EX20 , EX03	EX13 , EX02	0.453	0.698
298	EX13 , EX03	EX02	0.478	0.697
299	EX13 , EX03	Z877 , EX02	0.478	0.697
300	Z877 , EX13 , EX03	EX02	0.478	0.697
301	Z877	EX03	0.694	0.696
302	EX03	EX02	0.48	0.692
303	EX03	Z877 , EX02	0.48	0.692
304	Z877 , EX03	EX02	0.48	0.692
305	EX03	EX13 , EX02	0.478	0.688
306	EX03	Z877 , EX13 , EX02	0.478	0.688

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
307	Z877 , EX03	EX13 , EX02	0.478	0.688
308	Z877	EX13 , EX03	0.686	0.687
309	EX13 , EX03	EX20 , EX02	0.453	0.661
310	EX13 , EX03	Z877 , EX20 , EX02	0.453	0.661
311	Z877 , EX13 , EX03	EX20 , EX02	0.453	0.661
312	EX03	EX20 , EX02	0.456	0.657
313	EX03	Z877 , EX20 , EX02	0.456	0.657
314	Z877 , EX03	EX20 , EX02	0.456	0.657
315	EX13	EX20 , EX03	0.641	0.653
316	EX13	Z877 , EX20 , EX03	0.641	0.653
317	Z877 , EX13	EX20 , EX03	0.641	0.653
318	EX03	EX13 , EX20 , EX02	0.453	0.653
319	EX03	Z877 , EX13 , EX20 , EX02	0.453	0.653
320	Z877 , EX03	EX13 , EX20 , EX02	0.453	0.653
321	Z877	EX20 , EX03	0.649	0.651
322	EX05	EX03	0.106	0.649
323	EX05	Z877 , EX03	0.106	0.649
324	Z877 , EX05	EX03	0.106	0.649
325	EX05	EX13 , EX03	0.106	0.649
326	EX13 , EX05	EX03	0.106	0.649
327	EX05	Z877 , EX13 , EX03	0.106	0.649
328	Z877 , EX05	EX13 , EX03	0.106	0.649

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
329	EX13 , EX05	Z877 , EX03	0.106	0.649
330	Z877 , EX13 , EX05	EX03	0.106	0.649
331	Z877	EX13 , EX20 , EX03	0.641	0.642
332	EX13 , EX20	EX02	0.554	0.641
333	EX13 , EX20	Z877 , EX02	0.554	0.641
334	Z877 , EX13 , EX20	EX02	0.554	0.641
335	EX20	EX02	0.563	0.64
336	EX20	Z877 , EX02	0.563	0.64
337	Z877 , EX20	EX02	0.563	0.64
338	EX13	EX02	0.618	0.63
339	EX13	Z877 , EX02	0.618	0.63
340	Z877 , EX13	EX02	0.618	0.63
341	Z877	EX02	0.628	0.629
342	EX20	EX13 , EX02	0.554	0.629
343	EX20	Z877 , EX13 , EX02	0.554	0.629
344	Z877 , EX20	EX13 , EX02	0.554	0.629
345	Z877	EX13 , EX02	0.618	0.619
346	EX05	EX20 , EX03	0.102	0.619
347	EX05	Z877 , EX20 , EX03	0.102	0.619
348	Z877 , EX05	EX20 , EX03	0.102	0.619
349	EX05	EX13 , EX20 , EX03	0.102	0.619
350	EX13 , EX05	EX20 , EX03	0.102	0.619
351	EX05	Z877 , EX13 , EX20 , EX03	0.102	0.619

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
352	Z877 , EX05	EX13 , EX20 , EX03	0.102	0.619
353	EX13 , EX05	Z877 , EX20 , EX03	0.102	0.619
354	Z877 , EX13 , EX05	EX20 , EX03	0.102	0.619
355	EX13 , EX20 , EX04	EX03	0.144	0.588
356	EX13 , EX20 , EX04	Z877 , EX03	0.144	0.588
357	Z877 , EX13 , EX20 , EX04	EX03	0.144	0.588
358	EX20 , EX04	EX03	0.148	0.585
359	EX20 , EX04	Z877 , EX03	0.148	0.585
360	Z877 , EX20 , EX04	EX03	0.148	0.585
361	EX03 , EX05	EX02	0.061	0.569
362	EX03 , EX05	Z877 , EX02	0.061	0.569
363	Z877 , EX03 , EX05	EX02	0.061	0.569
364	EX03 , EX05	EX13 , EX02	0.061	0.569
365	EX13 , EX03 , EX05	EX02	0.061	0.569
366	EX03 , EX05	Z877 , EX13 , EX02	0.061	0.569
367	Z877 , EX03 , EX05	EX13 , EX02	0.061	0.569
368	EX13 , EX03 , EX05	Z877 , EX02	0.061	0.569
369	Z877 , EX13 , EX03 , EX05	EX02	0.061	0.569
370	EX20 , EX04	EX13 , EX03	0.144	0.565
371	EX20 , EX04	Z877 , EX13 , EX03	0.144	0.565
372	Z877 , EX20 , EX04	EX13 , EX03	0.144	0.565
373	Z877	EX20 , EX02	0.563	0.565

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
374	EX13	EX20 , EX02	0.554	0.564
375	EX13	Z877 , EX20 , EX02	0.554	0.564
376	Z877 , EX13	EX20 , EX02	0.554	0.564
377	Z877	EX13 , EX20 , EX02	0.554	0.555
378	EX13 , EX04	EX03	0.151	0.554
379	EX13 , EX04	Z877 , EX03	0.151	0.554
380	Z877 , EX13 , EX04	EX03	0.151	0.554
381	EX04	EX03	0.156	0.552
382	EX04	Z877 , EX03	0.156	0.552
383	Z877 , EX04	EX03	0.156	0.552
384	EX04	EX13 , EX03	0.151	0.534
385	EX04	Z877 , EX13 , EX03	0.151	0.534
386	Z877 , EX04	EX13 , EX03	0.151	0.534
387	EX13 , EX04	EX20 , EX03	0.144	0.525
388	EX13 , EX04	Z877 , EX20 , EX03	0.144	0.525
389	Z877 , EX13 , EX04	EX20 , EX03	0.144	0.525
390	EX13 , EX20	EX03 , EX02	0.453	0.524
391	EX13 , EX20	Z877 , EX03 , EX02	0.453	0.524
392	Z877 , EX13 , EX20	EX03 , EX02	0.453	0.524
393	EX04	EX20 , EX03	0.148	0.524
394	EX04	Z877 , EX20 , EX03	0.148	0.524
395	Z877 , EX04	EX20 , EX03	0.148	0.524
396	EX20	EX03 , EX02	0.456	0.518
397	EX20	Z877 , EX03 , EX02	0.456	0.518

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
398	Z877 , EX20	EX03 , EX02	0.456	0.518
399	EX20	EX13 , EX03 , EX02	0.453	0.514
400	EX20	Z877 , EX13 , EX03 , EX02	0.453	0.514
401	Z877 , EX20	EX13 , EX03 , EX02	0.453	0.514
402	EX04	EX13 , EX20 , EX03	0.144	0.507
403	EX04	Z877 , EX13 , EX20 , EX03	0.144	0.507
404	Z877 , EX04	EX13 , EX20 , EX03	0.144	0.507
405	EX20 , EX05	EX02	0.07	0.49
406	EX20 , EX05	Z877 , EX02	0.07	0.49
407	Z877 , EX20 , EX05	EX02	0.07	0.49
408	EX20 , EX05	EX13 , EX02	0.07	0.49
409	EX13 , EX20 , EX05	EX02	0.07	0.49
410	EX20 , EX05	Z877 , EX13 , EX02	0.07	0.49
411	Z877 , EX20 , EX05	EX13 , EX02	0.07	0.49
412	EX13 , EX20 , EX05	Z877 , EX02	0.07	0.49
413	Z877 , EX13 , EX20 , EX05	EX02	0.07	0.49
414	EX13	EX03 , EX02	0.478	0.487
415	EX13	Z877 , EX03 , EX02	0.478	0.487
416	Z877 , EX13	EX03 , EX02	0.478	0.487
417	Z877	EX03 , EX02	0.48	0.481
418	Z877	EX13 , EX03 , EX02	0.478	0.478

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
419	EX13	EX20 , EX03 , EX02	0.453	0.462
420	EX13	Z877 , EX20 , EX03 , EX02	0.453	0.462
421	Z877 , EX13	EX20 , EX03 , EX02	0.453	0.462
422	Z877	EX20 , EX03 , EX02	0.456	0.457
423	Z877	EX13 , EX20 , EX03 , EX02	0.453	0.454
424	EX05	EX02	0.074	0.452
425	EX05	Z877 , EX02	0.074	0.452
426	Z877 , EX05	EX02	0.074	0.452
427	EX05	EX13 , EX02	0.074	0.452
428	EX13 , EX05	EX02	0.074	0.452
429	EX05	Z877 , EX13 , EX02	0.074	0.452
430	Z877 , EX05	EX13 , EX02	0.074	0.452
431	EX13 , EX05	Z877 , EX02	0.074	0.452
432	Z877 , EX13 , EX05	EX02	0.074	0.452
433	EX05	EX20 , EX02	0.07	0.429
434	EX05	Z877 , EX20 , EX02	0.07	0.429
435	Z877 , EX05	EX20 , EX02	0.07	0.429
436	EX05	EX13 , EX20 , EX02	0.07	0.429
437	EX13 , EX05	EX20 , EX02	0.07	0.429
438	EX05	Z877 , EX13 , EX20 , EX02	0.07	0.429
439	Z877 , EX05	EX13 , EX20 , EX02	0.07	0.429
440	EX13 , EX05	Z877 , EX20 , EX02	0.07	0.429

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
441	Z877 , EX13 , EX05	EX20 , EX02	0.07	0.429
442	EX20 , EX05	EX04	0.06	0.415
443	EX20 , EX05	Z877 , EX04	0.06	0.415
444	Z877 , EX20 , EX05	EX04	0.06	0.415
445	EX20 , EX05	EX13 , EX04	0.06	0.415
446	EX13 , EX20 , EX05	EX04	0.06	0.415
447	EX20 , EX05	Z877 , EX13 , EX04	0.06	0.415
448	Z877 , EX20 , EX05	EX13 , EX04	0.06	0.415
449	EX13 , EX20 , EX05	Z877 , EX04	0.06	0.415
450	Z877 , EX13 , EX20 , EX05	EX04	0.06	0.415
451	EX05	EX04	0.064	0.393
452	EX05	Z877 , EX04	0.064	0.393
453	Z877 , EX05	EX04	0.064	0.393
454	EX05	EX13 , EX04	0.064	0.393
455	EX13 , EX05	EX04	0.064	0.393
456	EX05	Z877 , EX13 , EX04	0.064	0.393
457	Z877 , EX05	EX13 , EX04	0.064	0.393
458	EX13 , EX05	Z877 , EX04	0.064	0.393
459	Z877 , EX13 , EX05	EX04	0.064	0.393
460	EX05	EX03 , EX02	0.061	0.369
461	EX05	Z877 , EX03 , EX02	0.061	0.369
462	Z877 , EX05	EX03 , EX02	0.061	0.369

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
463	EX05	EX13 , EX03 , EX02	0.061	0.369
464	EX13 , EX05	EX03 , EX02	0.061	0.369
465	EX05	Z877 , EX13 , EX03 , EX02	0.061	0.369
466	Z877 , EX05	EX13 , EX03 , EX02	0.061	0.369
467	EX13 , EX05	Z877 , EX03 , EX02	0.061	0.369
468	Z877 , EX13 , EX05	EX03 , EX02	0.061	0.369
469	EX05	EX20 , EX04	0.06	0.363
470	EX05	Z877 , EX20 , EX04	0.06	0.363
471	Z877 , EX05	EX20 , EX04	0.06	0.363
472	EX05	EX13 , EX20 , EX04	0.06	0.363
473	EX13 , EX05	EX20 , EX04	0.06	0.363
474	EX05	Z877 , EX13 , EX20 , EX04	0.06	0.363
475	Z877 , EX05	EX13 , EX20 , EX04	0.06	0.363
476	EX13 , EX05	Z877 , EX20 , EX04	0.06	0.363
477	Z877 , EX13 , EX05	EX20 , EX04	0.06	0.363
478	EX20 , EX04	EX02	0.087	0.342
479	EX20 , EX04	Z877 , EX02	0.087	0.342
480	Z877 , EX20 , EX04	EX02	0.087	0.342
481	EX13 , EX20 , EX04	EX02	0.082	0.336
482	EX13 , EX20 , EX04	Z877 , EX02	0.082	0.336
483	Z877 , EX13 , EX20 , EX04	EX02	0.082	0.336
484	EX04	EX02	0.095	0.334

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
485	EX04	Z877 , EX02	0.095	0.334
486	Z877 , EX04	EX02	0.095	0.334
487	EX13 , EX04	EX02	0.09	0.329
488	EX13 , EX04	Z877 , EX02	0.09	0.329
489	Z877 , EX13 , EX04	EX02	0.09	0.329
490	EX20 , EX04	EX13 , EX02	0.082	0.323
491	EX20 , EX04	Z877 , EX13 , EX02	0.082	0.323
492	Z877 , EX20 , EX04	EX13 , EX02	0.082	0.323
493	EX04	EX13 , EX02	0.09	0.317
494	EX04	Z877 , EX13 , EX02	0.09	0.317
495	Z877 , EX04	EX13 , EX02	0.09	0.317
496	EX04	EX20 , EX02	0.087	0.307
497	EX04	Z877 , EX20 , EX02	0.087	0.307
498	Z877 , EX04	EX20 , EX02	0.087	0.307
499	EX13 , EX04	EX20 , EX02	0.082	0.3
500	EX13 , EX04	Z877 , EX20 , EX02	0.082	0.3
501	Z877 , EX13 , EX04	EX20 , EX02	0.082	0.3
502	EX04	EX13 , EX20 , EX02	0.082	0.29
503	EX04	Z877 , EX13 , EX20 , EX02	0.082	0.29
504	Z877 , EX04	EX13 , EX20 , EX02	0.082	0.29
505	EX20	EX04	0.254	0.288
506	EX20	Z877 , EX04	0.254	0.288

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
507	Z877 , EX20	EX04	0.254	0.288
508	Z877	EX04	0.283	0.284
509	EX13 , EX20	EX04	0.244	0.282
510	EX13 , EX20	Z877 , EX04	0.244	0.282
511	Z877 , EX13 , EX20	EX04	0.244	0.282
512	EX13	EX04	0.273	0.279
513	EX13	Z877 , EX04	0.273	0.279
514	Z877 , EX13	EX04	0.273	0.279
515	EX20	EX13 , EX04	0.244	0.277
516	EX20	Z877 , EX13 , EX04	0.244	0.277
517	Z877 , EX20	EX13 , EX04	0.244	0.277
518	Z877	EX13 , EX04	0.273	0.274
519	Z877	EX20 , EX04	0.254	0.254
520	EX13	EX20 , EX04	0.244	0.249
521	EX13	Z877 , EX20 , EX04	0.244	0.249
522	Z877 , EX13	EX20 , EX04	0.244	0.249
523	Z877	EX13 , EX20 , EX04	0.244	0.245
524	EX13 , EX20 , EX04	EX05	0.06	0.244
525	EX13 , EX20 , EX04	Z877 , EX05	0.06	0.244
526	Z877 , EX13 , EX20 , EX04	EX05	0.06	0.244
527	EX13 , EX04	EX05	0.064	0.236
528	EX13 , EX04	Z877 , EX05	0.064	0.236

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
529	Z877 , EX13 , EX04	EX05	0.064	0.236
530	EX20 , EX04	EX05	0.06	0.235
531	EX20 , EX04	Z877 , EX05	0.06	0.235
532	Z877 , EX20 , EX04	EX05	0.06	0.235
533	EX20 , EX04	EX13 , EX05	0.06	0.235
534	EX20 , EX04	Z877 , EX13 , EX05	0.06	0.235
535	Z877 , EX20 , EX04	EX13 , EX05	0.06	0.235
536	EX20 , EX03	EX04	0.148	0.229
537	EX20 , EX03	Z877 , EX04	0.148	0.229
538	Z877 , EX20 , EX03	EX04	0.148	0.229
539	EX04	EX05	0.064	0.228
540	EX04	Z877 , EX05	0.064	0.228
541	Z877 , EX04	EX05	0.064	0.228
542	EX04	EX13 , EX05	0.064	0.228
543	EX04	Z877 , EX13 , EX05	0.064	0.228
544	Z877 , EX04	EX13 , EX05	0.064	0.228
545	EX03	EX04	0.156	0.225
546	EX03	Z877 , EX04	0.156	0.225
547	Z877 , EX03	EX04	0.156	0.225
548	EX13 , EX20 , EX03	EX04	0.144	0.224
549	EX13 , EX20 , EX03	Z877 , EX04	0.144	0.224
550	Z877 , EX13 , EX20 , EX03	EX04	0.144	0.224
551	EX20 , EX03	EX13 , EX04	0.144	0.221

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
552	EX20 , EX03	Z877 , EX13 , EX04	0.144	0.221
553	Z877 , EX20 , EX03	EX13 , EX04	0.144	0.221
554	EX13 , EX03	EX04	0.151	0.221
555	EX13 , EX03	Z877 , EX04	0.151	0.221
556	Z877 , EX13 , EX03	EX04	0.151	0.221
557	EX03	EX13 , EX04	0.151	0.218
558	EX03	Z877 , EX13 , EX04	0.151	0.218
559	Z877 , EX03	EX13 , EX04	0.151	0.218
560	EX13 , EX04	EX20 , EX05	0.06	0.218
561	EX13 , EX04	Z877 , EX20 , EX05	0.06	0.218
562	Z877 , EX13 , EX04	EX20 , EX05	0.06	0.218
563	EX03	EX20 , EX04	0.148	0.214
564	EX03	Z877 , EX20 , EX04	0.148	0.214
565	Z877 , EX03	EX20 , EX04	0.148	0.214
566	EX04	EX20 , EX05	0.06	0.21
567	EX04	Z877 , EX20 , EX05	0.06	0.21
568	Z877 , EX04	EX20 , EX05	0.06	0.21
569	EX04	EX13 , EX20 , EX05	0.06	0.21
570	EX04	Z877 , EX13 , EX20 , EX05	0.06	0.21
571	Z877 , EX04	EX13 , EX20 , EX05	0.06	0.21
572	EX13 , EX03	EX20 , EX04	0.144	0.209
573	EX13 , EX03	Z877 , EX20 , EX04	0.144	0.209

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
574	Z877 , EX13 , EX03	EX20 , EX04	0.144	0.209
575	EX03	EX13 , EX20 , EX04	0.144	0.207
576	EX03	Z877 , EX13 , EX20 , EX04	0.144	0.207
577	Z877 , EX03	EX13 , EX20 , EX04	0.144	0.207
578	EX20	EX03 , EX04	0.148	0.169
579	EX20	Z877 , EX03 , EX04	0.148	0.169
580	Z877 , EX20	EX03 , EX04	0.148	0.169
581	EX13	EX05	0.164	0.167
582	EX13	Z877 , EX05	0.164	0.167
583	Z877 , EX13	EX05	0.164	0.167
584	EX13 , EX20	EX05	0.144	0.166
585	EX13 , EX20	Z877 , EX05	0.144	0.166
586	Z877 , EX13 , EX20	EX05	0.144	0.166
587	EX13 , EX20	EX03 , EX04	0.144	0.166
588	EX13 , EX20	Z877 , EX03 , EX04	0.144	0.166
589	Z877 , EX13 , EX20	EX03 , EX04	0.144	0.166
590	Z877	EX05	0.164	0.164
591	Z877	EX13 , EX05	0.164	0.164
592	EX20	EX05	0.144	0.163
593	EX20	Z877 , EX05	0.144	0.163
594	Z877 , EX20	EX05	0.144	0.163
595	EX20	EX13 , EX05	0.144	0.163

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
596	EX20	Z877 , EX13 , EX05	0.144	0.163
597	Z877 , EX20	EX13 , EX05	0.144	0.163
598	EX20	EX13 , EX03 , EX04	0.144	0.163
599	EX20	Z877 , EX13 , EX03 , EX04	0.144	0.163
600	Z877 , EX20	EX13 , EX03 , EX04	0.144	0.163
601	EX13 , EX20 , EX03	EX05	0.102	0.159
602	EX13 , EX20 , EX03	Z877 , EX05	0.102	0.159
603	Z877 , EX13 , EX20 , EX03	EX05	0.102	0.159
604	Z877	EX03 , EX04	0.156	0.157
605	EX20 , EX03	EX05	0.102	0.156
606	EX20 , EX03	Z877 , EX05	0.102	0.156
607	Z877 , EX20 , EX03	EX05	0.102	0.156
608	EX20 , EX03	EX13 , EX05	0.102	0.156
609	EX20 , EX03	Z877 , EX13 , EX05	0.102	0.156
610	Z877 , EX20 , EX03	EX13 , EX05	0.102	0.156
611	EX13 , EX03	EX05	0.106	0.155
612	EX13 , EX03	Z877 , EX05	0.106	0.155
613	Z877 , EX13 , EX03	EX05	0.106	0.155
614	EX20 , EX02	EX04	0.087	0.154
615	EX20 , EX02	Z877 , EX04	0.087	0.154
616	Z877 , EX20 , EX02	EX04	0.087	0.154
617	EX13	EX03 , EX04	0.151	0.154

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
618	EX13	Z877 , EX03 , EX04	0.151	0.154
619	Z877 , EX13	EX03 , EX04	0.151	0.154
620	EX03	EX05	0.106	0.153
621	EX03	Z877 , EX05	0.106	0.153
622	Z877 , EX03	EX05	0.106	0.153
623	EX03	EX13 , EX05	0.106	0.153
624	EX03	Z877 , EX13 , EX05	0.106	0.153
625	Z877 , EX03	EX13 , EX05	0.106	0.153
626	Z877	EX13 , EX03 , EX04	0.151	0.152
627	EX02	EX04	0.095	0.151
628	EX02	Z877 , EX04	0.095	0.151
629	Z877 , EX02	EX04	0.095	0.151
630	Z877	EX20 , EX03 , EX04	0.148	0.149
631	EX13 , EX03	EX20 , EX05	0.102	0.148
632	EX13 , EX20 , EX02	EX04	0.082	0.148
633	EX13 , EX03	Z877 , EX20 , EX05	0.102	0.148
634	Z877 , EX13 , EX03	EX20 , EX05	0.102	0.148
635	EX13 , EX20 , EX02	Z877 , EX04	0.082	0.148
636	Z877 , EX13 , EX20 , EX02	EX04	0.082	0.148
637	EX03	EX20 , EX05	0.102	0.146
638	EX03	Z877 , EX20 , EX05	0.102	0.146
639	Z877 , EX03	EX20 , EX05	0.102	0.146

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	Conclusion		
640	EX03	EX13 , EX20 , EX05	0.102	0.146
641	EX03	Z877 , EX13 , EX20 , EX05	0.102	0.146
642	Z877 , EX03	EX13 , EX20 , EX05	0.102	0.146
643	EX13	EX20 , EX05	0.144	0.146
644	EX13	Z877 , EX20 , EX05	0.144	0.146
645	Z877 , EX13	EX20 , EX05	0.144	0.146
646	EX13	EX20 , EX03 , EX04	0.144	0.146
647	EX13	Z877 , EX20 , EX03 , EX04	0.144	0.146
648	Z877 , EX13	EX20 , EX03 , EX04	0.144	0.146
649	EX20 , EX02	EX13 , EX04	0.082	0.146
650	EX20 , EX02	Z877 , EX13 , EX04	0.082	0.146
651	Z877 , EX20 , EX02	EX13 , EX04	0.082	0.146
652	EX13 , EX02	EX04	0.09	0.145
653	EX13 , EX02	Z877 , EX04	0.09	0.145
654	Z877 , EX13 , EX02	EX04	0.09	0.145
655	Z877	EX20 , EX05	0.144	0.144
656	Z877	EX13 , EX20 , EX05	0.144	0.144
657	Z877	EX13 , EX20 , EX03 , EX04	0.144	0.144
658	EX02	EX13 , EX04	0.09	0.143
659	EX02	Z877 , EX13 , EX04	0.09	0.143
660	Z877 , EX02	EX13 , EX04	0.09	0.143

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
661	EX02	EX20 , EX04	0.087	0.138
662	EX02	Z877 , EX20 , EX04	0.087	0.138
663	Z877 , EX02	EX20 , EX04	0.087	0.138
664	EX13 , EX02	EX20 , EX04	0.082	0.133
665	EX13 , EX02	Z877 , EX20 , EX04	0.082	0.133
666	Z877 , EX13 , EX02	EX20 , EX04	0.082	0.133
667	EX02	EX13 , EX20 , EX04	0.082	0.131
668	EX02	Z877 , EX13 , EX20 , EX04	0.082	0.131
669	Z877 , EX02	EX13 , EX20 , EX04	0.082	0.131
670	EX13 , EX20 , EX02	EX05	0.07	0.127
671	EX13 , EX20 , EX02	Z877 , EX05	0.07	0.127
672	Z877 , EX13 , EX20 , EX02	EX05	0.07	0.127
673	EX13 , EX03 , EX02	EX05	0.061	0.127
674	EX13 , EX03 , EX02	Z877 , EX05	0.061	0.127
675	Z877 , EX13 , EX03 , EX02	EX05	0.061	0.127
676	EX03 , EX02	EX05	0.061	0.126
677	EX03 , EX02	Z877 , EX05	0.061	0.126
678	Z877 , EX03 , EX02	EX05	0.061	0.126
679	EX03 , EX02	EX13 , EX05	0.061	0.126
680	EX03 , EX02	Z877 , EX13 , EX05	0.061	0.126
681	Z877 , EX03 , EX02	EX13 , EX05	0.061	0.126

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
682	EX20 , EX02	EX05	0.07	0.125
683	EX20 , EX02	Z877 , EX05	0.07	0.125
684	Z877 , EX20 , EX02	EX05	0.07	0.125
685	EX20 , EX02	EX13 , EX05	0.07	0.125
686	EX20 , EX02	Z877 , EX13 , EX05	0.07	0.125
687	Z877 , EX20 , EX02	EX13 , EX05	0.07	0.125
688	EX13 , EX02	EX05	0.074	0.12
689	EX13 , EX02	Z877 , EX05	0.074	0.12
690	Z877 , EX13 , EX02	EX05	0.074	0.12
691	EX02	EX05	0.074	0.118
692	EX02	Z877 , EX05	0.074	0.118
693	Z877 , EX02	EX05	0.074	0.118
694	EX02	EX13 , EX05	0.074	0.118
695	EX02	Z877 , EX13 , EX05	0.074	0.118
696	Z877 , EX02	EX13 , EX05	0.074	0.118
697	EX13 , EX20	EX03 , EX05	0.102	0.118
698	EX13 , EX20	Z877 , EX03 , EX05	0.102	0.118
699	Z877 , EX13 , EX20	EX03 , EX05	0.102	0.118
700	EX20	EX03 , EX05	0.102	0.115
701	EX20	Z877 , EX03 , EX05	0.102	0.115
702	Z877 , EX20	EX03 , EX05	0.102	0.115
703	EX20	EX13 , EX03 , EX05	0.102	0.115
704	EX20	Z877 , EX13 , EX03 , EX05	0.102	0.115

Table B Association rules results of FP-Growth (cont.).

No.	Association Rules		Support	Confidence
	Premises	**Conclusion**		
705	Z877 , EX20	EX13 , EX03 , EX05	0.102	0.115
706	EX13 , EX02	EX20 , EX05	0.07	0.114
707	EX13 , EX02	Z877 , EX20 , EX05	0.07	0.114
708	Z877 , EX13 , EX02	EX20 , EX05	0.07	0.114
709	EX02	EX20 , EX05	0.07	0.112
710	EX02	Z877 , EX20 , EX05	0.07	0.112
711	Z877 , EX02	EX20 , EX05	0.07	0.112
712	EX02	EX13 , EX20 , EX05	0.07	0.112
713	EX02	Z877 , EX13 , EX20 , EX05	0.07	0.112
714	Z877 , EX02	EX13 , EX20 , EX05	0.07	0.112
715	EX13	EX03 , EX05	0.106	0.108
716	EX13	Z877 , EX03 , EX05	0.106	0.108
717	Z877 , EX13	EX03 , EX05	0.106	0.108
718	Z877	EX03 , EX05	0.106	0.107
719	Z877	EX13 , EX03 , EX05	0.106	0.107
720	EX13	EX20 , EX03 , EX05	0.102	0.103
721	EX13	Z877 , EX20 , EX03 , EX05	0.102	0.103
722	Z877 , EX13	EX20 , EX03 , EX05	0.102	0.103
723	Z877	EX20 , EX03 , EX05	0.102	0.102
724	Z877	EX13 , EX20 , EX03 , EX05	0.102	0.102

APPENDIX C

TECHNICAL PAPER OF 2015 INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY

Discovering Association between Metabolic Syndrome and Its Related Chronic Diseases Represented by ICD-10 Code

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Abstract

This paper applies the association rules method to discover the relationship between metabolic syndrome and its chronic diseases. The sample data used in this research is medical records specified to metabolic syndrome patients in a large government hospital. The Apriori and FP-Growth algorithms are chosen to be compared in the performance and applicable results of extracting the relationship of the metabolic syndrome patient records represented by ICD-10 code. The results show that the Apriori can extract 6 rules and 724 rules from FP-Growth. The comparative results between Apriori and FP-Growth found that 6 rules are common. The overall results show that the metabolic syndrome patients mostly have strong relationships with hypertension, obesity and diabetes. Interestingly, these diseases often occur with the patients was diagnosed that was metabolic syndrome. Additionally, the results would bring to the suggestion in metabolic syndrome patients to know about the relationship of these chronic diseases. Moreover, the physicians could use this guide for the treatment strategy in the future.

Keywords: association rules, Apriori, FP-Growth, metabolic syndrome, chronic diseases, ICD-10.

1. Introduction

Metabolic syndrome [1] is obesity condition to especially the lumbar. It makes adversely affect various body systems the multiple system. This condition refers to a group disease caused by metabolic the disorders which affect pose the hyperlipidemia, hypertension, has insulin resistance and would cause heart disease and high artery.

The main cause of metabolic syndrome has two main respects: obesity and insulin resistance. The obesity is imbalance of food intake and energy consumption of the body which makes the fat accumulation in part the abdominal surface and the waistline. Additionally, the insulin resistance was caused by genetic causes and external causes such as the obesity, increasing age and uses the certain drugs.

The term "Chronic diseases" [2] means a disease that may without symptoms but the symptoms will gradually intensified as when it is not treated. It often needs to be treated continued and caused the symptoms acute redundancy is always such as diabetes, hypertension, heart disease, hypercholesterolemia and cancer.

In the currently there is a classification of various diseases and symptoms of diseases by using classification codes of various diseases such as myocardial disease, renal disease, aborticide and metabolic syndrome. This classification code is called the ICD-10 [3] which stands for International Classification of Diseases and Related Health Problem 10th Revision. It is the code of the disease and symptoms prepared by the World Health Organization (WHO). It has been developed for recording and gathering statistical data in health planning internationally such as E88.9 Metabolic disorder unspecified, E66.9 Obesity unspecified, E51.9 Heart disease unspecified, etc.

From problems and diseases that occurred with patients that are metabolic syndrome motivates authors to study metabolic syndrome by using data represented by the ICD-10 code for discover the relationship of metabolic syndrome with its chronic diseases caused followed from it by the association rules method is to find relationship of two data sets or more to set up within a larger data group. The expected results of this research is that the usage of the discovered relationship from data of metabolic syndrome patients to raise awareness in caring, medical protection, medical suggestion, attitudes, and also policy, according to metabolic syndrome.

2. Related theories

This section presents theory about diseases, data mining and its approaches.

2.1 Metabolic syndrome

Metabolic syndrome [4] is obesity condition to especially the lumbar. It makes adversely affect various body systems the multiple system. This condition refers to a group disease caused by metabolic the disorders which affect pose the hyperlipidemia, hypertension, has insulin resistance and would cause heart disease and high artery. Olden would call this disease groups that syndrome X, insulin resistance syndrome.

The main cause of metabolic syndrome has two main respects: obesity and insulin resistance. The obesity is imbalance of food intake and energy consumption of the body which makes the fat accumulation. Especially precinct part the abdominal surface and the waistline. Additionally, the insulin resistance was caused by genetic causes and external causes such as the obesity, increasing age and uses the certain drugs. Usually, the metabolic syndrome patients will have insulin resistance rather than obesity patient hip precinct and pose the Hypertension, sugar in the low blood and also cause heart disease and artery subsequent. Besides relaxation is not enough, sleep deprivation, stress and work has the style of part-time job affects being metabolic syndrome as well [5].

2.2 Chronic diseases

The term "Chronic diseases" means a disease that when the onset the symptoms may without symptoms but the symptoms will be gradually intensified as when it is not treated. It often needs to be treated continued may lifelong and often is not completely cured and caused the symptoms acute redundancy is always such as diabetes, hypertension, heart disease, hypercholesterolemia and cancer. Causes the chronic diseases be several cause are that is [6] disorders of the immune system such as Allergies, Systemic Lupus Erythematosus, etc., disorders of genetic such as psoriasis and diabetes type 1, caused by use everyday life invalid prolonged until led to mechanism the health disorders and caused by the deterioration of mechanisms field the various health as age increases.

2.3 International classification of diseases and related health problem 10th revision (ICD-10)

International Classification of Diseases and Related Health Problem 10th Revision or ICD-10 [7] is the code of the disease and symptoms. It has been developed for recording and gathering statistical data in health planning internationally.

ICD started use in 1893. For use in specified code the death was an international code and in 1948 the WHO has come responsible in improvement the ICD to be the 6th Edition. WHO has developed ICD-10 codes continuously and added information to be modern. The latest revised edition is ICD 10: 2010 which is improved on the A.D. 2010 or B.E. 2553.

ICD-10 codes are alphanumeric codes. By each code to begin with the English characters A-Z then followed by Arabic numbers 0-9, two to four digits which provide diseases codes for the individual patients. In general, providing the ICD-10 codes will provide the code to disease that the patient is just one disease. Providers the code wants to name the disease a clear and has good looks.

2.4 Data mining

Data mining [8] liken evolution in the storage and interpreting the data easily one from the original there the data storage easily until enter store in the form of database that can be extract information come used until data mining that can discover knowledge hidden in the data. Generally, data mining consists of three tasks which are classification, clustering and association. In this paper, the method of association rules extraction is considered.

1. Association Rules

Association rules [8] is to find the relationship rules of data by finding relation of at least two data sets, setting up within data groups at large, and displaying the relationship of events or objects that occur simultaneously. An example of the applied uses the association rules such as if it is found that people who usually bought a video tape often bought adhesive tape together by consider products that buyers often bought simultaneously. Stores maybe set stores for both

products closer together to increase sales. There are several approaches in the finding of association rules as follows:

1) Apriori algorithm: This is the most basic which Apriori was use to find all frequent itemsets in the regulative database. The main concept of Apriori algorithm is to make multiple pass over the database. It justly dependent the Apriori characteristic which state that "All non-empty itemsets of a frequent itemset must be the frequent" [9]. Also explain the anti-monotonic characteristic which if the system could not pass the minimum support test, all its supersets will fail to passes the test.

2) FP-Growth algorithm: FP-Growth [9] is other efficiently frequent pattern mining method. It creates frequent itemsets without candidacy generation which use tree based structure. The problem of Apriori algorithm is manage by introduction a novel, compact data structure, called frequent pattern tree or FP-tree then dependent this structure an FP-tree-based pattern segment growth method has been the develops. Which construct conditional frequent pattern tree and conditional pattern base from database which satisfaction the minimum support and FP-growth traces the set of concomitant item.

3. Methodology

This paper uses the association rules techniques to find the relationship between metabolic syndrome and its chronic diseases. In the preparation of the data used in find association rules there are various process as shown in Figure 1.

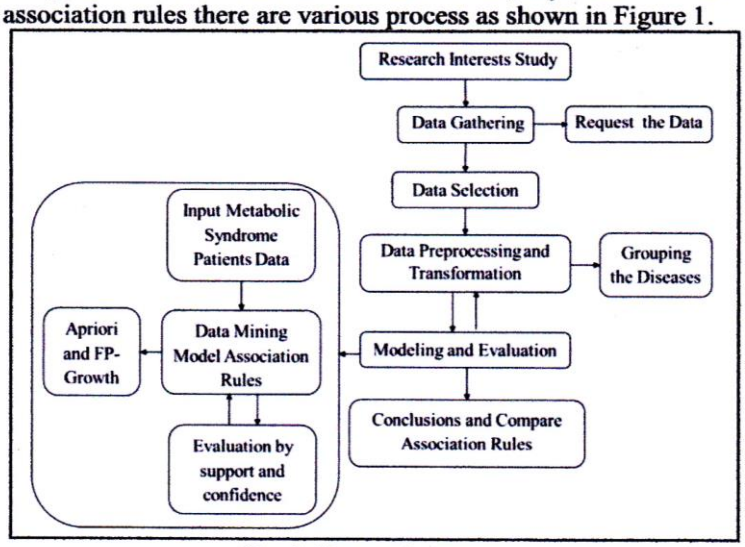

Fig. 1: Research process

3.1 Research interests study

Starts from searching research that is interested before that the authors has interested about research any aspect and then find research about field to the

authors interested. Then, the research summarizes those that to make study that those research is research about anything. Use any method technique in make above research and results that get from research is what.

3.2 Data gathering

This paper gathered data requested the data of metabolic syndrome patients from a government hospital in Thailand, in the period of the year 2009 - 2014. The data that used in this study is a secondary data which has been already collected. By the data structure has 13 attribute, 3677 instances.

3.3 Data selection

This step will select data used in research by bringing information obtained from collected data of patient which has been requested data of the patients was diagnosed that was metabolic syndrome from a government hospital. Consequently, authors will select data that preferred to use in find the relationship between metabolic syndrome and its related chronic diseases consists of two attribute that is enc_id and dx_code that would use in this paper.

3.4 Data preprocessing and transformation

After the selected data is ready, the data would be grouped by dx_code which is the attribute about diseases that patient came for treatment, by merging diseases that have character the related or similar symptoms into same group such as E119 (Non-insulin-dependent diabetes mellitus without complications) and E113 (Non-insulin-dependent diabetes mellitus with ophthalmic complication) are grouped as EX04 (diabetes), E669 (Obesity, unspecified) and E668 (Other obesity) are grouped as EX03 (Obesity), and so on. To reduce the amount of the attributes that would be fed into the modeling, the authors will determines code to each group and must be unique to the ICD-10 codes, which would has 85 attribute and then, brings the enc_id to transform from the numeric as nominal by transform them to ID01, ID02 to ID1024.

3.5 Modeling and evaluation

The preprocessed data is used for modeling by using association rules techniques, which are selected as the Apriori and FP-Growth method. The results from both methods will be shown and compared to find model that are reliability and acceptable the most. To measure the reliable and acceptable results, the association rules discovery methods usually use two common indicators which are support and confidence [8]:

- Support value is a value that represents the accuracy of the association rules that use or the probability of an event occurring simultaneously as shown in equation (1).:

$$\text{Support} = P(A \cap B) = \frac{\text{Tansaction number that A and B occurring simultaneously}}{\text{Tansaction number that all occurring}} \quad (1)$$

- Confidence value is value that says rules acquired has an actuality how much as shown in equation (2).:

$$\text{Confidence} = P(A \mid B) = \frac{P(A \cap B)}{P(A)} \quad (2)$$

$$= \frac{\text{Transaction number that A and B occurring simultaneously}}{\text{Tansaction number that has A occurring}}$$

3.6 Conclusions and comparing the extracted association rules

The association rules should be interpreted and analyzed its results and conclude research. For find the relationship between metabolic syndrome and chronic diseases caused by metabolic syndrome and compare association rules that same between Apriori and FP-Growth method. Thus, there presentation about suggestions, attitudes and preventing of metabolic syndrome for used in further treatment.

4. Experimental results

In this paper, chosen techniques are Apriori and FP-Growth method applied to the metabolic syndrome patient data represented by ICD-10 code. Modeling association rules for find relationship between metabolic syndrome and its related chronic diseases in metabolic syndrome patients which have 1,024 patients. In Modeling has define the minimum support to 0.1 and minimum confidence to 0.1.

4.1 Result of Apriori

Result of modeling the association rules between metabolic syndrome and its related chronic diseases by Apriori method has six rules, as shown in Table 1.

Table 1: Association rules result of Apriori

No.	Association Rules	Support (%)	Confidence (%)
1	EX04 ==> EX02	10	67
2	EX03 ==> EX02	10	52
3	EX02 ==> EX04	10	51

No.	Association Rules	Support (%)	Confidence (%)
4	EX04 ==> EX03	10	45
5	EX02 ==> EX03	10	43
6	EX03 ==> EX04	10	42

From the results shown in Table 1, it can be interpreted the discovered rules, for example:

- Rule 1: If patients were Metabolic syndrome (EX01) and Diabetes (EX04) they would were Hypertension (EX02).
- Rule 2: If patients were Metabolic syndrome (EX01) and Obesity (EX03) they would were Hypertension (EX02).

4.2 Result of FP-Growth

Results of modeling the association rules between metabolic syndrome and its related chronic diseases by FP-Growth method have 724 rules. Total 10 rules were discovered as shown in Table 2.

Table 2: Association rules result of FP-Growth

No.	Association Rules	Support (%)	Confidence (%)
1	EX13 ==> Z877	98.1	100
2	EX20 ==> Z877	88.1	100
3	EX03 ==> Z877	69.4	100
4	EX02 ==> Z877	62.8	100
5	EX04 ==> Z877	28.3	100
6	EX05 ==> Z877	16.4	100
7	R730 ==> Z877	9.8	100
8	EX07 ==> Z877	6.2	100
9	EX05 ==> EX13	16.4	100
10	R730 ==> EX13	9.8	100

From the results shown in Table 2, it can be interpreted the discovered rules, for examples:

- Rule 1: If patients were Metabolic syndrome (EX01) and Disease involving the urinary system (EX13) they would were Personal history of congenital malformations, deformations and chromosomal (Z877).
- Rule 2: If patients were Metabolic syndrome (EX01) and Diseases of the respiratory (EX20) they would were Personal history of congenital malformations, deformations and chromosomal (Z877).

4.3 Comparison of Apriori and FP-Growth method

According to the results of Apriori and FP-Growth, their comparative results showed that there are six common association rules are extracted by both methods, as shown in Table 3. There are also association rules not common to several the rules from the comparison of Apriori and FP-Growth which these rules are extracted by FP-Growth only.

Table 3: Show association rules between Apriori and FP-Growth method that same

No.	Association Rules	Apriori		FP-Growth	
		Support (%)	Confidence (%)	Support (%)	Confidence (%)
1	EX04 ==> EX02	10	67	9.5	33.4
2	EX03 ==> EX02	10	52	48	69.2
3	EX02 ==> EX04	10	51	9.5	15.1
4	EX04 ==> EX03	10	45	15.6	55.2
5	EX02 ==> EX03	10	43	48	76.5
6	EX03 ==> EX04	10	42	15.6	22.5

5. Conclusions

This paper is to apply the association rules, for discover the relationship between metabolic syndrome and its chronic diseases represented by ICD-10 which authors chosen using Apriori and FP-Growth method in extracting the relationship of the metabolic syndrome patient data. The results of Apriori have 6 rules and the results of FP-Growth have 724 rules. Which the result from comparison between Apriori and FP-Growth method found has 6 rules that same in finding this relationship. The results show that the metabolic syndrome patients mostly have relationship with Hypertension, Obesity and Diabetes. The metabolic syndrome patients often would were hypertension or obesity or diabetes along or were more than one disease, Moreover, these diseases often occur with metabolic syndrome patients. Additionally, the results would bring to the suggestion in metabolic syndrome patients to know about the relationship of these chronic diseases and physicians can guide for the treatment metabolic syndrome patients in the future.

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